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Faculty of Economics and Business Admintration

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ECONOMIC MANAGEMENT IN MINERAL ACTIVITIES - EMMA 5

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FOREWORD

On behalf of the Organizing Committee of the Fifth International Conference on Economic Management in Mineral Activities – EMMA 5, I would like to extend my warmest welcome to all participants. As traditional, the EMMA 5 Conference is organized again at the Hanoi University of Mining and Geology, Viet Nam, in collaboration with the University of Applied Sciences Georg Agricola Bochum, Germany. EMMA 5 continues to bring together scientists, researchers, experts, and students worldwide, who have been actively working on economic management in mineral activities and other relevant topics. This conference also marks the celebration of the 20th anniversary of the Faculty of Economics and Business Administration of Hanoi University of Mining and Geology.

EMMA 5 has received 52 papers from Canada, China, Germany, Japan, Iran, Myanmar, Thailand, the U.S, and Vietnam. After a tightly peer-review process, 48 articles are qualified for publication in the conference proceedings. These works are the outcome of the most recent knowledge and experience in various fields of economic management in mineral activities, from organizational structure management, financial management, human resource management, business strategy, environment and ecological protection, sustainable development, risk management, occupational safety and health management in the mining industry and other subjects. The Organizing Committee strongly believes that EMMA 5 will offer a unique opportunity to inspire attendees to meet, exchange their ideas, and reach concrete suggestions and recommendations to tackle challenges in all aspects of the mineral sector.

I want to take this opportunity to thank all members of the Organizing Committee and the Board of Reviewers for their devotion to make this conference successful. I would also like to express my gratitude to the participants for contributing their research results and their accomplishment. Special thanks are given to the Faculty of Economics and Business Administration of Hanoi University of Mining and Geology and the University of Applied Sciences Georg Agricola Bochum, and the sponsors, who have significantly contributed to the successful organization of this conference.

I wish EMMA 5 2020 a great success and all participants an enjoyable and fruitful scientific gathering in Hanoi.

On behalf of the EMMA 5 Organizing Committee

Prof. Tran Thanh Hai, PhD

FOREWORD

Mining is an industry that has developed from an artisanal, mostly small business (mining 1.0) to a digitalized high-tech industry (mining 4.0) during the last hundred years. This development is based mainly on technological innovations that we often call progress. Despite these innovations, some issues in mining we know for hundreds of years are still outstanding. I only would like to mention three Georg Agricola described in his book De Re Metallica in the year 1556:

1. "There has always been the greatest disagreement amongst men concerning metals and mining, some praising, others utterly condemning them." (Georg Agricola, 1556, p. 4)

2. "Mining is a perilous occupation (...) there is no compensation which should be thought great enough to equalize the extreme dangers to safety and life." (Ibid, p. 6)

3. "The strongest argument of the detractors is that the fields are devastated by mining operations." (Ibid, p. 8).

Today we name the issues Georg Agricola mentioned (1) (how to get the) social license to operate, (2) (how do we avoid) risks in Occupational Safety and Health (OSH), and (3) (how do we secure) ecological sustainability, especially in post-mining?

We have to solve these issues to shape the best possible future of mining. Very often, this is not a question of knowledge. It is a question of how to apply this knowledge in practice in the mining industry.

No doubt, extractive industries are in the focus of public interest. As mining operations always affect the natural environment, economy, and social structure of a region, it should become the leading objective to minimize the adverse environmental and social impacts in all operations stages. At the same time, the operations shall strive to maximize social and local benefits.

The mining industry has lost much of its attractiveness among the younger generation in many countries. Nonetheless, unilateral condemnation is insufficient. Many countries still have a primary emphasis on the mining and metals sectors. They secure employment that enables regional social upswing.

Sustainability in mining and its development is multifaceted and complex. It can be summarized into six practical recommendations: (1) improved planning; (2) enhanced environmental management; (3) cleaner technology implementation; (4) zero accidents as a vision; (5) increased stakeholder involvement and formation of partnerships, and (6) promoted training.

It is a common aim of HUMG and THGA to contribute actively to a sustainable future in mining, which has been the main reason why we have jointly developed the EMMA conferences. I am delighted that EMMA has grown up. Today it is a well-established academic event with contributions from many different countries. This has been possible due to the continuous engagement of our partner HUMG, and I am very thankful for this.

Because of the Corona pandemic, EMMA 5 has got an exceptional hybrid format. Maybe this is not ideal, especially for the social part of the conference. But the epidemic should not stop us from exchanging knowledge and experiences and deepen our cooperation and friendship.

Take care and Glückauf

Jürgen Kretschmann

SUSTAINABLE DEVELOPMENT IN THE MINING INDUSTRY

RESEARCH ON APPLICATION OF CIRCULAR ECONOMY FOR COAL INDUSTRY OF VIETNAM

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Abstract: *To meet the demand for coal of the economy, coal industry of Vietnam causes many kinds of waste in large amounts and negative impacts on the environment for its mining and processing. Therefore, it is necessary to find suitable solutions to solve the environmental pollution problems on the one hand and to create economic benefits from waste on the other hand. It is also critical to learn about the circular economy because this model supports the sustainable development of the economy coping with the exhaustion of resources and solving environmental pollution from waste. This paper reviews the circular economy in general and the application of this model for the coal mining and processing through options of recycling and reuse the waste of coal mining and processing. Besides, the paper also proposes some solutions to implement a circular economy of the coal industry in Vietnam.*

Keywords: *Circular economy, coal industry, Vinacomin*

1. INTRODUCTION

The coal mining of Vietnam is mainly located in Quang Ninh Province, distributed in districts from Dong Trieu, Uong Bi, Hon Gai to Cam Pha. The coal production process has caused changes in topography; mining pits create an adverse terrain while the disposal sites create artificial hills with a height of up to 300m of the slope, such as Dong Cao Son disposal site in 2019. The soil in the mining area has lost the rich layers and is prone to erosion. Coal production not only causes pollution of the rivers, streams, and lakes system but also causes degradation, exhaustion, and pollution of underground water sources.

Besides, the air environment in the coal mining area is heavily polluted by dust, toxic gas, explosive gas, and noise, especially in Uong Bi and Cam Pha. Also, most of coal mines in Vietnam have been in operation for decades, thus, the exploitation goes deeper into the ground. In contrast, the mining technology has not been synchronized and modernized completely. This fact leads to a considerable loss of coal resources and the fuel needed during the mining process.

According to the Coal Industry Development Plan to 2030 approved in Decision 403/2016/QĐ-TTg, the amount of wasted rock and soil from surface mining (excluding local coal mines and peat mines) will be discharged to the environment from 2021 is 2,675,536 thousand m^3 and be divided by regions as in the following table:

Table 1: Amount of rock and soil waste according to Decision 403

Unit: $1000m^3$

Area	Total	Amount of rock and soil waste 2021 to 2025	2026 to 2030	After 2030
Total	**2,675,536**	**1,069,856**	**562,890**	**1,042,790**
Uong Bi	168,045	62,198	38,900	66,947
Hon Gai	276,526	276,526		
Cam Pha	1,430,326	613,202	401,310	415,814
Noi dia	800,639	117,930	122,680	560,029

Source: (Decision 403/2016 / QĐ-TTg)

Wasted water from mining, repairing, and mechanical factories till 2030 are estimated based on the annual average coal production volume. The average mining wasted water for each ton of coal as follows:

Table 2: Amount of estimated mining wastewater to 2030

Category	Unit	2021 to 2025	2026 to 2030
Raw coal production amount	Million of tons per year	52.5	57.5
Average mining wasted water	m^3per ton	2	2
Average mining wasted water	Million of m^3per year	105	115

Source: (TKV, 2018)

Additionly, in the process of coal production, the coal industry also generates dust, mine emissions, wastes from the materials used, including many hazardous wastes, etc.

Due to the above reasons, the coal industry and coal enterprises need to have practical solutions to reduce material consumption, reduce resource losses, and especially recycling the waste in the process of exploitation to minimize environmental pollution and increase its economic value. To achieve those goals, it is necessary to study and apply a circular economy - a model that is highly effective in reducing waste of resources and reducing negative impacts on the environment through specific activities such as repairing, reusing, and recycling.

2. THE CONTENT

2.1. The theoretical basis of the circular economy

2.1.1. Concept of circular economy

Many authors offer the concept idea of the circular economy. For example:

The circular economy describes an industrial economy designed to produce no waste or pollution (Anna Littleboy et al, 2016).

A circular economy is an economic system of closed loops in which raw materials, components, and products lose their value as little as possible, renewable energy sources are used, and systems thinking is at the core.

The circular economy is a new economic model with a vast economic potential in zero waste creation (Ellen MacArthur Foundation, 2013).

Päivi Kinnunen, (2019) "A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro-level (products, companies, consumers), meso-level (eco-industrial parks) and macro-level (city, region, nation and beyond), to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."

According to the Journal of Environment (2020): The circular economy is an economic model in which design, production, and service activities aim to extend the life of material and eliminate negative impacts on the environment.

Thus, the circular economy focuses on managing and regenerating resources in a closed circle to avoid generating waste based on reusing what can be reused, recycling what can not, repair what is broken, reproduce what cannot be fixed.

2.1.2. The role of the circular economy

To avoid creating waste in production and consumption, the circular economy plays an essential role in the development of enterprises in particular and the economy in general. Specifically:

- For enterprises:

+ To save input costs by utilizing raw materials in the production process and creating products from recycling waste at the same time.

+ To reduce waste and thereby reduce environmental costs due to emission reduction and economic damage caused by environmental pollution from waste.

+ To ensure occupational safety and health of the employees and the local people.

+ To show the corporate social responsibility as a basis to improve their images and competitive positions in the market.

- For the national economy:

+ The circular economy provides opportunities for rapid and sustainable development of the economy through socio-economic indicators and reducing impacts on climate change.

+ The circular economy brings excellent social and economic efficiency, especially in the context of challenges that non-renewable mineral resources are becoming exhausted, the waste increases and the climate changes are in negative directions.

+ The circular economy is a useful tool for fulfilling environmental commitments and sustainable development.

2.2. Activities to reduce the environmental pollution of the coal industry in Vietnam

Recently, Vietnam National Coal and Mineral Industry Holding Corporation Limited (Vinacomin) has been implementing many activities to overcome impacts of coal mining on the environment, such as:

- Renovating large discharge areas with high risk of landslides, such as 7-8 Ha Tu, Chinh Bac, Nam Lo Phong, and Nam Deo Nai, etc., to reduce dangers during rainy seasons.

- Constructing and operating wastewater process stations. Quang Ninh province currently occupies 57 stations with a capacity of 15m^3/h to 2,400m^3/h (Vinacomin, 2017), meeting the requirements of treating mine wastewater up to the standards for the coal industry.

- Building 21 specialized transport routes with a total length of 131km (Vinacomin, 2017). Therefore, since 2008 Vinacomin has stopped transporting coal on national and provincial roads to limit the generation of dust and noise, minimizing the effects of coal transportation, and contributing to improve the environment and landscape of urban areas and population in the province.

- Investing in over 90 dust spraying systems, installing dust screens, solidifing screening areas and warehouses; building 2 car-wash stations (Nui Beo, Coc Sau), 3 carriage-wash stations (Cua Ong, Nam Cau Trang) (Vinacomin, 2017); carring out watering against dust and canvases on means of transportation and warehouse, reducing the generation of dust and noise, contributing to improve the landscape environment. Factories processing minerals, thermal power, cement are invested in synchronous emission treatment lines and technological lines, automatically controlled, ensuring emission standards before being discharged into the environment.

- Before 2016, Vinacomin planted over 1,000 ha of greening the disposal area, equivalent to 35% of the area. From 2016 to 2018, with the solution of high density planting, Vinacomin has rehabilitated 415 ha of landfill such as Chinh Bac of Nui Beo mine, Nam Khe Tam, Dong Khe Sim, Mong Gioang, Khe De and Dong Cao Son.

- The industrial hazardous waste treatment factory in Cam Pha - Quang Ninh, operated since 2014 with a capacity of 6,900T per year, handled 172/196 hazardous waste codes generated in production. The wastes are treated following the regulations, some of hazardous wastes are recycled into materials for other industrial production units.

Thus, the coal industry of Vietnam has many activities to minimize the negative impact on the environment. However, there are some remain disadvantages:

- There is no plan to treat and recycle all types of coal waste given rehabilitate pit roads and mines, recovering methane, ordinary wastes, and hazardous waste.

- Most of the activities have been implemented only to reduce negative impacts on the environment without taking into account the economic values brought to businesses, the coal industry, and the economy. This does not encourage coal companies to handle actively and recycle wastes to protect the environment.

- The development speed of environmental treatment and recycling activities has not kept pace with the growth rate of coal production due to inadequate planning.

- Waste treatment, recycling, and ecological rehabilitation do not have a combination of related industries leading to ineffective efficiency, causing waste of secondary resources, and negative impacts on the environment.

2.3. Building a circular economy for coal mining and processing

As analyzed above, there are certain limitations in activities to reduce environmental pollution in the coal industry. To solve this problem, the coal industry in Vietnam needs to develop and apply a circular economy. This model will cover the most exhaustive streams of coal production and processing, along with recycling and reuse directions to reduce environmental pollution on the one hand and to raise the value of waste on the other hand. The authors propose a circular economy applied to coal mining and processing, as shown in Fig 1.

- Recycle wasted rock and soil from mining and shift into construction sand (replacing natural sand which is currently restricted from exploitation). Two alternatives are using of waste rock and soil as materials to fill the void after underground mining to limit the subsidence or for pits, roadbeds, as backfilling materials to create construction land fund, etc.

- Recycle a part of mine wastewater into clean water for coal production and other daily needs, especially in Quang Ninh, where water demand is increasing, while freshwater source is limited.

- Research and apply technology to recover methane (CH_4) from coal seams to generate electricity and heat energy, from the lessons learned of the USA, Australia, China, Germany, and England. According to the experience of these countries, if the mining enterprises can ensure electricity and heat, coal prices will be reduced by up to 30% (the reduction depends on the proportion of electricity cost in the price).

- Renovate an open pit to become a water reservoir; backfill, revert and develope forest economy on the area of the discharged sites, the exploitation area that has ended its operation; improving the galleries into material storages, etc.

- Reclaim and recycle coal dust in the coal processing line to sort appropriate products for using as domestic fuels or construction materials, etc.

- Collect ordinary waste such as automobile tires, broken conveyor belts, broken machine parts, and anti-broken steel, etc. to recycle without releasing into the environment.

- Hazardous wastes such as grease and batteries are collected, processed, and recycled to other useful products for industrial production.

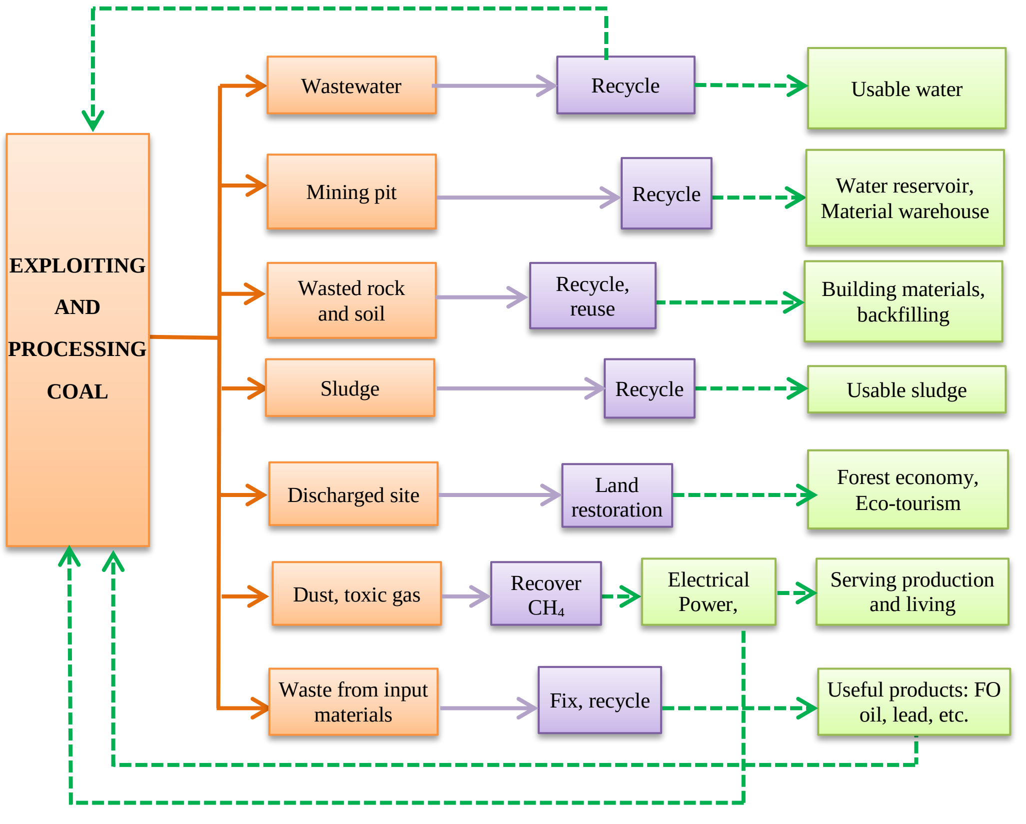

Fig 1. The circular economy applied to coal mining and processing.

2.4. Proposing solutions to implement circular economy for coal mining and processing

Currently, the coal industry is applying many solutions to recover, recycle, and reuse some types of waste. However, the amount and types of recycled waste is still limited. To move towards a circular economy, the coal industry of Vietnam can consider the following suggestions.

Firstly, Vinacomin develops a mechanism to encourage coal mining and processing enterprises to recycle and reuse the waste to reduce the amount of waste at the source.

Secondly, Vinacomin researches and applies appropriate technology to recover methane gas from coal mines and coal as fuel to produce electricity and thermal energy on-site for production at coal mining and processing enterprises. At the same time, it can serve other industrial enterprises as well as for living in the area.

Thirdly, Vinacomin expeditiously prepares projects to renovate mines and tunnels for underground mining after all surface mining totally close by the end of 2021.

Fourthly, factories to treat and recycle hazardous wastes should be expanded or improved the capacity to create economic values from wastes and minimize environmental pollution.

Finally, the coal industry combines with other sectors of transportation, construction, and private businesses to improve the value of waste rock and soil by using it to level the roads and producing artificial sands.

3. RECOMMENDATIONS

The application of the circular economy is an indispensable and objective trend, especially for the current coal industry, when challenges of exhausting coal resources, discharging of waste, and negative impacts on the environment are increasing. Here are some recommendations to facilitate the application of a circular economy for the coal industry of Vietnam.

- In-depth study on the circular economy, given the state-of-the-art in the economy of Vietnam and the coal industry.

- Introduce widely of the circular economy to labor force, entrepreneurs and authorities to raise awareness about the circular economy.

- Develop mechanisms and policies on the implementation of the circular economy with related issues, such as implementation process, application roadmap, evaluation criteria on the extent of application and the effectiveness, etc.

- Create favorable conditions for the coal industry to have the capital to invest in renovating mining technology and equipment by allowing coal prices to operate according to the market mechanism.

- Encourage investment in mine waste recycling projects with preferential policies on tax, capital, and land use, even subsidies.

- Adopting policies to promote the use of recycled products from waste.

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TOWARD UN SDG 11: PATHS OF MINING CITIES SUSTAINABILITY AS PRACTICED IN CHINA

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Abstract: *The world-wide consensus on sustainability has been challenging to the mineral industries, and public concerns keep growing on workplace safety, occupational health, community wellbeing and environmental impacts as associated with mineral development. As one of the major emerging and radically developing economies, China has experienced much of those safety, health, resource and environmental issues in recent years, and allegations and complaints are often reported against mineral developers for safety and health incidents at mining workplace, environmental disturbances and pollutions from mining activities, resource curse with mine communities, and even mining cities shrinkage in general.*

To address those problems and issues, the Chinese government has made great efforts in terms of national policy priorities and their implementations since the 1980s. This current paper briefly reviews and analyzes some of those policies, initiatives and models for the economic transformation of mining cities and communities as well as the sustainability of cities, including those promoted by the Chinese central government and its departments, such as the National Innovation Demonstration Zones Initiative on Implementation of the 2030 Agenda for Sustainable Development, the Opinions of the State Council on Promoting the Sustainable Development of Resource-Based Cities and the National Strategies for Sustainability of Resource-Based Cities (2013-2020) by the State Council of China (SCC), the Directive on Strengthening Type-Based Guidance and Fostering the Transformation of Resource-Based Cities by the National Development and Reform Commission of China (NDRC), and the green mine initiatives by the Ministry of Land and Resources of China (MLR).

The goals, processes and outcomes of those policies, initiatives and models are presented and observations are also given for potential adoptions or adaptations in similar cases around the globe.

Keywords: *mining city; green mine; models for mining cities sustainability; sustainable cities; urban shrinage.*

1. INTRODUCTION

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs) as shown in Fig 1, which are an urgent call for action by all countries - developed and developing - in a global partnership. Furthermore at the leading edge of the global sustainability agenda are the world's growing cities and their sustainability. The eleventh SDG refers to the issues and problems with such cities and communities.

Fig 1. United Nations Sustainable Development Goals.

It has been reported that in 2018, 4.2 billion people, 55 percent of the world's population, lived in cities and by 2050, the urban population is expected to reach 6.7 billion, about two-thirds of all humanity (UN Department of Public Information, 2018). In the growing urbanization process, cities face many challenges. Urban sprawl, transportation congestion, resource depletion and greenhouse gas emissions (GHGs) are expected to worsen, and the effects of climate change will increase cities' vulnerability to natural hazards and the risk of migration and displacement.

On the other hand, urban shrinkage or shrinking cities, and in particular those associated with resource-based cities also bring about diverse and multifaceted issues and problems of economic growth and social development such as disinvestment, depopulation and outmigration.

To address those problems and issues, the Chinese government has made great efforts since 1980s in terms of national policy priorities and their implementations by its subordinate departments such as the Directive on Strengthening Type-Based Guidance and Fostering the Transformation of Resource-Based Cities and the green mine initiatives and practices as promoted by the Ministry of Land and Resources of China (MLR). Analyses on those policies, initiatives and models are presented in the following sections for potential adoptions or adaptations in similar cases around the globe.

2. INITIATIVES ON IMPLEMENTATION OF 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT BY SCC

On September 19, 2016 one year after the United Nations had adopted the 2030 Agenda for Sustainable Development, China's National Plan on Implementation of the 2030 Agenda for Sustainable Development (SCC, 2016a) was released by Premier Li Keqiang while he chaired a roundtable at the United Nations Headquarter in New York, USA (Fig 2). The plan consists of five parts - achievements and experiences on the Millennium Development Goals, challenges and opportunities, general principles, overall approaches, and implementation plan for SDGs.

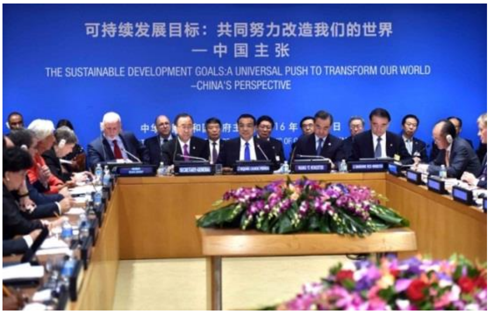

Fig 2. Release of China's National Plan on Implementation of the 2030 Agenda for Sustainable Development at UN.

As a part of the concrete measures to implement the national plan, China's National Innovation Demonstration Zones Building Initiative on Implementation of the 2030

Agenda for Sustainable Development is practiced (SCC, 2016b). The initiative's goal is to innovate and form a series of replicable and applicable models for the building of sustainable cities by developing 10 demonstrative zones or cities during the period of China's Thirteenth Five-Year Plan. The initiative has been based on the previous projects for building National Sustainable Development Pilot Zones which were implemented since 1986 and have resulted in 189 pilot zone cases and models for regional sustainable development.

Consequently, the State Council of China approved the cities of Taiyuan, Guilin and Shenzhen in February 2018 as the first round Innovation Demonstration Zones to be built, with the core subjects and objectives to transform mineral resource rich cities as Taiyuan, to sustain landscape resource rich cities as Guilin and to develop innovation driven megacities as Shenzhen, respectively.

Again in May 2019, the State Council of China approved three more cities as Innovation Demonstration Zones to be built, and they were Chenzhou toward sustainability with a focus on water resources utilization, Lincang toward sustainability with a focus on innovation for multi-ethnic remote frontiers and Chengde toward sustainability with a focus on water conservation functions with conurbations and urban agglomeration.

It is interesting to note that Taiyuan is treated as a model of mineral resource rich city to be built for demonstrating its sustainable transformation, but it has not been classified as a "resource-based" city by the Ministry of Land and Resources (MLR) as discussed in the following sections. Rather Taiyuan's major problems and issues toward sustainability are urban air pollution and water contamination, and its tasks as an Innovation Demonstration Zone are to demonstrate best practices for solving those problems with new patterns of energy utilization and consumption such as clean coal and low carbon.

In contrast, Chenzhou, Lincang and Chengdu as models for Innovation Demonstration Zones are also classified as maturing "resource-based" cities, and their tasks and efforts on utilization and services of water resource, inclusiveness of immigrant workers and multi-ethnic aboriginal residents, and mitigation of mining-induced environmental impacts will also contribute to the best practices for mining and resource-based cities toward sustainability.

3. NATIONAL STRATEGIES FOR SUSTAINABILITY OF MINING CITIES AND COMMUNITIES BY SCC

Booms and Busts with Mining Cities in China

In February 17 of the year 1950, an impromptu phrase for remembrance was handwritten and presented to a Chinese student, who was studying geology and geological prospecting at a university in Moscow, by the past Chairman Mao Zedong at the Chinese Embassy and it reads "to develop mineral industries" as shown in Fig 3.

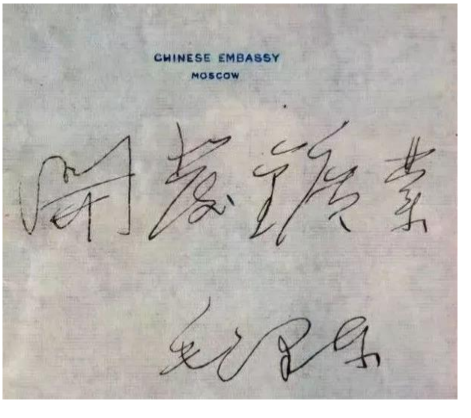

Fig 3. "To develop mineral industries" by Chairman Mao

Since that time when the New China was eager for an economic takeoff, those words have been becoming the vision, mission and motto of the Chinese mineral industries. Even now when the concept and practices of sustainability for low carbon, resource efficiency and social inclusiveness is widely accepted, the Chinese minerals sector is constantly celebrating its successful stories on the scale and speed of Chinese minerals development and exploitation endeavors by quoting that phrase.

At the present, the Chinese minerals industry as a whole has been growing and becoming one of the biggest in the world. Meanwhile, the mining cities and communities associated with radical minerals development are beginning to experience booms and busts. Table 1 illustrates the booms of mining cities and communities (Zhu, 2015).

Table 1. Booms of mining cities and communities

Year	Number of cities and % of mining ones			
	Mining	Non-mining	Total	% of mining
1980	43	(396)	(439)	10
1987	68	(310)	(378)	18
1991	99	380	479	21
1997	160	(506)	666	(24)
2013	119*	(214)	333	(36)

* *This number included the jurisdictive cities only and smaller communities such as counties or districts were not included.*

** *Those numbers in parentheses were not given by the quoted reference, and instead they were inferred by the authors.*

It is reported that the problems and issues of urban shrinkage were already realized as early as in the late 1980s in the mining cities and communities such as Fuxin, Benxi and Fushun in the province of Liaoning.

Over the decades and in some cases even a century of mining activities, minable reserves and mine production were decreasing and the urban economies heavily depending on minerals development were slowing down; Long-term effects of environmental disturbances induced by minerals development activities were also emerging. Previous booms were vanishing and employment and wellbeing of workers and residents were getting in grim situations. In some cases, even social disruptions and instability could be seen. Two of the then governmental departments (the Ministry of Geology and Mineral Resources and the State Planning Commission) made efforts to study those situations, though the resulting findings and recommendations were neglected by the central government without imminent or immediate priorities for years.

Ten years later in 1997, a national symposium on the sustainability of mining cities and communities were held under the auspices of several governmental departments and national organizations, including the Ministry of Geology and Mineral Resources, the Ministry of Construction, China Mining Association, and China Association of Mayors. The issues of mining city and community shrinkage were then intensively discussed and the concept of mining city and community transformation was consented and encouraged lately by the State Council of China. Since then, mining cities and communities with further problems had led to initiate strategies and practices toward transformation and sustainability.

By the year of 2002 when the Communist Part of China held its Sixteenth National Congress, “to support the practices of mining city and community transformation” has become one of the national policy priorities.

As a result, the governmental policy document of Opinions of the State Council on Promoting the Sustainable Development of Resource-Based Cities was released to implement (SCC, 2007).

Approaches to Transformation toward Sustainability

As directed by the national policy for transformation toward sustainability (SCC, 2007), mining or resource-based cities and communities are encouraged to restructure their economy depending on the single resource industry and develop extended and substitute industries so as to reduce their heavy dependencies on the primary sectors, increase the economic value of their resource products and service chains, improve local employment and mitigate mining induced environmental problems.

An extended industry refers to the expansion and extension of the traditional industry chains. Industrial expansions and extensions in mining or resource-based cities and communities include updating the resource-centered industry by adopting innovative processes and technologies and diversifying products and services to help increase added values and comparative advantages of the industrial processes and activities and sustain local economies and prosperity. In contrast, a substitute industry refers to a non-traditional industry to be developed by using capitals, innovations and talents accumulated in resource development activities or utilizing external resources and forces instead of local ones. The development of a substitute industry is preferred as a supplemented industrial and economic transformation toward sustainability.

Paths for Implementation toward Sustainability

The 2007 national policy for the sustainability of mining or resource-based cities and communities were further specified as national strategies (SCC, 2013) to supplement the policy priorities and guide their implementation with the goals of building the capacity of sustainability for resource-based cities and communities and developing typical models, best practices and paths toward the sustainability of resource-based cities and communities.

In 2017 when the national policy for transforming resource-based cities and communities toward sustainability has been implemented and practiced for ten years, the governmental department of NDRC restated and updated the policy priorities by the Directive on Strengthening Type-Based Guidance and Fostering the Transformation of Resource-Based Cities (NDRC, 2017).

Types or models of mining cities and communities

By the 2013 national strategies (SCC, 2013), 262 resource-based cities and communities were identified with 244 as mining and oil and gas extracting cities and communities, and 18 as ones focusing on the forest or wood industry. Those resource-based cities and communities are further classified into four types or models according to the life cycle stages of city and community development for differentiated paths toward sustainability. The proportion or distribution of those mining ones (with the forest or wood industry excluded) is shown in Table 2.

Table 2. Types or models of mining cities and communities

Type, model or life cycle stage of city	Proportion by jurisdictive division			
	City	County or district	% of type	Typical cities
Growth	20	11	12.7	Shuozhou, Altay
Maturity	63	69	54.1	Datong, Jinchang
Decline	21	39	24.6	Fuxin, Huangshi
Regeneration	15	6	8.6	Tangshan, Zibo
Total	119	125	100.0	N/A

Paths for growing type, model or stage

The growing type of newly developed mining cities and communities such as Shuozhou and Altay with a wealth of mineral resources are to be oriented toward sustainable mineral resource supply bases by improved regulation in conformity with green economy and resource efficiency. The high-level norms and rules are to be built for selective market entries with best practices for rational speed of growing, proper internalization of environmental and social costs, and strategic mineral resource development and utilization paths for concerted and sustained industrialization and urbanization.

Downstream mineral chains are to be integrated toward final goods or services instead of primary mineral products only. Economic activities of mineral development and utilization are to be coordinated with and based at existing cities in the vicinity, and mined lands are to be completely reclaimed and restored without any permanent residential infrastructures remained.

Paths for maturing type, model or stage

The maturing type of mining cities and communities such as Datong and Jinchang with steady mineral production streams and supply chains, fully built infrastructures, and well developed social-economic levels are to upgrade their technical innovation capacity and processes, continually improve the economic efficiency of mineral development and utilization, and mitigate mining-induced environmental and ecological impacts.

More vim, vigor and vitality are to be stimulated. The problems of outdated production capacity and oversupply are to be addressed. Corporations of strong competency are encouraged to acquire, merge as public-private partnerships (PPP) or reach out by playing a proactive role in the national Belt and Road initiative. City or community services and infrastructures originating from the times of planned economy and historically managed by mining companies are to be transferred to local government. Mining-based industrial clusters are to be upgraded for advanced manufacturing, and new materials and energy.

Strategies are to be directed to the expansion and extension of mineral industrial chains and the creation of substituting industries and service sectors to sustain the prosperity of mining cities and communities as mineral resources tend to be depleted.

Paths for declining type, model or stage

The declining type of mining cities and communities such as Fuxin and Huangshi with mineral resource already exhausting during the radical development of national economies in the past decades are experiencing the problems and issues of so-called resource paradox. Mining induced environmental and ecological impacts are emerging, economic activities and growth led by mineral development are slowing down, and employment and social wellbeing are at pressure. The problem of social equity for immigrant workers and local residents is to be addressed in particular.

Public investment is provided by the central government to encourage economic and social transformation and job creation by the development of substituting and service economies such as manufacturing, logistics, and tourism with environmental and ecological restoration and housing improvement. Displacement and out-immigration may be arranged when necessary.

Paths for regenerating type, model or stage

The regenerating type of mining cities and communities such as Tangshan and Zibo have had innovative modes or models of economic and social development restructured and are leading their ways toward sustainability without further heavy dependence on mineral development.

They are becoming urban sprawls in the rapid process of Chinese industrialization and urbanization and need to be more open and innovative for their social and economic development to be stabilized and for the standards of living, equity and wellbeing to be continually improved.

4. PRACTICES FOR GREEN MINING IN CHINA

Green Mine Initiatives and Green Mining

Green mine is a buzzword that has been officially used as early as in 2007 when a high-level governmental officer of China called for "developing green mineral industries" at the yearly international conference and exhibition of China Mining and in 2008 when China Mining Association launched the initiative of Green Mine Protocol. The phrase was apparently coined with a meaning similar to the concept of green economy for resource efficiency, low carbon and social inclusiveness. It emphasizes the implementation and best practices of innovative technologies and governmental regulations that are aimed to improve economic efficiency and environmental performance of mining activities and processes. Subsequently, the concepts of green mining have been officially adopted by Natural Resources Canada in its CANMET Mining Research Plan 2016-2021 (NRCan, 2016) and by Massachusetts Institute of Technology (2016) in its educational materials.

Practices of Green Mines Building

As a major practice of the green mine and green mining concepts, MLR issued its Opinions on Developing Green Mineral Industries and Building Green Mines by Practices with a standard of the Basic Requirements for National Accreditation as Green Mines in 2010. Specifically, a nationally accredited green mine must meet the basic requirements of standard from nine aspects: legal and regulatory compliance, integrated managerial norms and best practices, mineral resource efficiency, innovation, emission and waste disposal, environment protection, mined land reclamation, stakeholder engagement, and corporate culture.

By 2014, 661 mines were approved to join the green mine building programs initiated by MLR in 29 provinces, and by 2016, 187 mines were officially recognized as nationally accredited green mines.

Green Mines and City Sustainability

With the consensus and joint support from five relevant governmental departments, MLR (2017) issued its Opinions on Promoting the Practice of Green Mines Building again to encourage the practices of green mine building and green mining with improved green mine standards for separate industrial sectors, including coal, oil and gases, metals, industrial minerals, and aggregates.

It is visioned that the green mine building programs by MLR will be further integrated into the National Innovation Demonstration Zones Building Initiative toward the goal of sustainable cities and, in particular, sustainable mining cities and communities.

CONCLUSIONS

It has been said (by Gary Lawrence) that sustainability is a political choice, not a technical one. It's not a question of whether we can be sustainable, but whether we choose to be.

As a developing and emerging country, China has made great efforts to promote sustainability. As early as 1986, the National Sustainable Development Pilot Zones programs have been practiced toward sustainable cities and now starting in 2018, those programs have been upgraded as China's National Innovation Demonstration Zones Building Initiative for Implementation of the 2030 Agenda for Sustainable Development to further build replicable sustainable city models..

At the same time, the sustainability of resource-based cities and, in particular, mining cities and communities which have experienced the problems and issues of resource paradox has been paid additional attention. Those resource-based cities are classified into the four types of growing, maturing, declining and regenerating ones and given differentiated policy priorities, approaches and paths for their transformation toward sustainability.

Green mines building initiatives and green mining practices are also proactively promoted by the Chinese central government and they will be integrated into the National Innovation Demonstration Zones Building Initiative to better contribute to the goal of mining city and community sustainability.

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OPPORTUNITY AND CHALLENGES IN DEVELOPMENT OF HERITAGE TOURISM IN POST-MINERAL-EXPLOITATION IN VIETNAM

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Abstract: *Vietnam has a variety of natural mineral resources, i.e., above 5000 mines and 60 types of different minerals. The activities on exploiting and processing occur in many locations with enlarging of scale. The continuous exploitation for a long period leads to the degradation of the environment as well as out of mineral resources. According to the law of mineral exploitation in 2010, enterprises have to close mines and respond to recovering the environment where they used. Nevertheless, exploitation also leaves some infrastructure such as the ways in mines, scaffolds, and particular hypaethral geology. However, with the advantages of geography as well as nature and unique culture, Vietnam becomes an attractive tourism point for abroad tourists. Nowadays, tourism is mostly developed, its contributions recorded 5.9% GDP of Vietnam in 2017, and is expected to be higher. Therefore, the possible idea about the development of a combination of the strength of tourism and historical outcomes of mineral exploitation needs to be approved to enhance tourism in mines and geology. This idea might be a good strategy for enterprises in the post-mineral exploitation. In this report, the author will present the study on the potential in heritage tourism in the post-mineral exploitation period. Besides, the authors also present possible opportunity and challenges as this idea is realized in Vietnam*

Keywords: Heritage tourism, mining heritage tourism, post-mineral exploitation.

1. INTRODUCTION

Recently, personal experience or cultural tourism have been popular. The first one helps tourist experience, discover and collect updated information for recreative and educational demands.

The target of tourism is to discover the cultural heritage and their historical value as well as social effects. Therefore, mining or heritage tourism is a kind of cultural tourism.

Culture has appeared since the last decades of the 20th century as the result of the post-industrial period, which relates to the variation of economy, development of new technology, and job structure. Such variation generates a diversity of cultural heritage relating to the industrial period, including heavy industry and mining exploitation. The mining and mineral exploitation has been important to the national economy. This activity uses many numbers of labor and creates characterized culture. The depletion of natural resources is the result of its limitation and avalanche of exploitation. As a result, many mining stations close certainly.

Nevertheless, people do not totally negate its existence in part. It is considered as the heritage for education and culture, which needs to be preserved. Mining and heritage tourism are solutions to preserve concern and the next generations. During the period we exploited natural resources to develop the domestic economy, many mines are exhausted and possibly close. However, these enterprises neither close mining stations nor recovering the environment. They may develop by applying environment-friendly and -sustainable solutions, i.e., mining and heritage tourism. This report will discuss and mention the effect of mining and heritage tourism on enterprises in the post-exploitation period as well as evaluate opportunity and challenges which the enterprise needs to anticipate when realizing above recommended ideas.

2. SOME NOTICEABLE POINTS ABOUT MINING - AND HERITAGE TOURISM

2.1. Utilizing heritages left by mineral activities as cultural possession

Heritage might not be considered as complex of immaterial and material phenomena, which are the results of culture and human consciousness about their past in a particular circumstance. That also includes the heritage from history and present results. The exploitation industry is considered as an important one. However, its outcomes after related activity for a long time become uninteresting; people prefer to get rid of it rather than preserve. However, it stands for historical value as well as the development level, habit or religion of our ancestors in the past. The fact that many international conferences are organized, and the International Committee of industrial heritage Preservation is proof of experts' interest in this field (Jakub Jelen, 2018). The rest part of exploitation relates to explaining matters which respond to mining exploitation, so it can be considered as the cultural heritage of a particular social empire. That might be physical heritages, such as mining, hole, building, etc, or cultural heritages such as a habit, customs, and traditions.

2.2. Origin of mining heritages and relevant problems for using them

a. Origins of mining heritages

The mining industry usually has an organic relation to economic development. Initially, this industry generates funds for economic development. This activity requires much labor, which relates to knowledge, skills, culture, and religions of workers. This situation creates a diversity of culture, religion in the places where mining activities occur. They are considered as intangible heritage created during mining activity.

Due to the limitation of the resource amount, certainly, the mining activity will terminate. The life span of a mining project is affected by many factors such as resource amount, technique, law, and matter relating to the environment, etc. During mining, these places generate many kinds of stuff like mines, holes, way, etc. When the mines close, these kinds of stuff become rubbish and need to be removed. Nevertheless, on the other hand, they have value in history and education because they are proof of the development of particular periods.

b. Matters relating to using mining heritages

Nowadays, preservation, recovery for mining heritages become popular. In some countries, they are used as a tourist attraction. However, there are some problems :

- Environmental pollution is pressure for enterprises. The mining activities require a large area to store rubbish and create a risk for the environment due to heavy irons. When this activity ends up, the used area needs to be processed to recover. The problem for it is the expense which must be made by enterprises. That is also an obstacle to using heritages.

- Lack of plan for building destroys particular heritages. The biggest problem for enterprises is how to optimize the usage of natural resources due to the limitation of human resources. It needs a long period to convince people to understand the value of mining heritage. Renew the mining area is a possible solution. In that way, success will become a pattern for other countries in the world. The host of enterprise will have a strategy for the future after mining activity finishes.

2.3. Exploiting heritage as tourist attractive area

Culture tourism focuses mainly on points concerning mineral exploitation, such as mines, holes, workshops, or workers' culture and religion. Mining tourism does not only preserve historical values, the humanity of a particular period, but it is also a commercial activity of workers after finishing exploitation. The proof for mining tourism can be found in Brazil, Spain, etc.

However, the relationship between mining heritage and tourism is complicated because mining tourism relates to danger and instability, and it becomes uninteresting. There are two problems relating to mining tourism, namely, uninteresting place as people said, and the contradiction in preservation as well as investment duty. This problem does not occur in the Czech Republic as the growth of tourist numbers in mines. Besides, UNESCO approves 15 places for international heritages, which proves that heritage preservation is considered. The different point is that the site for mining tourism is far from the road. Therefore, it consumes more money and time to visit, and also the good physical factor is necessary. These points mean that mining tourism never becomes an attractive place. Nevertheless, it can be developed in a particular circumstance, and heritages can be preserved.

3. POTENTIAL FOR MINING HERITAGES AND SITUATION OF ORGANIZE MINES FOR TOURISM IN VIETNAM

3.1. Potential to develop heritages tourism in Vietnam

Vietnam has a large number of natural resources. The mining activity has started at the end of the 19th century as France mined and collected natural resources. The mining activities have occurred with a bigger scale and modern technology and created a diversity of mining heritages. These heritages include both visible and invisible heritages with a big value of history, religion, industry and technology development in Vietnam. Nowadays, Vietnam has priority for developing tourism. Mining heritage is a new strategy for enterprise after mining activities finish. In fact, almost all the mining enterprises have a traditional room where historical heritages are preserved. This idea is already realized in the Cao Son mine, which corporates with tourism companies and bring tourists to visit this place. The journey starts by visiting traditional rooms, listening to the history of geology and its development of the Vietnam coal industry and Cao Son mine, etc. Next, tourists come to visit mines, experience the work of workers.

The mines in Vietnam are close to traditional points for tourism. These advantages will promote tourism; by combining with mining tourism, tourists will have many chances to experience more and longer. There are many mines with the potentials to develop mining tourism, such as the Quang Ninh mine or oil-rigs offshore.

Fig 1. A corner of the traditional room of Vietnam Petrolimex Corporation (PVN, 2018).

Quang Ninh is the "birthplace" of the Vietnam mining industry, where there are a large number of mining companies. These companies had worked here for tens of years, or even since when France governed. Moreover, these mines locate quite close to many famous tourism points, such as Halong bay, Yentu landmark, Tuan Chau island, Quan Lan island, etc. There are tens of millions of visitors from different countries coming here. In 2019, there were around 14 million visitors, including 5,749 million international visitors (baoquangninh, 2019). Since 2020, Quang Ninh province has been approved a decision to pause all mine to avoid negative effects on traditional tourism. With the advantages of location, the special mining heritages in this area possibly become places for tourism. These places can be used for recreational areas and sports games as climbing mountain, diving, etc. The area where mining heritage is preserved can become an experience tourism place. Tourists act as mining workers to experience the job of them with good safety conditions. Besides, the job of fine-art for coal needs to be recovered, the big block of rock can become high-value products for souvenirs, such as paints made from coal, coal carving, etc. Besides, utilize traditional days of the Vietnam Mining industry for festivals to announce mining heritage tourism.

Fig 2. Fine-art products made from coal in Quang Ninh (Baovanhoa, 2018).

The oil-rigs of mining companies can also be mining heritage for tourism. The offshore-oil rig has been a symbol of Petrolimex companies in Vietnam. Oil-rigs are used to drill well to collect and process crude oil and restore temporary before moved to process areas or sold on the markets. In some cases, the oil-rigs contain functional rooms, such as operation rooms, recreation areas for workers after working. These oil-rigs are designed with modern style, huge and durable. The sea becomes a colorful city by night. Therefore, when the oil-rig closes, they can be used for tourism instead of removing them. With reparation and decoration, these oil-rigs become hotels with many rooms. The tourists can experience some activities like fishing, diving to discover flatforms, etc. This idea is not so new in the world, even it is realized in some countries, such as Saba Malaysia) is designed and become a high-quality hotel (Hiephoixangdau, 2015)

Fig 3. An oil-rig in Sabah state, Malaysia, is used as a hotel.

3.2. Situation of planning of mines for mining tourism

In order to realize and utilize the potential and advantage to develop mining heritage tourism in Vietnam, the plan to organize and recognize the mines with high potential. In macroscope, there has been no official document of government about planning mines for mining heritage tourism yet. In Vietnam, there is only one mine, namely Na Duong, planned for mining heritage tourism. This mine has been developed for about 100 years with many historical pieces of evidence of this enterprise. During mining, this place is recognized as a special area. Many fossil animals with a large amount have been discovered. Researchers show that this is a Miocene ecosystem (occurred between 2.03 and 5.33 million years ago). It is really crucial to preserve this area.

Fig 4. Fossil Stromatolite om Na Duong mine.

Fig 5. A view of Na Duong mine.

This mine becomes attractive since it exists as a special minging heritage. Due to this point, Na Duong company plan to develop the mine for tourism orientation without any recovery. According to this plan, this place will be a museum to preserve the outdoor geology about the Miocene ecosystem and animal population here. At present, the company starts planning landfills, planting trees on this place, collect fossil plants and animals to contribute to the museum building. In 30 years, this place will become a tourism attraction diversity of mining heritage, geology. The visitors do enjoy not only nature but also learn more about the process of geology formation and the museum of outdoor geology. Besides, Na Duong mine is also planned for education and research purpose. There are many groups of mining students and experts coming here to visit and research.

Some mines in Quang Ninh have been planned for mining tourism, such as Cao Son, Ha Tu. In the short term, other outdoor mines in Ha Long will also be designed for this purpose.

4. THE OPPORTUNITIES AND CHALLENGES OF CHANGING THE MINING PLACES INTO TOURIST-ATTRACTIVE POINTS IN VIETNAM

4.1. Opportunities

After studying, the authors infer some potentials to develop mining tourism:

- *Mining tourism and other concerning fields are developed by the government to become highlighted economy area:* The development of tourism enhances economy structure, culture, and preservation, international cooperation, etc. Understanding the importance of tourism, in 2017, the ministry of politics had decision number 08-NQ-TW to develop tourism as a key branch. Also, in this year, Tourism law (modified) was discussed in parliament, will help tourism develop more in Vietnam in the near future. [3].

- *Recently, thanks to governmental policies, Vietnam tourism has developed with a large number of tourists. Vietnam tourism also is considered by society and people.* In 2017, there were 13 million tourists, and this number increased by 25% for the next two years. That fact presents that Vietnam tourism has a good level in the world. Some places are voted as favorite destinations of international tourists. Some of them is chosen for special scenes in some Hollywood films. The Vietnam policy of visa exemptions for international tourists from the European West and international flight crew, electric VISA… contribute the increase of a number of tourists to Vietnam and enhance Vietnam tourism.

- *Mineral exploitation leaves potential heritages for tourism:* The mining activity leaves a large number of specific heritages such as mines, machines, factories, etc. which are proof of mining activities as well as the development of Vietnam mining and geology. These heritages remind our next generation about humanity, morale, spirit, mental values of workers, and their contribution to national economic development. These regions can be developed and become recreation areas with different sports like mountain climbing, diving, etc., or area for discovery about the workers' stuff in mining. By cooperating with museums, the traditional room where the heritages are preserved will help tourists experience well.

- *The traffic system in the locals where there are mines is so convenient:* Traffic and tourism share some similar points, and they have organic mutual relations. The Vietnam traffic system has been improved recently with a large network to connect locals with each other. Therefore, the physical distance becomes smaller, which beneficial point to develop mining tourism. On the other hand, many mines are close to attractive tourist points such as Ha Long Bay, Cat Ba, Yen Tu, etc. By combining traditional- and mining tourism, Vietnam tourism will be fruitful and diverse.

4.2. The challenges

Besides the opportunities, the development of mining tourism in Vietnam faces to some following challenges:

- *Mining tourism- a new tourism style but attractive due to prejudice in the past:* In Vietnam, mining tourism is so unique, and not actualized yet, just only on the plan in some particular mines. The actualization is a big duty due to many challenges and risks. The limitation of experience in planning heritages becomes obstacles for enterprises to actualize. Moreover, people used to suppose that the heavy industry was more interesting. Therefore, it needs a long time to convince that mining tourism is attractive and valuable in recreation, education, and culture.

- *Lack of an initial plan*. In fact, there are not any mines planned to become the heritage of mining exploitation for tourism in Vietnam. Due to this problem, many regions and technology are destroyed. The diversity of exploitation heritages is dismissed. Therefore, the potential to develop mining tourism is limited.

- *The giant scale of exploitation causes higher expenses for recovery:* The recovery fee relates to environment recovery, renewing and preserving exploited works, and so on. The first one relates to the highest amount of money. This expense depends on the degradation of the environment due to mineral exploitation. In order to recover the environment, the expense of 2-4 million USD/ha is evaluated by some scientists. In fact, some enterprises cancel the recovery procedure instead of continuing their project due to giant expense upon the large scale of exploitation.

- *Environmental degradation relating to most of the exploitation areas:* Most of these areas negatively affect the environment and cause different levels of environmental degradation depending on environment treatment activities. This degradation becomes human prejudice, which considers these areas as a polluted and uninteresting area.

5. CONCLUSIONS

Heritage tourism, including geological and mining tourism, is a new solution for exploitation enterprises in the post-mineral period. It contributes to the development of the domestic economy and society, as well as history and cultural preservation. Vietnam has many potentials to develop these tourisms, although facing some challenges and matters. In order to develop this field, proactive activities, and subsidization from the government.

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AN LCA-LCCA DECISION MAKING FRAMEWORK FOR SELECTING THE MOST SUSTAINABLE MATERIAL TRANSPORTATION SYSTEM IN SURFACE MINES

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Abstract: *One vital step in sustainable mining practice is choosing the best available option for each process that meets sustainable development goals and has the least impact on the environment. One of the main processes in mining operations is the transportation of extracted material. In surface mines, either an only-truck system or an in-pit crushing and conveying (IPCC) system, transports extracted material to desired destinations. Choosing between these two transportation systems, especially when expanding an existing pit, is a critical long-term decision that is impacted by different factors. The economic and technical factors used to be the only essential inputs to this decision-making procedure in traditional mining practices. However, these systems have impacts on global warming and climate change, as well. Thus, environmental impact is another factor in sustainable mining practices that must have an input to the transportation system selection procedure. In this paper, we developed a combined life cycle assessment-life cycle cost analysis (LCA-LCCA) framework to quantify and compare the environmental impacts of only-truck and IPCC transportation systems in surface mines. The developed framework provides precise environmental input to the procedure of transportation system selection in surface mines, helping to choose a more sustainable transportation option. We implemented the developed framework in a mining case study and presented the results in this paper.*

Keywords: *Life cycle assessment; life cycle cost analysis; environmental sustainability; material transportation; surface mining*.

1. INTRODUCTION

Concerns about sustainable development rose around 150 years ago. Starting from the Rio Conference in 1882, the world started to follow the goals of sustainable development by defining a convergence path between its three main pillars (environment, economy, and society) (Hilson & Basu, 2003). Ever since, all the industrial fields at least in developed countries have been establishing workflow towards sustainable development and mining sector is not excluded. The World Economic Forum also aims to achieve sustainable global mining by 2050 (Ranängen & Lindman, 2017; WEF, 2015). In addition to providing valuable resources for modern civilization, mines and mining industries have a large share in the economy of any country, and this industry is necessary to produce goods, services, and infrastructure. However, this contribution of mining in human life comes with several associated costs. According to the U.S. Energy Information Administration (EIA) in 2019, 24% of the country's electricity generated came from coal consumption (EIA, 2019). This paper contributes to the sustainable development in mining sector by presenting a comprehensive method for making closer to optimal decisions on material transportation system to reduce environmental and economical footprint of a surface mine.

In our developed method we combined Life Cycle Assessment (LCA) with Life Cycle Cost Analysis (LCCA). The introduction of Life Cycle Assessment (LCA) method dates back to the 1960s. Life Cycle Assessment (LCA) is a tool for analyzing environmental effects to ultimately identify and control the effects of a product, process, or system on the environment (Grande et al., 2017). The LCA approach can provide comparisons between different scenarios and provide guidelines for reducing environmental impact and improvement (Goglio et al., 2015; Song et al., 2017). The main feature of the LCA is its comprehensiveness (Ditsele, 2010; Guinée & Lindeijer, 2002; Muga, 2009). The use of LCA as a complement to Environmental Impact Assessment (EIA) tools in mining has been recommended in the Ditsele study (Ditsele, 2010). Despite the increasing use of LCA in all branches of engineering sciences, unfortunately, there has not been much progress in the mining industry (Awuah-Offei & Adekpedjou, 2011). According to the results of a 2020 scientific research database, only 3% of LCA-themed articles were about the mining industry. The lack of access to the mining databases due to its confidentiality could be one of the main reasons for the limitation (Reid et al., 2009). In recent years, due to the increasing interest in mining industry across the globe and the subsequent increase in mined material transportation, a new space has been created for further study in this area.

90% of the world's ore is extracted using open-pit mining method (Abbaspour et al., 2019). Conventional open-pit mines implement two sets of material handling system to mine and move mined ore to processing plants: Truck-Shovel (TS) and Crusher-Conveyor (CC). Four common combination of TS and CC are presented in Fig. 1. Among all four combination, 80% of open-pit mines use the first one where trucks are main transportation units (Osanloo & Paricheh, 2020; Paricheh et al., 2017). However, the completion of high-grade and low depth mine deposits in recent years has created new conditions for miners, which has led us to look deeper into future mining projects. At greater depths, the stripping ratio also increases dramatically, resulting in longer haulage distances from the bench face to the outside of the mine, resulting in reduced production. Trucks are vehicles that spend only 40% of their energy on moving materials, and the rest is spent on their transportation, (Shuzhao et al., 2011) and are always empty on the way back. In addition to the high cost of maintenance and accessories, they need more workforce (24 hr/day) (Koehler, 2003). Disadvantages of trucks have forced researchers to study more about transportation systems (de Lemos Pires, 2013; Norgate & Haque, 2013). Their alternative was to use the IPCC ystem, which over time becomes more popular among mining managers (Lonergan, 1977). Many IPCC systems are designed and built by different companies, (Koehler, 2003) which generally include three fully mobile, semi-mobile, and fixed categories (Dean et al., 2015; Osanloo & Paricheh, 2020). Fully Mobile in-pit Crushing and Conveying (FMIPCC) are designed to be mounted on chain continuous track and can move around the shovel and feed directly from the shovel. Therefore, material trucks are entirely removed from the system (Darling, 2011). ThyssenKrupp company installed the world's first FMIPCC system in 1956 at the Hover limestone mine in Germany (FRIZZEL, 1985; Malhotra, 2009). Semi-Mobile in-pit Crushing and Conveying (SMIPCC) system are placed next to the face, but because the haulage route is short, a small fleet of trucks is needed. After the bench face develops and the pit becomes more profound, the crusher is moved to a new location so that the trucks travel the shortest distance from the face to it (Abbaspour et al., 2019). A study about IPCC shows more inclined to use the SMIPCC type (Osanloo & Paricheh, 2020). The last type is Fixed in-pit Crushing and Conveying (FIPCC) system, which have a fixed place during the life of the mine and are installed near a mine pit on a concrete structure. This type of crusher costs less to grind than other models (Mohammadi et al., 2011).

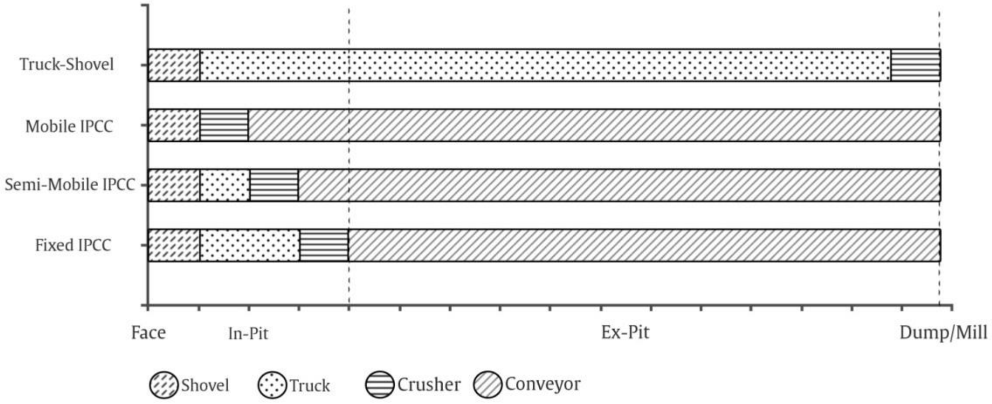

Fig 1. Surface mining transportation systems classification.

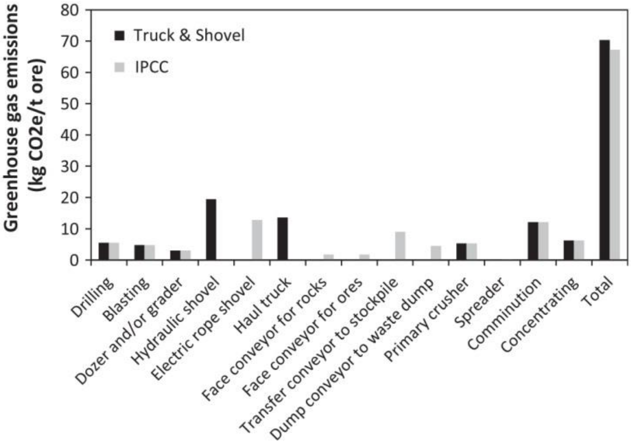

Fig 2. Greenhouse gas emissions from IPCC and TS systems (Norgate & Haque, 2013).

On one hand, each of transportation systems listed above has several economic advantages and disadvantages (de Werk et al., 2017; Mohammadi et al., 2011). On the other hand, they differ less in CO_2 emissions (Fig. 2). Given their imbalance in terms of economic and environmental issues and the importance of balancing them in order to achieve the sustainable development goals, it is necessary to have a general method that can include all indicators and parameters in choosing the right transportation system.

(Awuah-Offei et al., 2009) were among the vanguard Figs in the study of the harmful effects of mines' transportation systems on the environment. Their study focused on belt conveyors and trucks. In their study, the largest share of Global Warming Potential (GWP) related to belt conveyors. Unlike trucks that had high acidification potential. Their findings were inconsistent with those of (Norgate & Haque, 2013) studies. Norgate and Haque looked at it more comprehensively. In a comparison between the LCA - based mine transport systems, if the electricity generated by natural gas used, IPCC can emit 22% less GHG than trucks. This number can be reduced by about four times if it is based on coal-fired electricity. In another study by (Liu et al., 2015) the effect of the slope angle in different transportation systems on energy consumption and carbon emission was investigated, which showed that increasing the slope angle for one t/km material haul, considered a relationship in the ratio of truck to belt conveyor for both options. (Erkayaoğlu & Demirel, 2016) examined the effects of trucks and belt conveyors on climate change and acidification. After studying a 5 km route with the production of 20,000 t/day coal, it concluded that a significant amount of the climate change was related to belt conveyors and versa for trucks in the acidification category. It aligned with the study of (Awuah-Offei et al., 2009). Another study based on the LCA method by (Aguirre-Villegas & Benson, 2017) found that if biodiesel fuel were used instead of diesel, about 40% of GHG emissions and fossil fuels would be reduced. Among various factors, fossil fuel consumption has the most significant impact on the environment and emissions of gases from the mining industry (Agwa-Ejon & Pradhan, 2018; Farjana et al., 2019). (Bharathan et al., 2017) examined the fuel and carbon footprint consumption of transportation systems in 36 different underground mines in Canada. Some of their study findings show that electric haulage consumes less energy than Compressed Natural Gas (CNG) and diesel. However, due to regional electricity conditions, GHG emissions may not always be desirable. In the above-mentioned researches, the effects of mining on the environment have been evaluated mostly after launching the project. However, it is vital to be able to make brighter decisions before designing different parts of the mine to prevent any environmental and economic damages of the project.

Despite all efforts listed above, mining sector lacks a comprehensive method including all important parameters and indicators to select the best possible transportation system for an open-*pit mining* operation that can be implemented prior to project kick off and at the pre-feasibility study and feasibility study stages. In this research we tried to address this problem using a new combined Life Cycle Assessment-Life Cycle Cost Analysis (LCA - LCCA) approach.

2. METHODOLOGY DEVELOPMENT

As one of the most widely used industries, the mining industry is the need to optimize transport methods concerning sustainable development policies. Decisions that are made for the future of this industry are based on conditions that we expect from the future. When we face the future with this intensity of change, the best way to improve the decisions today will be the selection of the best haulage method from this perspective. Hence, optimal models will be of great help in determining the most stable transportation system among selected systems.

Model assumptions

The selection of haulage systems and their associated equipment was carried out to determine their energy consumption in terms of tonnage and distances. In this model, the fleet of equipment is considered homogeneous. That is, all the shovels have the same capacity as similar, as well as all the trucks and other selected equipment are similar in size.

Equations (1-5) is the computation of shovel-truck capacity and production (Osanloo, 2019). Shovels are classified by

m^3/hr based on nominal capacity. This capacity is subject to the size of the bucket, material type, work time, type of haulage equipment, loading, and working conditions. Usually, the values that are declared as shovels production capacities are for intact rock. However, in the case of material haulage equipment, the volume of crushed material is used as capacity.

$$Q_h = \frac{3600 \times BC \times F_f \times F_s \times F_{sk} \times J_e \times Y_b}{C_t} \quad (1)$$

$$Whpd = Nspd \times Whps \times R_a \quad (2)$$

$$N_s = \frac{Q_d}{Q_h \times Whpd} \quad (3)$$

Where: Q_h is shovel production capacity per t/hr, BC is nominal shovel bucket capacity per m^3, F_f is filling factor, F_s is swelling factor, F_{sk} is shovel rotation factor relative to loading height, J_e is operation efficiency, Y_b is rock density per t/m^3, C_t is shovel cycle time per sec, N_s is required shovel quantity, Q_d is required daily production capacity per t, Whpd is useful working hours in a day, Nspd is number of shifts per day and R_a is equipment efficiency. Available time for the mining equipment is 50 min/hr, unless there are other special circumstances (Hartman & Mutmansky, 2002).

The truck production rate per hour from Eq. 4 and its numbers are calculated from Eq. 5:

$$TPH = \frac{60 \times C_{bt} \times F_s \times F_f \times J_e}{T_T} \quad (4)$$

$$N_T = \frac{Q_d}{TPH \times Whpd} \quad (5)$$

Where TPH is truck theoretical production rate per t/hr, C_{bt} is truck dump box capacity per t, T_T is truck cycle time per min and N_T is num of trucks.

The capacity of the truck must be as standard 3-5 times of the shovel bucket capacity. Of course, the upper limit of this capacity is sometimes up to 6 times (Caterpillar, 2001).

The truck cycle time can also be calculated using Eq. 6:

$$T_T = \frac{60}{1000}\left(\frac{HD}{LTS} + \frac{HD}{ETS}\right) + MA + LO + DU + SP \quad (6)$$

Where: HD is haulage distance in each cycle per m, LTS and ETS are loaded and empty travel velocity per Km/hr, respectively, MA is loaded and empty idle time, LO is loading time, DU is dumping time and SP is spot time per min. Details of the technical parameters listed in Table 1 can be seen.

2.1. Energy consumption measurement

To obtain energy consumption, it is first necessary to provide equations for estimating fuel and electricity consumption for diesel equipment and belt conveyors. In general, there are two ways to obtain fuel consumption; Use of mines dataset and refer to the equipment manufacturer's guide. If it is not available, its value can be estimated by the existing equations. (Filas, 2002; Runge, 1998) were able to estimate the fuel consumption by the following equation:

$$FC = P \times LF \times 0.3 \quad (7)$$

In the above equation, FC is amount of fuel consumption per L/hr to move equipment with engine power P (kW), LF is engine load factor. Its value varies between 0.25-0.75 and 0.3 is conversion rate (L/kW/hr).

Furthermore, the energy consumption of the belt conveyor can be estimated in relation to the capacity, length and amount of useful working hours through Eq. 8 (Paricheh & Osanloo, 2019).

$$HP = 0.262 \times \left(\frac{PR}{1000}\right) + 0.144 \quad (8)$$

Table 1. The values of technical parameters.

No.	Parameter	Value

1	Rock density (t/m^3)	1.8
2	Swelling factor (%)	80
3	Bucket fill factor (%)	90
4	Shovel cycle time (sec)	24
5	Shovel rotation factor (%)	80
6	Shovel operating efficiency (%)	75
7	Truck operating efficiency (%)	75
8	Fuel density (kg/l)	0.85
9	Daily useful work (hr)	20
10	Power factor	0.8

Where HP is required horsepower for each meter of belt and PR is production rate per t/hr.

Life cycle assessment

LCA can be chosen as a valuable way to evaluate the environmental impact of various types of mining haulage systems and provide a more comprehensive understanding of their environmental impacts. By using LCA, it is possible to determine the number of pollutant emissions at each stage of the life cycle and to adopt policies that reduce pollution as much as possible.

Generally, the main steps in LCA include determining a purpose and defining the scope of the study, Life Cycle Inventory (LCI) analysis, Life Cycle Impact Assessment (LCIA), and interpreting the results. These steps should be performed in each LCA study, according to the ISO 14040 and 14044 standard (Kittipongvises, 2017).

2.2. Goal and scope definition

According to existing standards, the first step in LCA is to specify the goal and define the scope. The aim of this study, evaluate and compare environmental and economic effects on mining haulage scenarios and identifying the best option that has the least damaging. For this purpose, four scenarios have been studied, which are: Truck Shovel (TS), Fully Mobile IPCC (FMIPCC), Semi-Mobile IPCC (SMIPCC), and Fixed IPCC (FIPCC).

The functional unit makes it possible to compare various systems with data normalization via an input and output with a reference unit (Restrepo et al., 2015; Sonesson et al., 2010). In different studies, depending on the goals, a different functional unit can be considered (Morales et al., 2019). In this study, the functional unit is defined as 1 ton of extracted material, which depending on the arrangement of scenarios.

One of the most complicated steps in LCA is determining the system boundary (LeVan, 1995). System boundary must be determined in such a way that it is determined in the direction of the goal. Besides, any activity within the system boundary should affect the outcome of the assessment. In this study, the system boundary consists of fuel consumption (diesel) by equipment, emissions result from it, and the materials used to construct the dirt road for the mine.

2.3. Life cycle inventory analysis

This stage of LCA involves gathering and quantification of input and output data (ISO, 2006), which, details of the inputs (materials and energy) and system outputs (emission to the environment) are prepared for mining haulage.

Constraints and assumptions

According to a case study, it is a hypothetical and simulated mine with the Sungun copper mine in Iran. Following this situation, no monitoring and operational datasets were available for research, and to perform the necessary assessments, information that is available to the public has been used. Given that FMIPCC does not require any road construction, for other scenarios, the same road infrastructure is assumed to be the same. The difference is that the length of the road varies for different scenarios. Road width is 30 meters and is considered the same for all roads. For ease of operation, the input materials and energy are limited to the fuel consumed by the equipment for transporting the mineral and materials used in road construction. As well as waste and pollutants are also limited to gas emissions from fuel consumed by equipment. Details of the items specified are visible in Table 2.

Primary data

Primary data include recorded information, such as the amount of energy consumption and the required materials for road construction. In this study, the part of the equipment fuel consumption was estimated through the data provided by the equipment manufacturer (Caterpillar, 2017), and the remaining part was estimated by following the presented equations in section 2.1. Other equipment, including dozer, crushers, generators, were selected according to the characteristics of each scenario.

HOMER 2.68 Beta software was used to design and select the most stable generator for required energy in each of the scenarios, which fuel consumption of the generators was also calculated using it. Furthermore, for the foundation of roads according to "Guidelines for Mine Haul Road Design" (Tannant & Regensburg, 2001), it is assumed that three layers of Pit-run Gravel, Crushed Gravel, and sand are also used, that thickness of these layers is determined by overall thickness and amount of load passing through the road.

Secondary data

Includes emissions datasets from types of equipment, such as: CO, CO_2, CH_4, N_2O, NO_x, NMVOCs, SO_2, NH_3, which cannot be measured directly and are calculated according to the instructions. The influence range of these pollutants into water, soil, and air. Given the defined system boundary, only gas emissions that enter the air have been investigated. In this study, the HOMER software used again to determine the gas emissions from the generator. To calculate the emissions, other equipment was treated according to the IPCC and EMEP/EEA guidelines (EMEP, 2019; OECD & IEA, 1996).

2.4. Life cycle impact assessment

This process used to provide a link between inventory and environmental impacts as well as information to interpret the life cycle (ISO, 1997). There are several applications for this connection, such as SimaPro, Gabi,

Table 2. Summary of used datasets

	Types of systems			
Parameters	**TS**	**FMIPCC**	**SMIPCC**	**FIPCC**
Ore production, t/d	**60000**	**60000**	**60000**	**60000**
Haul profile				
Total truck round trip, m	4000	0	500	2000
Total belt conveyor length, m	0	3100	2700	1550
Equipment details				
Hydraulic shovels, 30t	1	1	1	1
Dump trucks, 140t	13	0	6	9
Dozers, 97kW	2	2	2	2
Pickup trucks	4	2	3	3
Diesel generator required, kW/h	450	1847.0	3190.5	1373.5
Total Diesel fuel consumption, L/h	789.3	751.5	920.3	864.8

	Types of systems			
Parameters	**TS**	**FMIPCC**	**SMIPCC**	**FIPCC**
Hourly personnel requirements				
Truck drivers	17	2	9	12
Equipment operators	5	7	7	7
Control Room Operators	3	2	2	2
Crusher Operator	3	2	3	3
Utility operators	1	2	2	2
Mechanics/electricians	16	5	10	12
Laborers/maintenance	26	3	13	17
Total hourly personnel	**65**	**19**	**41**	**50**
Salaried personnel requirements				
Manager	1	1	1	1
Superintendent	1	1	1	1
Engineer	3	2	2	2
Supervisor	3	3	3	3
Technician	5	3	4	4
Total salaried personnel	**13**	**10**	**11**	**11**
Operating costs, $/Year				
Supplies & Materials	18,826,460	27,630,580	14,642,416	16,418,524
Labor	36,510,004	20,741,374	27,592,980	29,919,286
Sundry Items	5,533,646	4,837,195	4,223,540	4,633,781
Environmental Prices	6,246,071	7,204,702	8,482,808	9,815,289
Total operating costs	**67,116,180**	**60,413,851**	**54,941,744**	**60,786,879**
Capital costs, $				
Haul Roads/Site Work	5,183,912	375,833	647,965	2,527,156
Dump and pickup truck	30,133,379	70,000	13,948,098	20,869,647
Shovel and dozer	3,842,583	3,842,583	3,842,583	3,842,583
Crusher	4,244,584	28,615,000	4,244,584	4,244,584
Crusher installation cost	6,027,309	0	3971997	6,027,309
Belt conveyor	0	32,600,000	27,900,000	15,650,000
Belt installation cost	0	9,780,000	8,370,000	4,695,000
Generator	790,000	3,190,000	3,600,000	2,400,000
Installation labor cost	882,814	4,779,989	3,152,966	2,225,337
Transportation cost	3,901,055	6,831,758	5,353,527	4,700,681
Auxiliaries	5,500,564	9,008,516	7,503,172	6,718,230
Total capital costs, $	**60,506,199**	**99,093,679**	**82,534,892**	**73,900,527**

Source: Data from InfoMine USA 2007 (Normalized by 2020) and equipment manufacturer's guide

OpenLCA, etc. Each of these software includes a large number of evaluation methods, which Some of them scrutiny midpoint indicators that focus on single environmental problems (such as GWP and ozone depletion, etc.) and some of scrutiny endpoint indicators that focus on human health, ecosystems, resource, and others examine both and the connection between them. Finally, according to the data collected and the goal and boundary of the defined system, method or assessment methods are selected. It may be used in a study due to the goal of multiple assessment methods. ReCiPe method is one of several methods in the SimaPro software used in this study. The results obtained from ReCiPe method with 18 midpoint and 3 endpoints can be expressed. In this study, due to lower uncertainty (Goedkoop et al., 2008), the hierarchism midpoint approach was used, and among the available midpoint, climate change, terrestrial acidification, human toxicity, photochemical oxidant formation, particulate matter formation were chosen.

Life cycle cost analysis

In many fields, the economic comparison of alternatives is the fundamental pivot of decisions and is one of the essential pillars of sustainable development, especially for project owners. There are several ways to conduct an economic study, such as LCCA, which can cover all life costs, including initial and long-term costs (fuel, spare parts, maintenance, labor, replacement, etc.) that can be consider in economic evaluation (Haghshenas & Vaziri, 2012; Rossi et al., 2013; Yu et al., 2013). The initial formation of LCCA dates back to 1965, which was expressed in a report titled "Life Cycle Costing in Equipment Procurement" (LMI, 1965). This method, considering all the costs, it makes a correct and accurate comparison of the different scenarios and selects the most valuable and least expensive option here.

The economic rules in the LCCA method play a significant role as it is required to calculate costs, information, and economic relations. In these calculations, one of the most critical points is to calculate future cost value when it is obtained according to the annual inflation rate (interest rate).

Eq. 9 is used to calculate the future cost value:

$$F_n = P(1 + i)^n \tag{9}$$

Where F_n is future cost value in n_{th} year, P is the current cost value and i is the interest rate.

2.5. Cost data

Mine road construction

Given that road is considered to be dirt, most of mines use the materials in the mine to build it, which prevents materials from entering from outside the mine (Tannant & Regensburg, 2001), and as a result, it prevents materials from transport and resulting costs. Besides, according to the system boundary, the transportation of these materials is outside the system boundary. The cost associated with road construction materials and site work varies depending on the road and type of scenario. Road construction costs are part of the initial costs and are independent of mining operations in the remainder of the mine life.

Mine material haulage

All costs were selected according to the LCA study boundary. The purchasing equipment cost in the first year of mine life is one of the initial costs and operating costs, which is one of the long-term or secondary costs. A large part of it depends on the amount of extracted mineral and other mining operations. In this study, the interest rate is the 3%, salvage value is 20% of purchasing cost on a 20-year mining life period were considered for all scenarios. The selected useful life for trucks was 45,000 hr (Dean et al., 2015), and for other equipment, it was selected according to the guidelines provided by the manufacturers, and at the end of their lives, the replacement option was considered.

Additional information is provided in Table 2 (Infomine, 2007).

Applying the LCA-LCCA framework

Due to the need to use scientific and explicit criteria regarding the assessment of costs imposed on the environment, proper knowledge of environmental prices can determine the amount of lost economic welfare per kilogram of pollutants. In this study, the factors created by the CE Delft research organization, which was recently developed in the SimaPro 9.0 version, were used to calculate environmental prices. These costs were included as part of annual operating costs in LCCA. The value of each price in the impact categories used in the LCA is shown in Table 3 (Bruyn et al., 2018).

Table 3. Midpoint level environmental prices (€$_{2015}$/unit)

Theme	Unit	External cost	Weighting factor
Climate change	€/kg CO2-eq.	€ 0.0566	€ 0.0566
Acidification	€/kg SO2-eq.	€ 4.97	€ 7.48
Human toxicity	€/kg 1,4 DB-eq.	€ 0.0991	€ 0.0894
Photochemical oxidant	€/kg NMVOC-eq.	€ 1.15	€ 1.15
Particulate matter	€/kg PM10-eq.	€ 39.2	€ 39.2

RESULT

Life cycle assessment

2.6. Mine road construction

In this phase, FMIPC does not require any road construction due to the equipment it uses, and at this stage, it does not cause any environmental damage. Instead, TS has the most extended road length and therefore requires more infrastructure than other scenarios. For the reason that the amount of material needed for infrastructure roads is based on the selected guide, about 85% of the thickness layer is made up of sand and pit-run gravel, and because they are materials that can be found on the mine site and do not require special operations, they have a minimal environmental impact. Versus, about 15% of the remaining thickness, is filled with crushed gravel, which has the highest environmental impact compared to the other two materials. Considering that the thickness and width of the road are the same in all scenarios, it is not surprising that as the length of a road increases, so makes its environmental impact.

2.7. Mine material haulage

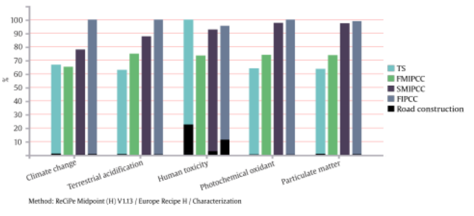

Fig 3. Comparison of scenarios in different impact categories on the environment (first-year).

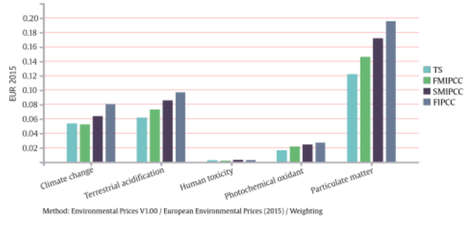

Fig 4. Comparison of environmental prices as for hauling 1 ton of materials.

At the haul stage, SMIPCC consumes more fuel than other scenarios. In terms of gas emissions, this scenario has the highest emissions of CH_4, N_2O, NMVOCs, SO_2, and

NH_3 gases. Furthermore, FIPCC, which is the second most-consumed scenario in terms of fuel consumption, releases more CO, CO_2, and NO_x gases into the environment than other scenarios. Differences in emissions from FMIPCC and SMIPCC, can be due to the use of extra trucks fleet and compared to TS, the belt conveyor can justify more energy consumption despite the simultaneous fuel consumption of trucks.

2.8. Impact evaluation analysis

Fig. 3 shows the midpoint impact for all scenarios in road construction and haulage. Road construction has the most significant impact on human toxicity and has little impact on other impact categories. In all the studied effects except human toxicity, FIPCC has a significant impact on the environment. At the same time, SMIPCC is in the first place in terms of fuel consumption, and FIPCC in second place. Nevertheless, based on the length of the road construction, the SMIPCC requires a much shorter length than the FIPCC, and this can make a small contribution to the difference between the expected and obtained results. Because FMIPCC consumes less fuel than other scenarios and does not require a truck fleet, it has the least impact in the category of human toxicity and climate change. TS, on the other hand, has less effect on acidification, photochemical oxidant, and particulate matter than other scenarios.

Life cycle cost analysis

According to the environmental prices obtained in Fig. 4 and the results used in the color ranking system technique presented in Table 4, TS has a low capital cost, in contrast, the FMIPCC has a higher. Since the TS requires the truck's replacement for every seven years, the cost of this method increases over time, so that it is the most expensive method after the fourth year and long run.

Table 4. Future cost analysis during mine life (10^7 \$).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TS	6	12	20	28	36	45	54	64	78	89	101	113	126	140	154	169	189	205	223	241	261
FMIPCC	10	15	22	29	37	45	53	63	72	82	93	104	116	128	141	155	169	184	200	217	234
SMIPCC	8	13	19	26	33	40	48	56	66	75	85	96	106	117	129	142	157	170	185	200	216
FIPCC	7	13	20	27	35	43	51	60	72	82	93	104	116	128	141	155	172	187	203	220	238

FMIPCC, which is one of the Eco-Friendly scenarios, economically viable, it is one of the costliest, and in the first year and long-term shows its economic weakness. But its long-term cost is lower than TS.

SMIPCC is the second most costly scenario in the first year at the cost of \$82 million. Indicates that this method has a high initial purchase cost, but from the second year, its costs are reduced, and in the long run, it is among the lowest cost scenarios and ranks first among other competitors.

Finally, FIPCC has a lower capital cost than SMIPCC and more than TS, but over time its cost increases so that its long-term cost is higher than SMIPCC and lower than TS.

CONCLUSION

Following the intensification of environmental pollution due to fossil fuel consumption and climate change, the world is trying to find a Course of action to this crisis through renewable energy energies. A large part of the electricity produced in developed countries is using fossil fuels, which means that fossil fuels are used to support various industries, including mines. Therefore, the system boundary is from the base, including the power generation required by the mine.

According to the results presented by following the two aspects of the environment and economy, the use of SMIPCC system is more economical into input characteristics. Although the use of this system requires a high capital investment, due to its low operating costs after the early years, it becomes more cost-effective than other scenarios. It also makes it more necessary to continuity production and reduces environmental pollution, labor, energy, traffic, road construction.

In the end, it should be noted that the advantage and difference of the research is the ability to perform the stability assessment of mining haulage systems with incomplete or partial information. The main challenge for this study was to complete and develop the datasets for analysis, which has not yet been developed in the haulage system in open-pit mining. Also, considering the deficit of social criteria in the field of sustainable mining development, it is hoped that by adding this approach along with the two studied factors, it will be used to evaluate and select the most sustainable system.

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IMPLEMENTING THE SUSTAINABLE DEVELOPMENT REPORT IN VIETNAM NATIONAL COAL AND MINERAL INDUSTRY GROUP

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Abstract: *Nowadays, more and more businesses are publishing nonfinancial information to fulfill their performance and sustainability requirements and accountability requirements. Although Vietnam National Coal - Mineral Industries Holding Corporation Limited (Vinacomin) has achieved remarkable results in recent years, it maintained the role as one of the first leading energy suppliers to industries. Still, it cannot negatively impact the environment due to mining and mineral processing activities' specific characteristics. To achieve the goal of sustainable development and economic development, Vinacomin also pays great attention to human development and implements social responsibility and environmental remedies. However, these results are not widely known because Vinacomin has not paid much attention to developing a sustainable development report. The article discusses the Sustainable Development Report's current status in Vietnamese enterprises and some solutions to realize the Sustainable Development Report in Vinacomin.*

Keywords: *the Sustainable Development Report, nonfinacial, Vinacomin.*

1. INTRODUCTION

According to the Business Council on annual sustainable development, the sustainable development report (Sustainable Development) is considered a measurement, disclosure, accountability and commitment of the business' responsibility to the concerned parties about sustainable development activities. The Businesses develop and publish a Sustainable Development Report to evaluate and disseminate information on the operational efficiency of businesses on environmental and social aspects in addition to information on financial, operational efficiency and capital management, which is the information normally published.

The Sustainable Development Report is a new tool that helps businesses and Groups publish sustainable development information in the same way as financial statements. Through transparent, accountable and responsible reporting, businesses strengthen the confidence of the related parties in firms. The report also promotes improvements in many aspects of the business' production and operation, thereby helping businesses develop more comprehensively. Sustainable Development Report is also a tool to improve businesses' awareness of new business risks and opportunities. From this perspective, the Sustainable Development Report helps businesses prepare for recent development trends, decentralize responsibilities, and gradually improve operational efficiency management systems.

2. SITUATION OF IMPLEMENTING SUSTAINABLE DEVELOPMENT REPORT IN VIETNAMESE BUSINESSES

In Vietnam, according to the provisions of Circular No. 155/2015/TT-BTC dated October 6, 2015, guiding the disclosure of information on the stock market, the disclosure of information on environmental and social indicators are a mandatory requirement for all companies listed on the exchange, this helps businesses meet the obligation of transparency of information to related parties. The Circular clearly states:

"Reporting on environmental and social impacts of companies and public companies must report on sustainable development-related contents, including: management of raw materials, energy consumption, water consumption, compliance with the law on environmental protection, policies related to the employees, the report related to responsibilities to local communities, the report related to the green capital market. The businesses can prepare a Sustainable Development Report or present it in the annual report".

Over the past time, being aware of the importance of the application of the Sustainable Development Report in businesses' activities, the management agencies and business community have many positive moves. In August 2019, the State Securities Commission of Vietnam introduced the first Corporate Management Code of Vietnam, including several principles regulating the integration of sustainable development factors such as environment, socialize the enterprise's strategy, while encouraging the disclosure and transparency of non-financial information to investors, regulatory agencies, and the community. Particularly for listed public companies, Ho Chi Minh City Stock Exchange (HoSE) has given some important initiatives such as the Vietnam Sustainable Development Index (VNSI) basket, choosing 20 highest listed companies in practicing Governance - Society - Environment. The VNSI index partly shows the investment effectiveness of sustainable stocks and attracts investment funds and international organizations to operate under the Principles Of Responsible Investment (PRI).

Another operation that is organized by Vietnam Chamber of Commerce and Industry (VCCI), Vietnam Business Council for Sustainable Development and related Ministries and Branches is a rating program to publish sustainable businesses based on Corporate Sustainability Index (CSI). Up to now, the rating program has contributed to promoting the implementation and spread of sustainable development models and initiatives in the business community. The CSI has also been reviewed and revised to be more in line with international practices and the revised and updated legal regulations so that CSI can become a standard measure of sustainable development integration in the businesses' whole operation. Besides, there is the Sustainable Development Report Award in the framework of the annual report poll jointly organized by HoSE, Vietnam Investment Review and Dragon Capital Management Limited. This award is proposed to guide the businesses to care, learn, and prepare sustainable development reports. Through that, businesses honored in the Sustainable Development Report Award also receive community encouragement and strengthen investors' belief. The awarded Sustainable Development Reports also become a valuable source of illustration materials for other businesses to learn to prepare a Sustainable Development Report.

Notably, in Vietnam, many businesses and economic groups have pioneered in preparing Sustainable Development Report right from the time when there is no legal requirement to prepare the Sustainable Development Report such as BaoViet Holding (BVH), Vietnam Dairy Products Joint Stock Company (VNM), DHG Pharmaceutical Joint Stock Company (DHG), etc. A number of businesses have voluntarily applied the popular sustainable development report frameworks globally, such as the set of standards of the Global Reporting Initiative (GRI). Many pioneering companies have conducted a detailed assessment of the level of sustainable development integration into their strategies and operations. A few other businesses have surveyed the related benefit parties' opinions with the most comprehensive and multidimensional development of the Sustainable Development Report.

Specifically, BaoViet Holdings has very well integrated the contents of the reports under the GRI Standards and the 17 Sustainable Development Goals of the United Nations into its operations and reports. The Sustainable Development Report over the years of BaoViet Holdings is highly appreciated in both content and form, clearly demonstrating management processes, including assessing key issues, risks, feedbacks and expectations. The related parties' involvement in developing specific plans and targets to ensure sustainable growth.

Table 1. Five indicators are guaranteed by internal audit in the Sustainable Development Index of 2019 from BaoViet Holdings

No.	Indicators	Contents
1	GRI 202 - 1	The agreed salary rate of new recruits by gender compared to the regional minimum salary.
2	GRI 401 - 1	New recruits and retires
3	GRI 404 - 1	Average training hours per year for each employee
4	GRI 413 - 1	Activities involving local communities, impact assessments and development programs
5	GRI G4 - FS7	Value (in cash) of products and services designed to serve a given social benefit for each business fields by purposes

Source: Sustainable Development Index of BaoViet Holdings

In 2019, the Sustainable Development Report of Vietnam Dairy Products Joint Stock Company - Vinamilk (VNM) was prepared according to GRI Standard with a clear structure, brief presentation, combined with the use of drawings, illustrations and charts in a logical way. The report of VNM has visually and effectively conveyed to the readers' specific strategies and actions of the Company in sustainable development, demonstrating the connection between sustainable development of VNM and the global sustainable development context in general and Vietnam's dairy industry in particular in accordance with 17 United Nations' Sustainable Development Goals framework.

Century Synthetic Fiber Corporation has achieved remarkable achievements in three consecutive years in the TOP 10 Sustainable Development Report, which is also a proof of the implementation of the sustainable development commitment that the Company has set, not only bringing the economic interests but also always interested in the implementation of measures to protect the environment and create positive social impacts.

3. SOLUTIONS TO IMPLEMENT THE SUSTAINABLE DEVELOPMENT REPORT OF VIETNAM NATIONAL COAL - MINERAL INDUSTRIES HOLDING CORPORATION LIMITED

Vietnam National Coal - Mineral Industries Holding Corporation Limited (Vinacomin) was established in 2005, with the orientation to develop the coal and mineral industry, electricity industry, explosive industrial industry and other related industries in a sustainable manner; meet the coal demand of the economy, contribute to ensuring national energy security.

Since its establishment, Vinacomin has set up an internal management structure, with the operating structure following the Parent Company's model - Subsidiary Company and the diversified business model based on Coal - Mineral. With the organizational model, the development strategy, and the above management structure, Vinacomin has brought Vietnam's coal and mineral industry strong development step by step. In 2019, Vinacomin grew well in the main product of coal, meeting large consumers' needs, especially for electricity production.

Specifically, raw coal reached 40.5 million tons, equal to 101% of the plan; coal consumption reached 44.02 million tons, equivalent to 105% of the plan. In particular, domestic coal consumption reached 42.95 million tons, equal to 108% in 2018. Particularly coal consumption for electricity reached 36.06 million tons, increased 6.8 million tons in absolute number and 24% in relative numbers compared to the performance of 2018.

Imported coal reached 6.5 million tons, equal to 141% of the plan of 5.7 million tons increase compared to the same period of 2018. Aluminum production exceeds design capacity. Both Tan Rai and Nhan Co plants exceeded 5% of design capacity. Production reached 1.36 million tons, consumption reached 1.39 million tons, exceeding 7% of the plan. Other production sectors such as manufacturing industrial explosives, mechanical production, and fields of mineral exploration and prospecting are guaranteed. The total revenue of Vinacomin reached 131.5 trillion VND, which increased by 9% compared to 2018. Submit to the State budget 18.1 trillion VND, increased 1.5 trillion VND compared to the implementation of 2018. The Group's profit reached over 4,000 billion VND and increased 1,000 billion VND compared to the plan...

It can be seen that the achievements brought about from production and business operation at Vinacomin in recent years are undeniable. However, due to the specific characteristics of mineral mining and processing activities, it has caused many bad effects for the ecological and social environment such as labor accidents, due to the job characteristics causing many occupational diseases, the coal mining process causes many pollutions and harmful effects on the ecological environment. Thus there are many serious environmental consequences for mining areas such as water pollution, air pollution, damaging landscape, forests, farming land, and destruction of flora and fauna, etc.

To overcome this situation, every year, Vinacomin has set up the Coal - Mineral Environment Fund with a maximum deduction of 1.5% of the total revenue of coal - mineral production and processing units, with a total the Fund is tens of thousands of billion dong, aiming to pay for environmental protection fee and environmental tax payment; established the Fund of environmental renovation and restoration for mineral exploitation activities. Up to now, all units in the Group have prepared Environmental Impact Assessment (EIA), environmental protection commitments (62/62 units), approved 132/134 EIAs of coal and mineral mining and processing projects; well paying environmental protection fee for mineral exploitation and environmental protection fee for wastewater. Renovation and restoration the environment projects after coal mining are completed: 77 projects have been approved, 20 are pending approval and 13/ 115 projects are under preparation; Since 2014, the hazardous waste treatment plant in Cam Pha has been in stable operation, annually processing millions of liters of lubricant to ensure the quality re-supplied to power plants in the Group.

However, these results are not well known because Vinacomin has not yet prepared a Sustainable Development Report. To implement the Sustainable Development Report to provide the investors with more comprehensive information and meet the Sustainable Development requirements in the context of integration, Vinacomin should pay attention to the following issues:

Firstly, change the perception of the Sustainable Development Report's implementation: Failure to publish or limit the disclosure of the non-financial problems according to operational efficiency indicators may reduce Vinacomin's access ability to capital. Moreover, in the absence of interpretation related to sustainable development issues, it will be impossible to maximize the competitive advantage and face risks of losing customers and related parties' trust.

Secondly, Establish an integrated strategy for sustainable development, consider the investing resources to improve the management ability, gradually approach international standards' normal practices. Vinacomin needs to focus on data quality, processes and controls to create a meaningful report for the related parties. At the same time, pay attention to update on new trends and regulations to ensure effective communication with related parties.

Thirdly, Vinacomin should disclose the options for applying GRI's reporting standards, as well as disclose the evaluation criteria for selected key topics. The Vinacomin Sustainable Development Report proposal may include key fields and the following evaluation criteria (Table 2):

Table 2. Key fields and the following evaluation criteria in Vinacomin Sustainable Development Report

Aspects		Key fields	Evaluation criteria
Economic	Economic operational efficiency	Sustainable growth	Total consolidated revenue Consolidated profit before tax
		Value brought to shareholders and investors	Value paid to shareholders and investors
		Value brought to the government	Contribute to National Budget
		Salary and employee benefits	Average salary and employee benefits
	Indirect economic impact	Value traded with suppliers	Value traded with suppliers
		Create sustainable jobs	Jobs created at Vinacomin
		Develop local economic	The amount supporting local economic development, the amount of coal provided for local economic development
Society	Labor and employmen t	Salary and benefits	% of employees satisfied with salaries and benefits
		Solidarity and loyalty	% of retire employees
		Occupational health and safety	Accident rate, Occupational disease rate, Lost working day rate
		Training and developing	Number of training courses held
		Diversity, equality and open exchange	Number of turns of participants in training courses
		Labor relations	Rate of employees participating in collective labor agreement
	Product responsibili ty	Safe and quality products	The rate of product quality according to standards
		Responsible communication and marketing	Number of misconduct incidents related to responsible marketing and communications
		Satisfied customers	% satisfy domestic customers % satisfy international customers
Environment	Wastes and waste water	Control waste water and waste	Total amount of wastewater by source(m3)

Aspects		Key fields	Evaluation criteria
			Total amount of waste by type and disposal method Incidents related to the environment
	Materials, Energy	Using materials and energy efficiently	Number of materials, energy consumed / ton of product
		Modern technology and green energy	Compressed Natural gas (CNG) / total used energy Biomass energy / Total used energy
	Land	Sustainable land management	Value for planting trees to make green and prevent erosion
	Water	Use water responsibly, efficiently, and recirculating	Rate of water taken back Amount of water used
	Emission	Reduce CO_2 waste air	Waste CO_2/product ton
		Climate change protection	

Fourthly, enhance the comparability of the information by making targets and comparing it with other groups, comparing with previous years, instead of presenting only the recent data of 1 year as currently. It is also advisable to select the key data and have a direct comparison of these targets with domestic or regional regulations.

Fifthly, in the short-term conditions, if a separate Sustainable Development Report cannot be prepared, Vinacomin considers integrating the criteria of the Sustainable Development Report in the Group's annual financial statements, some of the less important and reference content can be transferred to the separate appendix. Regarding the presentation format, it is also advisable to replace tables to charts to improve the visualization and make the report more clear and attractive to readers.

Sixthly, focusing on the publication of sustainable development reports to achieve the highest efficiency, such as publishing sustainable development reports on the website, is also a right, reasonable and low-cost way. In addition, Vinacomin should also pay attention to the Sustainable Development Report's media on the mass media.

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DEVELOPING A SUITABLE BLAST DESIGN FOR DESIRED FRAGMENTATION IN YBB MONG SON QUARRY, VIETNAM

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Abstract: *Despite the rapid growth in technology of breaking rock mass and excavating the ore, blasting is still the most efficient and effective way of extracting the ore. The primary purpose of blasting is rock fragmentation and displacement of the broken rock. A blasted rock muckpile and the fragment sizes within it are very important for the mining industry since they affect the downstream processes from hauling, crushing to grinding. Here, to extract the ore in an economically viable way is a majority and consequently a proper blast design for the desired fragment size is a vital factor that affects the cost of entire mining activities. In this paper, the development of a suitable blast design of YBB Mong Son Quarry for the desired fragmentation using the Kuz-Ram model is stated. Here, the most influencing design parametric values on average sized fragmentation of the case study, which is between 600-800mm fragment sizes, are categorized thereby creating an economically effective blast design. It can be concluded that by adjusting the influencing design parameters on rock fragmentation by blasting, the desired results in fragment size of the rock required by the mine can be obtained either up to or more than 80% passing, thereby reducing the corresponding costs of the further operations of the next stages in mining and improving the economical conditions of the mine.*

Keywords: *rock blasting design, blast design parameters, fragmentation, fragment size, economical, Kuz-Ram model.*

1. INTRODUCTION

Mining is the production of various minerals from the earth and natural environment by the method of excavation for further purposes. These excavation methods can be both surface and underground. Surface excavation methods are the most common of all other methods. Quarry mine production is one of the basic methods of surface mining methods. The quarry mine production has various operations such as drilling, charging, blasting, and loading, hauling and dumping, which are related to each other. Rock blasting at quarries represents multiple challenges that we cannot see at the first sight. Surface mining operation and quarry projects still depend largely on blasting as a method of excavation (Hartmanet al., 2002).

In blasting, there is always a question of how well the blast is performed relative to the results required by the quarry of mine operator such that the overall cost-effectiveness of the production operations requires drilling and blasting to be optimized. The efficiency of blasting is determined by the degree of matching the blast outcome and the required fragment size. Therefore, fragmentation is one of the most important aspect of production blasting because of its direct effects on the cost of drilling and blasting and on the economics of the subsequent operations of loading, hauling and crushing. Inadequate fragmentation, the direct result of poor drilling and blasting techniques, results in oversized, and hard digging for the excavating equipment. As a result, it may cause higher secondary blasting costs, reduced excavation efficiencies, higher excavation costs, higher roads repair costs, and higher haulage equipment costs. Due to these problems, the fragmentation is one of the most important parameters in blasting for a mine production to be economically viable. The blasting design parameters influencing on rock fragmentation are categorized in order to develop a suitable blast design for the desired rock fragment size of the quarry of the case study, to be economically effective and efficient.

The case study goes for a white marble quarry in Yen Bai, Vietnam. In 1994, a Thai company named Banpu visits a cement production in Mong Son area, Vietnam. Banpu company researched the calcium carbonate (white marble) ore in 1996 and started registered to excavate the ore and perform mining operations legally in 1997, thereby changing the name of the company to YBB Calcium Products Company Ltd. The extraction of ore and white marble is produced continuously and starting from 2005, YBB company was taken over by IMERYS. Since then till now YBB is a member of IMERYS in Vietnam. The project is located in Northeast of Vietnam, Yen Bai Province, Yen Binh District, Mong Son Commune. The project is situated alongside of the Thac Ba River, or likewise the location of it is at latitude of 21° 52’ 22”N and longitude of 104° 54’ 53”E. It is 17.3 km away from Yen Bai city and 133 km from Hanoi Capital of Vietnam. The quarry totally covers 13.39 hectares and is divided into Zone A and Zone B as shown in Fig 1.7. The currently running project is zone A, which covers 11.81 hectares and zone B is kept for extraction in future. The top of the quarry is 325 m and the bench is currently at 194-202m. The capacity of the mine is 720k ton/year and according to the new license of mine, the estimate mine life is 14 years. However, now the quarry has already been extracted up to the capacity of only 400k ton/year after 14 years now so the extended estimate of mine life is 25-28 years. The products released are as follows;

- Chips - (6-50mm) - 9.5%
- Small lump - (50-140mm) - 19.5%
- Lump - (140-400mm) - 54%

and the rest 17% are waste, which are undersize (<15mm). The capacity of crusher was 180 ton/hour before and currently it is 200 ton/hour.

The existing design calculations will be described, determining whether the fragmentation results are economically viable. Moreover, development of a blast design for the desired fragment rock size of the quarry will be proposed using a semi empirical formula named Kuz-Ram model. This model is modified by Cunningham (1983), from Kuznetsov’s empirical equation to estimate the mean fragment size using the Rossin Rammler distribution to describe the entire size distribution of a blast.

2. AIM AND OBJECTIVE

There are many factors which impact upon profit and productivity. Majority of all these factors depend on how well a blast is designed. Thus, the primary objective of this paper is to develop a blasting design to optimize the blast performance in an economically viable way.

3. BLAST DESIGN PARAMETERS

Blasting can quickly fragment even the hardest known rocks over a large area. Their efficiency is largely dependent upon the proper choice of explosive, the weight of the charge, the number, depth and location of shot-holes, geological and hydro-geological conditions of the ground, physical and mechanical properties of rock to be excavated. The required blast design parametric values must be described using various methods and determine the most effective and efficient method to be applied for the desired results to be obtained.

3.1. Bench geometry

Bench height

Bench height is the vertical distance between the top and the floor of the bench. Unless geologic conditions dictate, all benches should have the same height. The height will depend on the physical characteristics of the deposit; the degree of selectivity required in separating the ore and waste with the loading equipment, the rate of production and the size and type of equipment to meet production requirements, and the climate conditions.

Relation between bench height and blast hole diameter is

D = (0.06 to 0.12) H

D = hole diameter (in.) (1)

H = bench height (ft.)

Bench width

There is a minimum bench width, measured horizontally in a direction perpendicular to the pit wall. The width must be such that the stability of excavation both before and after blasting should be ensured.

3.2. Blast geometry

3.2.1 . Hole diameter

The size of the blasthole is the very first consideration of any blast design. The blasthole diameter along with the type of explosives used and the type of rock being blasted, will determine the burden. The hole diameter is selected such that in combination with appropriate positioning of the holes, will give proper fragmentation suitable for loading, transportation equipment and crusher used. Additional factor that should be considered in the determination of the hole diameter are bench height, type of explosive, rock characteristics, and average production per hour.

3.2.2 . Burden

Burden is the distance from the blasthole to the nearest free face at the instant of detonation. With multiple row blast, the burden may not necessarily be given as the distance to the nearest free face. As boreholes with lower delay periods detonate, they too create new free faces. As a result, the true or effective burden will depend on the selection of delay pattern.

$$B = K_B \times D_e \qquad (2)$$

B = burden (ft.)

D_e = diameter of explosives (in.)

K_B = burden ratio

Burden ratio (K_B) values for ANFO (density - 0.8 g/cm^3)

Light rock (density 2.2 g/cm^3) - 28

Average rock (density 2.7 g/cm^3) - 25

Dense rock (density 3.2 g/cm^3) - 23

3.2.3 . Spacing

Spacing is the distance between the adjacent blastholes in a row, measured perpendicular to the burden. It controls mutual stress effect between charges. Spacing is calculated as a function of the burden and also depends on the timing between holes. Spacing is calculated as a function of the burden and also depends on the timing between holes. Too close a spacing causes crushing and cratering between holes, boulders in the burden, and toe problems. Too wide a spacing causes inadequate fracturing between holes, accompanied by humps on the face and toe problems between holes. Field experience has shown that the use of millisecond delays between holes in a row results in better fragmentation and also reduces the ground vibrations produced by the blast. When millisecond delays are used between holes in a row, the spacing-to-burden ratio must be reduced to somewhere between 1.2 and 1.8, with 1.5 being a good first approximation. Generally, large diameter blastholes require lower spacing-to-burden ratios (usually 1.2 to 1.5 with millisecond delays) than small diameter blastholes (usually 1.5 to 1.8). Because of the complexities of geology; the interaction of delays; differences in explosive and rock strength, and other variables, the proper spacing-to-burden ratio must be determined through onsite experimentation, using the preceding values as first approximations. Except when using controlled blasting techniques such as smooth blasting and cushion blasting, the spacing should never be less than the burden.

$$S = K_s \times B \qquad (3)$$

S = spacing (ft.)

K_s = spacing constant ($1.2<K_s<1.8$)

B = burden (ft.)

3.2.4. Stiffness ratio (SR)

Stiffness ratio is the ratio of bench height and burden. In any blast design, it is important that the burden and the bench height should be reasonably compatible. As a rule of thumb for bench blasting, bench height-to-burden ratio should be between 1.5 and 4.0. It can be calculated by the following formula. Bench height less than 1.5 times the burden cause excessive airblast and flyrock and, because of the short, thick shape of the burden, give coarse, uneven fragmentation. Where operational conditions require a ratio of less than 1.5, the primer should be placed at the toe of the bench to assure maximum confinement. Placing the primer in the subdrill can cause increased ground vibrations. If an operator continually finds use of bench height-to-burden ratio of less than 1.5 necessary, consideration should be given to increasing the bench height or using a smaller drill. Bench height, that is greater than four times the burden are also undesirable. The longer a hole is, in respect to its diameter, the more error there will be in its location at toe level, which is the most critical portion of the blast. A poorly controlled blast will result. Extremely long, slender holes have even been known to intersect. High benches with short burdens also create hazards, such as a small drill having to pull in the front row of holes near the edge of a high ledge or a small shovel having to dig at the toe of a precariously high face. The obvious solution to this problem is to use a lower bench height. There is no real advantage to a high bench height. Lower benches give more efficient blasting results, lower drilling cost and chances for cutoffs, and are safer from an equipment operation standpoint. If it is impractical to reduce the bench height, larger drilling and rock handling equipment should be used, which will effectively reduce the bench height-to-burden ratio.

$$SR = \text{Bench height} / \text{Burden} \qquad (4)$$

Table 1. Stiffness ratio's effects on blasting factors

Stiffness ratio	**1**	**2**	**3**	**>4**
Fragmentation	poor	fair	good	excellent
Air blast	severe	fair	good	excellent
Ground Vibration	severe	fair	good	excellent
Fly rock	severe	fair	good	excellent

3.2.5 . Stemming

Stemming is the distance from the top of the explosive charge to the collar of the blasthole. The primary function of stemming is to confine the gas produced by the explosive until they have adequate time to fracture the ground. The correct stemming length is dependent upon the size of the hole, the type of the material used and the rock mass properties. This zone is usually filled with an inert material called stemming to give some confinement to the explosive gases and to reduce airblast. Research has shown that crushed, sized rock works best as stemming but it is common practice to use drill cuttings because of economics. Too small a stemming distance results in excessive violence in the form of airblast and flyrock, and may cause backbreak. Too large a stemming distance creates boulders in the upper part of the bench. The selection of a stemming distance is often a tradeoff between fragmentation and the amount of airblast and flyrock that can be tolerated. This is especially true where the upper part of the bench contains rock that is difficult to break. In this situation, the difference between a violent shot and one that fails to fragment the upper zone properly may be a matter of only a few feet of stemming. Collar priming of blastholes normally causes more violence than center or toe priming, and requires the use of a longer stemming distance. Field experience has shown that a stemming distance equal to 70 percent of the burden is a good first approximation, except where collar priming is used. Careful observation of airblast, flyrock, and fragmentation will enable the blaster to further refine this dimension.

$$T = K_T \times B \tag{5}$$

T = stemming (ft.)

K_T = stemming ratio (usually 0.7)

B = burden (ft.)

3.2.6. Subdrilling

Subdrilling is the distance drilled below the floor level to assure that the full face of the rock is removed. If the toe formation will not avoid, it may increase the operating costs for loading, hauling and crushing activities. Where there is a pronounced parting at a floor level, to which the explosive charge can conveniently break, subdrilling may not be required. In most surface blasting jobs, it is necessary to do some subdrilling to make sure the shot pulls to grade. A good first approximation for subdrilling under average conditions is 30 percent of the burden. Where the toe breaks very easily, the subdrill can sometimes be reduced to 10 to 20 percent of the burden. Even under the most difficult conditions, the subdrill should not exceed 50 percent of the burden. If the toe cannot be pulled with a subdrill-to-burden ratio of 0.5, the fault probably lies in too large a burden. Priming the explosive column at the toe level gives maximum confinement and normally gives the best breakage. Other factors being equal, toe priming usually requires less subdrilling than collar priming. Excessive Subdrilling is a waste of drilling and blasting expense and may also cause excessive ground vibrations owing to the high degree of confinement of the explosive in the bottom of the blasthole, particularly when the primer is placed in the bottom of the hole. In multiple-bench operations, excessive subdrilling may cause undue fracturing in the upper portion of the bench below, creating difficulties in collaring holes in the lower bench. Insufficient subdrilling will cause high bottom, resulting in increased wear and tear on equipment and expensive secondary blasting. The optimum effective subdrilling depends on the structural formation, density of the rock, type of explosive, blasthole diameter and inclination, effective burden and location of initiators in the charge. In most circumstances, subdrilling can be estimated as follows,

$$J = K_J \times B \tag{6}$$

J = subdrilling (ft.)

K_J = subdrilling ratio

B = burden (ft.)

Table 2. Subdrilling ratio for bench blasting

Condition	Subdrilling ratio
Open bedding plane at toe	0
Easy toe	0.1-0.2
Normal toe	0.3
Difficult toe	0.4-0.5

Source: Rock Fragmentation

3.2.7. Charge length

Charge length is the length of the explosive pumped or charged into each blasthole. It is also called powder column charge.

$$L_e = L - T \quad (7)$$

L_e = charge length (ft.)

L = length of blasthole (ft.)

T = stemming (ft.)

3.2.8. Total explosive charge

Total explosive charge is the total weight of explosive per blasthole.

$$W = (0.3405d)\,(D^2)\,L_e \quad (8)$$

W = total explosive charge (lb.)

d = density of explosives

D = hole diameter (in.)

L_e = charge length (ft.)

3.2.9. Total rock volume

This factor is the total volume of the rock that is broken per one blasthole.

$$V = BSH/27 \quad (9)$$

V = total rock volume (yd^3)

B = burden (ft.)

S = spacing (ft.)

H = bench height (ft.)

3.2.10. Powder factor

Powder factor is defined as the charge of explosive that is needed to fragment 1 m^3 of rock. Powder factor is usually considered as not the best tool for blast designing unless it is expressed as energetic consumption. Powder factor for a single blasthole can be calculated as follows,

$$PF = W/V \quad (10)$$

PF = powder factor (lb/yd^3)

W = total explosive charge (lb)

V = total rock volume (yd^3)

3.2.11.Drilling-hole patterns

Blastholes are laid out on the bench in a sequential pattern in relation to the free face of the bench. The holes can be drilled in three different patterns, rectangular, squared and staggered pattern (Fig 1).

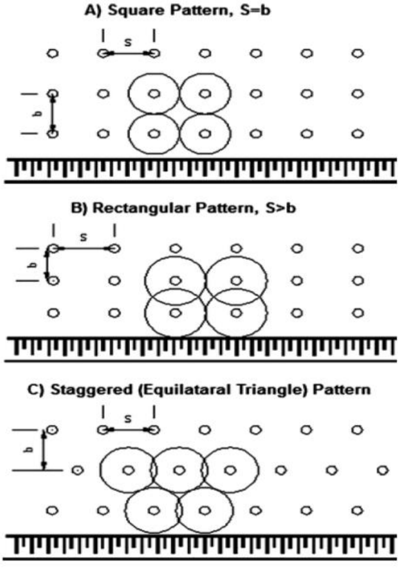

Fig1. Drilling-hole patterns

Source - Dingxiang Zou 2017

The squared drill pattern has equal burden and spacing, while the rectangular pattern has larger spacing than burden. The square of rectangular pattern provides straight edges on the newly formed highwall. Usually squared or rectangular patterns are applied since these allow for easier drilling conditions as the drill rig moves in straight parallel lines. The staggered pattern delivers a better distribution of explosive energy with in the rock mass, which leads to the better fragmentation results.

The staggered pattern produces a more uniform distribution of fracture circles and thus more even fragmentation in the rock pile for the same powder factor. In fact, optimum coverage is obtained when the holes formed equilateral triangles. In YBB Mong Son quarry, the staggered pattern is being used due to these effects.

4. EXPLOSIVE SELECTION CRITERIA

An explosive is a reactive substance that contains a great amount of energy that can produce an explosion if released upon ignition with the production of light, heat, sound, vibration, dust and gases. Explosives are used in the mining industry to fracture rocks, coal or ore either in an actual recovery of economic minerals or for the development work in preparation. There is a wide range of explosives in many different conditions. The most suitable explosive can only be determined for particular requirements or the explosives' properties. There are such criteria for generally selecting the explosives as

- Site conditions
- Degree of fragmentation required
- Blasthole diameter and conditions
- Safety and cost

When the wrong explosive is used or the right explosive is used improperly, the results can be costly, dangerous and unsafe. Poor fragmentation, flyrock, ground vibration, noise and dust can be developed. These conditions can be hazardous to the living things, which are environmentally unsafe and structurally damaging. Therefore, choice of explosives is also critical for fragmentation.

Some important performance properties of common explosives, mostly used in mining industry are shown in table 3.

Table 3. List of importance performance properties of common explosives

Source - Design of Surface Blast - A Computational Approach

Type of explosive	Emulsion	Poured ANFO	Packaged ANFO	Heavy ANFO
Hazard sensitivity	Low	Low	Low	Low
Performance sensitivity	Very good - Excellent	Poor - Good	Good - Very good	Poor - Good
Detonation velocity (m/s)	4200-5500	1800-4500	3000-4500	3300-5500
Detonation pressure (K bars)	40-90		20-60	20-90
Density (g/cm^3)	1.0-1.2	0.8-0.85	1.1-1.2	1.1-1.4

Source: Design of Surface Blast - A Computational Approach

5. INITIATION AND FIRING SYSTEMS

A considerable amount of energy is required to initiate an explosive. Blasting agents, which are the most common products used as the main column charge in the blasthole, are even less sensitive to initiation than high explosives. To assure dependable initiation of these products, the initiator is usually placed in a container of high explosives, which in turn is placed into the column of blasting agent. An initiation system consists of three basic parts;

- An initial energy source
- An energy distribution network that conveys energy into the individual blasthole
- An initiation device of detonator in the hole that initiates the explosive charge.

An initiation device is usually a detonator, which initiates the detonation of the explosive column. Where the main blasthole charge is high explosive, the detonator may be inserted into the column at any point.

However, most of the products used for blasting today (blasting agents) are insensitive to a No.8 detonator. To detonate these products, the detonator must be inserted into a unit of cap sensitive explosive (called primer), which in turn is inserted into the blasting agent column at the desired point of initiation. The initiation systems can be differentiated into four types;

- Electric initiation
- Cap and fuse initiation
- Detonating cord initiation
- Other non electric initiations

In YBB Mong Son quarry, non electric initiation system with nonel detonators are being used.

6. FRAGMENTATION

The term 'fragmentation' is an index that is used to estimate the effect of bench blasting in the mining industry. The primary purpose of blasting is to deliver a well-suited fragment size range to minimize the fractions that cannot be sold and to maximize that can be sold. Generally, there are some factors that need to be considered to improve the degree of fragmentation.

- Specific charge
- Charge concentration
- Distribution of explosive throughout the rock
- Coupling

Generally, the extent to which rock is broken into small pieces by blasting is known as fragmentation. The full spectrum of various sizes of fragments and a size band's proportion with respect to other size bands in a blasted muck are known as fragment size distribution. Fragmentation in a blast is the outcome of interactions between several static, dynamic and kinetic parameters of the material being blasted and detonation of explosives. Prasad et al. stated that the factors influencing rock fragmentation can be classified as controllable and non-controllable parameters. Controllable parameters are blast design and geometry and encompass input parameters like burden, spacing, bench height, stemming length, diameter of hole, delay sequence, explosive charge per delay, firing pattern, and powder factor. The uncontrollable parameters are largely geology-driven like rock mass properties, joints patters and joints spacing, which cannot be altered or modified.

Poor fragmentation refers to the case when large boulders requiring secondary blasting are in greater proportion. In most situations, the optimum fragment size depends on the requirements of the operation including those of loading equipment and crusher size. In production blasting, most often the number of boulders per unit mass of rock is considered as an index of fragmentation. Shovel loading and crusher performances are also used as indicators of fragmentation.

Knowledge of the fragmentation mechanisms in explosively loaded rock is critical for developing successful methods for excavating rock rapidly for a variety of purposes, and has advanced considerably in the last twenty years. To predict rock fragmentation in the mining industry, several models have been proposed. Fragment size distributions are most often represented using the Rosin-Rammler distributions. These models underestimate the fine material in predicting rock fragmentation. For this reason, it is conceivable that fines in blasted rock are generated by a different mechanism to that which leads to coarse fragments. There are some models that proposed to improve the Kuz-Ram's model's inability to predict the fragment size distribution. The CZM and TCM models are two examples of extended Kuz-Ram models to improve the prediction of fines; they are known as JKMRC models. In the CZM model, the size distribution of rock fragments consists of coarse and fine parts. According to CZM, two different mechanisms control the rock fragments produced by blasting. In this paper, the Kuz-Ram model is applied for the prediction of fragment size distribution, thereby creating a proposed blast design for required fragmentation of Mong Son quarry.

7. KUZ-RAM MODEL

Most practical purposes in blasting apply the empirical models for daily blast design. Amongst them, the Kuz-Ram model is the most widely used to predict the rock fragment size distribution by blasting. The basic strength of the model lies in its simplicity in terms of the ease of garnering input data, and in its direct linkage between blast design and rock breaking result. Although it has been used in practice extensively, it has some deficiencies, which are timing effect and lack in prediction of fines. Many authors pointed out the criticisms and improvements, but the major modification in the effect of precise timing has been developed over the years. Kuz-Ram model is the most popular empirical method to predict fragmentation from blasting among a variety of modeling approach. Cunningham modified the Kuznetsov's equation to estimate the mean fragment size (x), and used the Rossin-Rammler's distribution to describe the entire size distribution. The uniformity exponent of Rossin-Rammler distribution is estimated as a dunction of the blast design parameters. (Cunningham, 1987). The Kuz-Ram model for the prediction of the rock was first presented in 1983 at the Lulea conference on fragmentation by blasting. Since then, the model has been evaluated, improved and likely surpassed in performance by more complex fragmentation model. However, it is a simple method that gives reasonable approximations of blasting fragmentation results and it is a three parameters fragment size distribution model consisting of the Kuznetsov's equation, the Rossin-Rammler's distribution and Cunningham's uniformity index.

The adapted Kuznetsov's equation.

$$x_m = A\,K^{-0.8}\,Q^{1/6}\,(115/RWS)^{19/20} \qquad (11)$$

Where, x_m is the fragment size, A is the rock factor, Q is the mass of explosive been used in kg, K is the powder factor (specific charge) in kg/m^3 and RWS is the relative absolute weight strength of the explosive in use by the absolute weight strength of ANFO and multiplying by 100%. The mean fragment size is first estimated to give an overview of what outcome will be generated by the blast design parameters for effective prediction process.

Lilly's (1986) "blastability index A", was incorporated in the Kuz Ram model (Cunningham, 1983). He discussed that every assessment of rock for blasting should at least take into account the density, mechanical strength, elastic properties and fractures. He defined the rock factor A is as given below,

$$A = 0.06\,(RMD+JF+RDI+HF) \qquad (12)$$

Where RMD, is the mass description, JF is the joint factor, RDI is the rock density influence and HF is the hardness factor. Details of the model will be discussed later in this paper. Cunningham (2005) made further adjustment to this by introducing a correction factor, arriving at the rock factor A as a critical part of the process, but it is impossible to cater for all conditions in this simple algorithm. Normally, it is soon apparent if A is greater or smaller than the algorithm indicates, and, rather than trying to tweak the input, possibly loosing some valid input, a correction factor C(A) is now introduced. If preliminary runs against known results indicate that the rock factor needs to be changed, then C(A) is used as a multiplier to bridge the gap from the value given by this algorithm. The final algorithm is therefore given in equation (13) as,

$$A = 0.06\ (RMD+JF+RDI+HF) \times C(A) \quad (13)$$

The correction factor C(A) would normally be well within the range 0.5-2. (Cunningham, 2005)

The adapted Rossin-Rammler's distribution for percent passing,

$$\%passing = 100-(100\ e^{-0.693\times(mesh\ size/X50)^{\wedge}n} \quad (14)$$

$$R = e^{(X/XC)^{\wedge}n} \quad (15)$$

Where R is the weight fraction of fragments larger than X, n is the uniformity exponent, X_c is the characteristic size and X is the fragment size. % passing represents the percentage of material that will pass through a screen of a particular mesh size (X).

The Cunningham's uniformity index

$$n = [2.2\text{-}14(B/D)][0.5(1+S/D)]^{0.5}[1\text{-}W/B][L/H] \quad (16)$$

Where B is the burden (m), S is the spacing (m), D is the hole diameter (mm), W is the standard deviation of drilling accuracy (m), L is the total length of drilled hole (m) and H is the bench height (m). Cunningham proposed the model in its most basic form, wherein the parameters required for the fragmentation prediction were basically controllable elements of the blast design. There must be a unit balancing when the previous equations of blast design parameters and these models are used at the same time. The equation set was as described in equations 11 to 16, but with a slight difference in the calculation of the uniformity index, as shown in the equation 17.

$$n = [2.2\text{-}14(D/d)][1\text{-}D_t/D][1+(m_b\text{-}1)/2][l_{cb}/H] \quad (17)$$

where 'B' is the burden in m, 'd' is the hole diameter in millimeter, 'D_t' is the standard deviation of drilling accuracy in meter, 'm_b' is the spacing to burden ratio, 'l_{cb}' is the charge length above grade level in (m) and 'H_b' is the bench height in (m). Slight modification was made on the equation set in 1987, and the new equation set was as follows:

$$n = [2.2\text{-}14(B/D)][0.5(1+S/D)]^{0.5}[1\text{-}2/D]\ [0.1+ abs(L_b\text{-}L_t)/L]^{0.1}[L/H]\ P \quad (18)$$

Where, 'L_b' is the Bottom charge length, 'L_t' the top charge length, 'P' the blast pattern factor,Z is standard deviation of drilling error (m), Gustafsson (1973) suggested 3 cm /meter drill hole as an acceptable number for the faulty drilling or drillhole deviation. This index defines the uniformity of the blast results, i.e., the degree of uniformity in their sizes. The uniformity index, typically, has values from 0.6 to 2.2. The value of 'n' determines the shape of a curve. A value of 0.6 means that the muckpile is non uniform (dust and boulders) while a value of 2.2 means a uniform muckpile with the majority of fragments close to the mean size (Clark, 1987). From reviews, it is normally desirable to have uniform fragmentation (values of 1 or greater), thereby avoiding both excessive fines and oversize fragments in the broken ground (Sean and Anton, 2006). Furthermore, different versions of this index can be found in several literatures, all these attest to the fact that no single factor can encapsulate all of the variables in a blast design. Cunningham (2005) made adjustments to the equations stated above. The major changes to the model, however, were developed as a result of the introduction of electronic delay detonators (EDs), since these have patiently transformed fragmentation. Both the effect of assigned timing and the effect of timing scatter are accommodated (Cunningham, 2005). The new equation set includes changes in the uniformity and mean fragment size equations, which is as follows:

$$n = [2.2-14B/d][(1+S/B)/2]^{1/2}[1-W/B][abs\{(BCL-CCL)/L\}+0.1]^{0.1}[L/H] \quad (19)$$

where B = burden, m; S = spacing, m; d = hole diameter, mm; W = standard deviation of drilling precision, m; L = charge length, m; BCL = bottom charge length, m; CCL = column charge length, m; H = bench height, m.

Because of the ease with which the model can be categorized for blast layout spreadsheets, it has become widely used, but has not been seriously changed since the 1987 publication. Significant queries seeking clarification about the model and indicating its use in serious applications, use which has not always been wise, as well as ongoing interest in adapting it, demonstrate that it continues to provide a useful springboard for blast design. In addition, the author has been deeply involved in evolving the understanding of detonation for blasting, in building mechanistic models and in evaluating digital fragmentation systems and electronic detonator systems. During these processes, the idea of upgrading the Kuz- Ram model was always in the background, and various modifications have been incorporated in personal spreadsheets. The lack of publication has been due, largely, to an expectation that mechanistic models would overtake empirical models, but this has yet to happen, so it is necessary to rework Kuz-Ram.

7.1. Rock characterization A

It is always difficult to estimate the real effect of geology, but the following routine addresses some of the major issues in arriving at the single rock factor A, defined as

$$A = 0.06\,(RMD+JF+RDI+HF) \quad (20)$$

where RMD is the rock mass description, RDI is the density influence and HF is the hardness factor, the Figs for these parameters being derived as follows.

7.1.1 . RMD

A number is assigned according to the rock condition: powdery/friable = 10; massive formation (joints further apart than blasthole) = 50;

7.1.2. Joint factor (JF)

Vertically jointed - derive jointed rock factor (JF) as follows:

$$JF = (JCF * JPS) + JPA \quad (21)$$

where JCF is the joint condition factor, JPS is the joint plane spacing factor and JPA is the joint plane angle factor.

7.1.3 . Joint condition factor (JCF)

Tight joints	1
Relaxed joints	1.5
Gouge filled joints	2

7.1.4 . Joint plane spacing factor (JPS)

This factor is partly related to the absolute joint spacing, and partly to the ratio of spacing to drilling pattern, expressed as the reduced pattern, P:

$$P = (B*S)^{0.5} \quad (22)$$

The values of JPS are as follows for the joint spacing ranges:

- joint spacing < 0.1 m, JPS = 10 (because fine fragmentation will result from close joints);
- joint spacing = 0.1-0.3 m, JPS = 20 (because undrilled blocks are becoming plentiful and large);
- jointspacing = 0.3m to 95% of P, JPS=80 (because some very large blocks are likely to be left);
- jointspacing > P, 50 (because all blocks will be intersected).

Clearly, if the joint spacing and the

reduced pattern are both less than 0.3 m, or if P is less than 1 m, then this algorithm could produce strange results. In the original derivation, the index was linked to the maximum defined oversize dimension, but this is clearly not an appropriate input and has been omitted.

7.1.5. Joint plane angle (JPA)

Dip out of face	40
Strike out of face	30
Dip into face	20

'Dip' here means a steep dip >30m. 'Out of face' means that extension of the joint plane from the vertical face will be upwards. This is a change from the 1987 paper and is supported by Singh & Sastry (1987), although the wording in the latter is slightly confused and requires careful interpretation.

7.1.6. Hardness factor (HF)

If $Y < 50$, $HF = Y/3$

If $Y > 50$, $HF = UCS/5$

where Y = elastic modulus, GPa; UCS = unconfined compressive strength, MPa. This distinction is drawn because determining the UCS is almost meaningless in weak rock types, and a dynamic modulus can be more easily obtained from wave velocities. In the crossover area there are sometimes conflicts, and it is necessary to use personal judgment for these. It is better to use Figs where there is less scatter in the range of data.

8. EXISTING BLAST DESIGN OF MONG SON QUARRY

Mong Son quarry uses Non-Electric detonators (NONEL) in order for the explosive energy to be evenly distributed along the blastholes. Blasting tools used are, detonating cord of 12 g/m, delay detonators of 400ms, 17ms and 42ms, and primer of 0.175 g.

The drilling-hole pattern used is the staggered pattern. The column-by-column delay is 17ms and row-by-row, 42ms. The underground delay is 400ms from the first blasthole.

Table 4. Existing blast design parameters

Hole diameter	76 mm
Burden	3 m
Spacing	3 m
Bench height	8 m
Subdrilling	1 m
Length of hole	9 m
Stemming length	4 m (mean value)
Explosive length	5 m (mean value)
No. of holes	25 (variable)
Explosives	ANFO prills + Emulsion
Charging	60% ANFO, 40% Emulsion
Blast pattern	Staggered pattern
Initiation	Nonel shock tube
Fragmentation	Fair
Required fragment size	0.4 m
Stiffness ratio	2.7
Total explosive charge	27.74 kg
Powder factor	0.39 kg/m^3

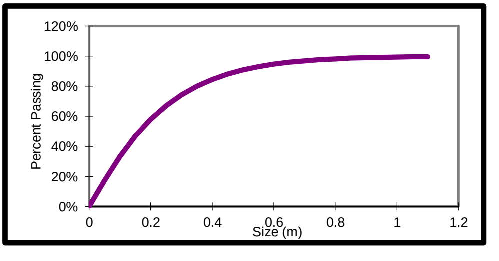

Fig2. Percent passing of existing blast design

According to the data resulted from using Kuz-Ram model as shown in Fig 2, the required fragment size of 400 mm (0.4 m of lump size) can be obtained up to 80%. Thus, the original blast design already has enough economic efficiency according to the fragmentation results. Again, the cost of blasting is a bit high due to the use of nonel detonators. Since ANFO is not as expensive as emulsion, we can reduce the cost by changing the explosives into ANFO in cartridge instead of emulsion. Assuming that currently, the cost of ANFO is 30,000 VND/kg whereas emulsion is 40,000 VND/kg. The actual charge weight is 27.74 kg. When calculating the costs of explosives used by one hole, the following results are obtained.

Table 5. Estimated costs of existing blast design

	Heavy ANFO
Charging	60%ANFO + 40% emulsion
Weight per hole	16.64 + 11.1
Price of 1 kg	(16.64) 30,000 + (11.1) 40,000
Total cost per hole	943,200 VND

Although results associated with fragmentation are good, the total cost per one blasthole is a little bit high due to the cost of explosives.

Here, the author will propose a blast design that will give better fragmentation results with lower cost for usage of explosives.

9. PROPOSED BLAST DESIGN OPTIONS

Table 6. Proposed blast design options

Hole diameter	76 mm
Burden	2.4 m
Spacing	3 m
Bench height	8 m
Subdrilling	0.8 m
Length of hole	8.8 m
Stemming length	3 m
Explosive length	6 m
No. of holes	25 (variable)
Explosives	Packaged ANFO
Charging	100% ANFO in cartridge
Blast pattern	Staggered pattern
Initiation	Nonel shock tube
Fragmentation	Good
Required fragment size	0.4 m
Stiffness ratio	3.3
Total explosive charge	19.18 kg
Powder factor	0.3 kg/m^3

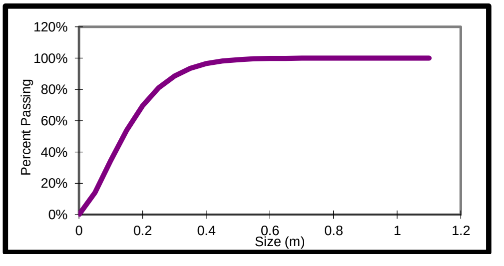

Fig3. Percent passing of proposed blast design

The proposed design has the 96% passing of 400 mm fragment size that is required for the production. Now, the costs will be calculated as in table 7. The cost of ANFO catridge will be estimated the same as 30000 VND/kg.

Table 7. Charging costs of proposed design

	Packaged ANFO
Charging	100%
Weight per hole	19.18 kg
Price of 1 kg	(19.18) 30,000
Total cost per hole	575,400 VND

10. COMPARISON OF COSTS

Table 8. Comparison of costs for existing and proposed blast designs

	Existing	Proposed
	Heavy ANFO	ANFO cartridge
Charging	60%ANFO + 40% emulsion	100%
Weight per hole	16.64 + 11.1	19.18 kg
Price of 1 kg	30,000 + 40,000	30,000 VND
Total cost per hole	943,200 VND	575,400 VND
Total number of holes (assumed)	25	25
Total cost per blast	23.58M VND	14.4M VND

The costs of the explosives are only the assumption values according with the standard local price of the explosive. Nontheless, the proposed design using the packaged ANFO significantly gives better fragmentation results and lower charging costs.

11. RESULTS AND DISCUSSIONS

In order to optimize the blasting, explosive is not the only criterion to be effective and efficient but also the length of stemming and the material to be considered as stemming are factors that should not be forgotten. Prilled ANFO blasting agent and emulsion, which is usually called heavy ANFO, are used in the existing blast design. In consideration of effectiveness of breaking rocks, using packaged ANFO would be the best option in this case, however, emulsion can increase the costs of operation and may produce oversized rocks at the bottom. Since ANFO is worldwide used and it is cheaper than emulsion, using the ANFO in cartridge as the explosives will give better results and lower costs, as mentioned in previous section. However, in higher level consideration of both technical and economical, many advanced things must be considered to optimize the fragment size distribution in rock blasting.

The degree of fragmentation plays an important role in optimizing the overall production cost including loading, hauling and crushing. Choudhary studied and stated that if rock fragmentation is not controlled, it can increase production cost and delay the quarrying process due to unnecessary secondary blasting or sizing. The controllable factors like drill-and-blast design parameters have a great say in optimizing the fragmentation. Brunton et al. demonstrated that proper fragmentation reduces the digging time of loading equipment and thus, the load and haul productivity increases. Therefore, blast design remains an area which can be experimented and studied in order to achieve optimum fragmentation and economy of operations - both drill-and-blast and subsequent cycle of activities like segregation, loading, hauling and crushing. Many studies have taken place in the past to establish and explain the influence of drill-blast design parameters on blast fragmentation in many rocks and minerals like coal, limestone, metallic ores, etc. Stone quarries in Indian context suggest very different operational experience due to numerous factors, i.e. small area under mining lease, lower bench height, vicinity to residential and other structures, higher degree of segregation of oversized boulders required after blasting, and heterogeneous geology, to name a few. The present study attempted to establish a quarry blast design in terms of fragmentation.

The following table 9 and Fig 4 shows the predicted fragmentation and the percent passing outcomes of various fragment sizes.

Table 9. Predicted fragmentation

Predicted Fragmentation	
Percent Oversize	0.2%
Percent In Range	98.4%
Percent Undersize	1.4%

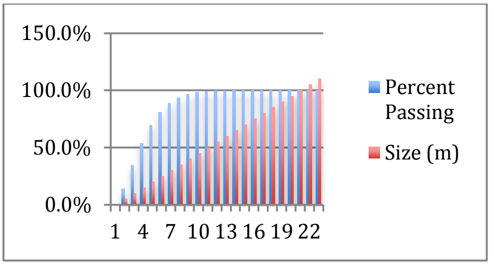

Fig4. Percent passing outcomes

The fragment sizes vary from 0 - 1000mm and amongst them the production lump size of 400 mm is taken as the required fragment size to reduce the costs for further operations as crushing and grinding. 800 mm to fit into hopper is regarded as the oversized and the chip size of 15 mm, as the undersized fragments. This is designated to get the most percent passing of required fragment size and the size below the undersized as waste products and the oversized to go for secondary blasting. According to table 9, the undersized products has only 1.4% probability to be resulted and the oversized, only 0.2%. The required size in range has 98% probability to be obtained.

Now, each common blasting parameters with fragmentation will be discussed.

Burden with fragmentation - the burden was varied from 2 m to 2.9 m, keeping spacing and stemming constant at 3 m and 2.75 m respectively, in the first 10 blasts. Normally, mean fragment size exhibited a positively proportionate relation with burden, i.e. mean fragment size increased with increase in burden. However, here, the mean fragment size is taken constant as 400 mm the same, the degree of fragmentation increases with increase in stemming length when we use the explosive as ANFO in cartridge.

Spacing with fragmentation - Very small values of spacing caused excessive crushing between the charges and superficial crater breakage, resulting in coarser fragmentation in front of the blast holes. As spacing was increased to a certain limit for a fixed burden distance, that is 3 m, explosives energy was utilized in creating radial fractures and adequate breakage resulting in finer mean fragment size, such that instead of resulting 80% of oversized, it gives that of the size in range. Effective breakage and adequate fracturing decreased with further increase in spacing beyond an optimum level as the availability of explosion energy per unit of area under breakage decreased.

Stemming with fragmentation - Increase in stemming length enhanced the height of the uncharged portion of the blast hole, which increased the generation of coarse fragments, especially in the collar region. Also, when multi-row blast was conducted, increased stemming length caused congested relief, which generated coarser fragments. Thus, when ANFO in cartridge, which can give more compact explosion than ANFO prills, the stemming length should be not more than 3.5 m according to the experience of trail and error.

Stiffness ratio with fragmentation - With increase in bench stiffness ratio, the burden rock mass beam under flexion became more flexible and less stiff and made the rock mass easier to get deformed and displaced generating fines fragments. As discussed in the previous sections, the stiffness ratio of 3-4 is the best suited optimum result to obtain better fragmentation.

Powder factor with fragmentation - The relation between powder factor and mean fragment size can be explained as the actual requirement of explosives energy to create effective fragmentation and cause displacement of rock mass, However, increasing availability of explosives energy did not mean increased utilization. Increasing powder factor beyond the optimum value caused adverse post-blast effects like fast ejection of stemming column, over-breaks, air blasts, etc. which can leave less explosion energy to cause actual fracturing and movement of rock mass, resulting in coarser mean fragment size and leading to undesired production results.

The fragmentation results are quite impressive using the Kuz-Ram model to develop improved design with better results. This paper wants to focus on how to excel fragmentation results by changing the blast design parameters. The cost comparison of charging with explosives is very general and it is included here just as an extensive factor, thus the price are regarded with standard local bounty. Withal, this research wants to focus on fragmentation results to stabilize and improve further mining activities later on.

12. CONCLUSION

The development of a better blast design needs to originate from evaluation. The evaluation for blasting practices at the mine indicates as there is room for improvement. The implementation of new blasting practices resulted in improved fragmentation and reduced charging costs. Further considerations can be added more as machine selection for reducing machinery costs and crushing and grinding costs can be examined as well. Not only fragmentation is the factor for improving rock blasting results. Even so, the target of improving fragmentation can also result in many changes in blasting performance and other activities in small-scaled quarries as the case study.

Drill and blast design parameters affect blast fragmentation which, in turn, influences subsequent cycle of operations, i.e. secondary sizing of oversized boulders, loading, efficiency of transporting vehicle and crushing. Attainment of optimum fragmentation is key to productivity and profitability of quarrying operations. Key blast design parameters, i.e. burden, spacing and stemming, when moved systematically and analyzed, it was observed that measurable and verifiable variations were caused in the degree of fragmentation. Each of these parameters affected fragmentation in distinguished manner.

Also, the Kuz-Ram empirical model applied is more compact to use than the other practices. Being an empirical model, which infers finer fragmentation from higher energy input, it is more about guidance rather than accuracy. The results obtained remain a starting point to give an overview of what is expected of an adjustment to a preexisting blast design. It can also serve as a basis for evaluating different designs, investigating the effect of changing certain variables and predicting the size distribution to be produced by the design. Inclusion of the newer multiplier pre-factors introduced by other authors also increases its accuracy at prediction. Furthermore, the simplicity of the model and the relative ease of gathering the data required to serve as feed to the model remains a major advantage of the model and putting it on the forefront of fragmentation prediction models. Other sophisticated and rather accurate model has evolved over the years, but suffers ambiguity. A general overview of results from various designs can also be examined using this simple model. The most important function of Kuz-Ram is to guide the blasting engineer in thinking through the effect of various parameters when attempting to affect blasting results. (Cunningham. 2005).

To conclude, the blasting performance is often judged almost exclusively on the basis of poorly defined parameters such as powder factor and is often qualitative which results in very subjective assessment of blasting performance. Thus, proper blast design, which includes all the principle parameters should be adopted according to the different rock mass properties and also depending on the demands which vary from company to company. More precise method of prediction of rock fragmentation and its models should be investigated and developed for better results in nearby future.

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SOME SOLUTIONS TO DEVELOP GEOLOGICAL TOURISM IN VIETNAM

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Abstract: *Geological tourism is a new field but takes more and more important part in the general development of tourism in Vietnam. With various geological heritages, many provinces in Vietnam can be developed into attractive tourism products. Vietnam is so proud of owning rich geological heritages from the North Pole of Ha Giang to the South Pole of Ca Mau, helping to broaden geological tourism and creating geological parks in Vietnam. However, up to now, these natural resources have not yet been reviewed, planned, deploited and developed enough to create economic and social benefits, provide stable development for the country. This article researches the situation of Vietnam geological tourism, analyzes chances and challenges as well as propose solutions for its development*.

Keyword: *Geological touris, geological heritage*.

1. INTRODUCTION

On January 22nd 2020, the Prime Minister decided to issue Decision No. 147/QĐ-TTg about strategy on tourism development of Vietnam until 2030, in which listed breakthrough objectives, solutions and action plans to develop tourism into a key economic sector in 2030. In this decision, Vietnam is expected to welcome 50 million international tourist arrivals in 2030. To be able to implement this objective, Vietnam needs to take full advantage of its potentialities in culture, history, and natural beauties. Besides these advantages, some provinces plus with strength in global large-scale tourism products are drawing attractive attention to many tourists not only in our country but also in the world. However, one weak point that Vietnam needs to improve is to notice and invest more to exploiting more other new geological tourism products.

2. GEOLOGICAL CHARACTERISTICS IN VIETNAM WHICH ARE SUPPORTIVE FOR TOURISM DEVELOPMENT

Geological tourism is a kind of tourism providing various information, knowdlege about the forming mechanism, history of beautiful sites, famous natural sceneries based on the endogenous and exogenous process for tourists, guests. The purpose of this kind of tourism is to help tourists not only feel curious and attractive with sightseeing but also make them understand the gigantic level and long-time history forming beautiful sceneries.

Under the review by international scientists, because of affection from diversified natural conditions, Vietnam becomes a country having a very complicated domain (both land and sea) in geographical and geological conditions. These conditions make geographical resources in Vietnam more and more diversified and full with all levels from worldwide until provinces, regions.

At the global level, Vietnam has a landscape complex like Ha Long Bay- Bai Tu Long with thousand islands developed based on carbonate sediments and terrigenous sediments. Especially, lines of beaches were created from the final glacier of limestone islands.

At the super area level, Vietnam has a system of late Quaternary red sand highlands in Ninh Thuan, Binh Thuan. Quaternary borders covered with Mesozoic rocks were broken by a modern geomorphological process to create typical characteristics in terrain: Aggression grooves, water collection tank, etc…

At the area level, Vietnam has many borders created from volcanos in Kainozoi. These are crushed sediments of the volcano in Con Co island, Quaternary craters in Con Co island, Ly Son island, Phu Quy island...

At the local level, there are many geographical vestiges such as Con Coc island, Lac Da island, Trong Mai island in Ha Long Bay, Trong Mai island in Sam Son, Thanh Hoa, Da Dia fall, Da Bia mountain (Vong Phu, Phu Yen), Chong island (Nha Trang), Do island, Da Den island (Ninh Thuan), Bay Mau beach, Ke Ga cape (Binh Thuan), Ky Van cape, Nghinh Phong (Ba Ria Vung Tau), Cuesta, Dinh Cau, Phu Quoc island (Kien Giang), etc… Besides, various smoothy and gently sloping sands - along the beaches and over the islands in Vietnam are geographical heritages

Moreover, Vietnam is a country with 3/4 areas covered by diversified-size hills and mountains. Most of them are the type of limestone terrain with many big caves stretched from the Northern part to Quang Binh province. These regions occupy a big area, of about 50,000-60,000 km^2, holding about 15% of the mainland area. The location covers Viet Bac region (Ha Giang, Cao Bang, Lang Son), Northeeast region (Quang Ninh), Northwest (Lai Chau, Lao Cai, Ninh Binh) and Northern Central (Quang Binh). It creates for Vietnam a big chance to develop geological tourism. By the year 2000, there were about 200 caves discovered in Vietnam. Most of them, nearly 90% are short and average caves (with lengh under 100m) and only above 10% of them are long caves with a length above 100m. In 2003, more than 300 caves were discovered in the Northwest region. Many of them are long caves with an altitude above 1000m such as Doi cave (1435m), Ran cave (1880m), Thi Doi (1551m), Nam Khum (1323m), Chieng Ban (1382m). In Tua Chua and Phong Tho Region (Lai Chau), many long and bottomless caves was discovered like: Ta Chinh (length: 2015m and depth: 402m), Doi Nuoc (length 1,035m and depth 290m), Si Leng Chai (length 1,162 and depth 286m…). Up to 2010, 300 caves of Phong Nha Ke Bang National Park were discovered and reported only in Quang Binh Province. There are 400 caves in Ninh Binh Province, in which 100 of them was found in the international landscape complex Trang An Tam Coc Bich Dong.

Up to now, there are about 1,000 caves discovered in Vietnam. Most of them are usually located under the feet of the mountain and halfway down the hill. Some shelters have gates with the dimension of up to 110m width and up to 120m hight like Doi Cave in Lang Son. The deepest cave in Vietnam is Ca cave - Be cave with the depth up to 123m. Primarily, there are many caves in Vietnam that have an underground river range flowing through limestone mountains and connecting with the river/spring system outside. Many caves in Vietnam with their own splendid, superb and miraculous beauty created by a million-year stalactite system are showing unique attraction with tourists. Besides natural beauty, these caves with many extra ordinary archaelogical vestiges, historical-cultural vestiges of nations help to create value for tourism development.

Although there are many caves in Vietnam, only some of them have been exploited with the purpose for tourism including: Son Doong cave, Phong Nha cave

(Quang Binh), Huong Tich cave (Hanoi), Tam Coc - Bich Dong cave, Thien Ha cave, Van Trinh cave (Ninh Binh), Pac Bo cave (Cao Bang), Nhi Thanh cave, Tam Thanh cave (Lang Son), system of caves in Ha Long Bay (Quang Ninh)...

Tay Nguyen (known as Central Highlands) is a group of many highlands with the height from 500-1,500m compared with sea level and listed as the type of geological red soil barzan. These groups are covered in the Eastern side by a range of mountains and high mountain blocks (Truong Son Nam). There are many specific natural heritages sites in this region. Dray Nur and Dray Sap waterfall which belong to Serepok River going through Dak Lak and Dak Nong have beautiful flow. In the heart of the waterfall, there is quite a-relative broad surface up to 120m covered with on unique pole bazan. Many bodies of fossil artemisias were found in Chu A Thai mountain, Phu Thien district, Gia Lai province. They are precious and rare because exhaustedly exploited during many past years. Besides that, in Tay Nguyen, there are some rarely valuable trees called "alive fossil trees". These are endemic trees that were discovered at the same time with dinosaurs more than 65 million years before. Kon Tum land block belonging to Tay Nguyen is one in two regions that having ancient rocks Arkei (over 2.5 billion years back) in Vietnam with superb volcano landscapes…

These above geographically diversified resources are valuable and can not be taken away like other geological resources. They will provide directly or indirectly essential values for building up scientific research and training, aesthetic culture and society-economy, especially for developing tourism types in Vietnam

3. THE CURRENT SITUATION ABOUT GEOLOGICAL TOURISM DEVELOPMENT IN VIETNAM

3.1. The state of the art of tourism development in Vietnam

Table 1: Analysis of the current situation about tourism development in Vietnam

Division	2015	2016	2017	2018	2019
Domestic tourists (million people)	57	62	73.2	80	85
Growth rate (%)	-	8.7	18	9.2	6.2
International tourists (Million people)	7.89	10.0	12.9	15.4	18.0
Growth rate (%)	-	26.8	29	19.9	16.2
Total Revenue from tourism (billion USD)	15.46	20.49	22.35	27.69	31.57
Growth rate (%)	-	17.3	29.6	17.7	13.9
Number of accomodation establishment	13,029	14,453	17,422	25,626	30,000
Growth rate (%)	-	10.9	20.5	47	17

(Source: Statistics report from General Department of Tourism)

From these numbers, the results of tourism in Vietnam are very positive. The number of domestic tourisms always increased by nearly 10% per year. The number of international tourists increased above 16% per year, in which there is one year up to 29% (2017). Total revenue from tourism activities also rises strongly, up to

100% for the past five years, contributing 10%, tho the Gross Domestic Product (GDP). At the same time, number of accommodation establishments has been investing and building up both in volumes of facilities, volumes of rooms and in-service quality. Many accommodations suppliers achieved 4-star, 5-star standards. Many local remote areas with difficult conditions also had strong developing steps.

The competitiveness index of tourism in Vietnam has been increased in 3 times of rating (once per 2 years). Vietnam tourism accelerated 12 levels, from position 75/141 in 2015 to place 63/140 in 2019

Additionaly, many honorable prizes in tourism like: "The leading destination in Asia", The leading golf destination over the world 2019", "The leading food destination in Asia", especially "The leading heritage in over the world" were given to Vietnam. Many locations in the country have been reported and mentioned with high frequency by foreign media companies

3.2 Actual situation of geological tourism development in Viet

3.2.1 Geological tourism products exploited in Vietnam

Up to now, five provinces in Vietnam were recognized as the world geological heritage and potential tourism by UNESCO. They are:

- Ha Long Bay - Bai Tu Long has an area of around 1.553 km2 including 1969 islets, most are limestones. The core of the bay has an area of 335 km^2 covered with high intensity of 775 islets. The limestone in this bay has gone through 500 million years of formation in different conditions and environments. The evolution of the karst in this bay has taken 20 million years under the impact of tropical wet climate, thick limestone floors, and slow tectonics process. Ha Long Bay was discovered and exploited for tourism very early to date, it is considered as the world tourism destination in Vietnam. Tourism development in Ha Long bay separately and Quang Ninh sections in general is a valuable lesson for many provinces in orienting their tourism development

- Dong Van rocky plateau is a significant rocky highland stretched on four districts of Ha Giang province, Vietnam: Quan Ba, Yen Minh, Dong Van, Meo Vac. On October 3rd 2010, "Dong Van rocky plateau Geopark" was recognized as a global geopark by UNESCO global geoparks Network (GGN). Up to now, although tourism exploitation activities in Ha Giang have some changes, its tourism products still are imperfect and limited, without creating a breakthrough for local economic development

- Non Nuoc geopark, Cao Bang is a national geopark that has an area of over 3275 km^2 in border area of Vietnam and China. Through some vestiges here, this geopark showed a historical value of up to 500 million years on earth. Fossil, sediment, volcanic rock, mineral, especially limestone sceneries are the fantastic evidences for the evolution and change of the earth.

On April 12th 2018, Non Nuoc geopark was recognized as the second global geopark in Vietnam by UNESCO (the first global geopark is Dong Van rocky plateau geopark). Like Ha Giang, Cao Bang has great geological strength to do tourism. However, tourism activities in Cao Bang still have some limitation. Ha Giang and Cao Bang still are poor provinces in Vietnam with little number of resorts and cultural products

- Trang An - Tam Coc Landscape Complex is recognized as the natural-cultural dual heritage of Ninh Binh province. During the past few years, Ninh Binh tourism has some clear development, contributing to escape the province from poverty

- Phong Nha - Ke Bang national park of Quang Binh province, Vietnam is a natonal park which locates in limestone regions with an area of about 200,000 ha. The location of its core is 85754 ha and its buffer zone is 195.400 ha. This national park was estblished with about 300 caves to protect one in two most promment karst regions of the world and to protect the northern Truong Son ecosystem in the south-central part of Vietnam. Characteristics of this garden are karst tectonics, 300 caves and many underground rivers. Caves here are estimated to have a length of over 80 km. However, Vietnamese and English cave explorers have still started with 20 km exploration, in which 17 km in Phong Nha region and 3 km in Ke Bang region.

Son Doong cave is the cave that has biggest size in over the world (its length is 5 km, height is 200m and width is 150m). It is larger considerably to compare with Deer cave of national garden Gunung Mulu in Sarawak, Malaysia. Karst tectonics of Phong Nha-Ke Bang national park was formed from 400 million years, even older before the Paleozoic. Therefore, it is assessed as the most ancient karst in Asia. Up to now, Son Doong discovery tours are always overloaded and very difficult to book schedule in recent times.

Some places/locations are preparing to propose/proposing UNESCO to consider as follows:

- Ly Son - Sa Huynh Geopark: Ly Son - Sa Huynh has continuous geological tectonics with widespread volcano activities, creating up to 300 heritages - "on earth". Cau cave great Cliff one of the natural sceneries in Ly Son district can be considered the most attractive location with geological tourism. According to scientists, this volcanic sediment cliff here has dates of about 10 million years. The mouth of this volcano at the top of Thoi Loi mountain exploded about 1 million years ago, with a diameter of about 0.35 km, the height of 149m.

- Phu Yen disc rock fall: There are many scientific workshops have been organized in this location, Phu Yen province. Now some organizers are preparing documents to propose UNESCO to recognize this location as a global geopark.

- Central highland has a beautiful scenery like terrestrial Ha Long Bay, called Ta Dung lake, Dak Nong.

- South part of Vietnam has a national tourism site of Ba Den mountain, Tay Ninh. In the olden days, it was a very cool and giant, hard acid macma block which spent a process of forming. Ba Den mountain was cracked to form giant rocks arranged disorderly creating a mysterious cave system.

Besides that, a system of beaches with white sand stretched along with the country and many islands helps to build up attractive products with domestic and international tourism.

3.2.2. Some typical geological tourism products

From these Figs, the tourism development size of provinces that have geological tourism products is very big. Their tourism growth speeds also are estimated higher than the average rate of the whole country. Some provinces like Quang Ninh, and Ninh Binh which gain unique attraction from international tourists are expected to be the key targets to develop in tourism sectors shortly. Other provinces like Cao Bang, and Ha Giang, with a modest attraction seem to be able to develop doubly in the future.

Table 2: Table of analyzing tourism activity result of some geological tourism products in some regions

Region	Devision	2015	2016	2017	2018	2019
Ha Giang	International tourists (thousand people)	0.146	0.176	0.200	0.213	0.225
	Domestic tourists (million people)	0.617	0.680	1	1.136	1.170
	Turnover (million USD)	30.17	34.57	39.13	43.48	65.22
	Number of accomodation establishment	124	142	180	239	138
Cao Bang	International tourists (thousand people)	0.034	0.040	0.059	0.100	0.175
	Domestic tourists (million people)	0.700	0.741	0.893	1.100	1.275
	Turnover (million USD)	5.01	6.35	8.22	15.65	19.57
	Number of accomodation establishment	170	196	205	222	230
Quang Ninh	International tourists (thousand people)	2.76	3.5	4.28	5.2	5.7
	Domestic tourist (million people)	5	4.8	9.88	12	14
	Turnover (million USD)	284.78	565.21	777.82	1,043.47	1,282.61
	Number of accomodation establishment	1,000	1,000	1,234	1,350	1,370
Ninh Binh	International tourists (thousand people)	0.6	0.72	0.77	0.88	0.97
	Domestic tourists (million people)	5.4	5.8	5.8	6.5	6.63
	Turnover (million USD)	61.74	76.69	84.53	139.13	156.52
	Number of accomodation establishment	389	423	463	570	583
Quang Binh	International tourists (thousand people)	0.47	0.037	0.100	0.200	0.270
	Domestic tourists (million people)	2.860	1.860	3.200	3.700	4.730
	Turnover (million USD)	83.91	73.17	161.13	195	242.17
	Number of accomodation establishment	250	280	297	350	370

(Source: Statistic report from Provincial Culture, Sport and Tourism Office)

4. DIFFICULTIES AND LIMITATION IN GEOLOGICAL TOURISM DEVELOPMENT IN VIETNAM

Although these geological tourism products have been developing quickly in recent years, there are some particular limits, such as:

Firstly, geological tourism is not a new definition, but many Vietnamese tour centers still have not yet had clear awareness of it. Hence, the exploitation of these geological tourism products "visiting and sightseeing", "without discovering and experiencing".

Secondly, the awareness of local communities of protecting tourism products is still weak. Overexploitation causes immense damage on to tourism products. For a long time, regions around Ha Long Bay have been polluted by waste water creating from coal exploitation, fish breading. Moreover, in recent years, there are many tourists, mostly Chinese tourists (with weak consciousness), have come to Quang Ninh province, bringing a giant garbage volume on the surface of Ha Long bay.

Thirdly, many tourism products have not yet received full attention and synchronous investment on human resources leading to unsuitable strategy, low quality, typically is Ha Giang and Cao Bang. Although UNESCO recognizes their products, infrastructure (road, hotel, etc…) and some products attached (cultural products) are still not adequately invested.

Fourthly, there is no connection between tourism products. Currently, there are still many areas with the popular situation called "work at my discretion and preference". Each region has its strategy to develop tourism. Most geological tours are not various and not connecting with geology. There is about 150 tours advertised by tourism companies in the northern part, about 50 ones in the central part of the country. Most of them are relating to Hanoi - Ha Long - Trang An - Sa Pa (in the north), Phong Nha - Ke Bang (in the central). It is possible to earn more revenue and create a large number of tourism employments if they could design smaller tours and various tours with longer periods for tourists.

Fifthly, invasion of spiritual tourism obstructed geological tourism. To date, there is only Trang An resort in Vietnam has been recognized as dual heritage (natural and cultural) by UNESCO. Some other regions have an advantage in nature and geology but they do not have specific cultural products. Their geological conditions are limestone mountains and scattered communities or limestone mountains attached with lakes or beaches... There is a trend to build up pagodas and temples in the core of heritage where many geological characteristics are suitable for tourism activities. It leads to the destruction of geological structure, natural beauties, and showing spiritual culture. As spiritual tourism with (temples and pagodas) is not attractive to Western tourists (whose religion is mostly catholic), it is necessary to do appropriate preventive actions.

Sixthly, tourism development do not only bring material benefit in the economy but also leads to a bad effect called "the reverse of tourism". Communities, especially teenagers have not yet prepared to become citizens of tourism site. They have still done some activities which are not professional and not suitable for general tourism development in their hometown.

5. SOLUTIONS TO DEVELOP GEOLOGICAL TOURISM IN VIETNAM

Basically, according to the objective of the government in Decision 147, tourism development must be the key economic sector, creating motivation for developing other sectors, playing an important part in forming modern economic mechanisms. Besides that, most provinces should focus on developing sustainable tourism and cultural tourism, covering the green growth base as well as using absolutely achievements of the industrial revolution 4.0, concentrating on both international and domestic tourism development. Until 2025, Vietnam is expected to become an attractive destination in the world, belonging to one of the three leading tourism countries in South East Asia. The objective of the government is making Vietnam to become top 50 leading competitive tourism countries in the world. As the result, tourism provide about 12-14% to GDP, creating about 5.5-6 million employments, receiving at least 35 million international guests and 120 million domestic guests, maintaining average growth speed of international tourists of 12-14% per year and domestic tourists of 6-7% per year.

To be able to improve tourism development, and meet the above objective, besides implementing all comprehensive solutions of the government, each province which has geological tourism product should focus on the following solutions:

Firstly, improving knowledge and awareness of geological tourism is attached to cultural and environmental tourism development which shows friendly and civilized behaviour with geological tourism products, etc…. Exploitation and usage without management will lead to damage and impossible to repair because almost geological tourism products in Vietnam are based on natural geology. If these provinces want to develop their geological tourism products, they should create public belief and understanding enough to be able to guard geological natural sites together.

Secondly, developing tourism infrastructure and tourism technical facilities should be focused on to serve tourism industry. In basic, geological tourism usually is attached to mountainous provinces where there are many disadvantages in transport infrastructure. Many solutions can help to overcome these difficulties, such as to develop quickly modern and form infrastructure, to build up transport infrastructure at tourism sites, to develop national tourism groups, to invest on stop-overs, to broaden the highway system, and to connect tourism sites. The purpose is to shorten traveling time and decrease the risks of accidents. Besides that, it is also important to build up a system of paths to leading to tourism sites, helping tourists in transporting while not breaking heritage structure.

Nowaday, besides Quang Ninh, Quang Binh, and Khanh Hoa is a province that also has developed geological tourism and also has its separate airport. Some other provinces like Ha Giang, Cao Bang, Ninh Binh, Lao Cai, Lai Chau, Son La and Phu Yen, etc... have many advantages in developing geological tourism but still lack their own airport. Especially, it is complicated to transport to Ha Giang and Cao Bang to exploit many new geological tourism sites.

Thirdly, developing human resources in tourism is also need to be involved. To develop human resources in geological tourism as well as build up standard tourism programs, explanatory documents, train good tour guides with high major in geology, it is necessary to cooperate between tourism training centers with geological training centers (Hanoi University of Mining and Geology, Vietnam National University, Hanoi University of Natural Resources and Environment, Vietnam National University of Argriculture...).

Fourthly, building up various tourism products to increase tourists's staying time and increase expenses is extremely necessary. As described above, these solutions could be useful when Vietnam could design many tours to connect provinces, making geological products and cultural products more various, increasing experiencing/discovering characteristics instead of visiting and sightseeing.

Fifthly, authorities also need to build up geological museums which are suitable with geological tourism sites. Now in Vietnam, there is only one large-scale geological museum in Hanoi. In many other provinces, although they have many geological potentialities, there are still not yet any suitable geological museum builded up for tourism exploitation. This is reason why many tourists in these sites have not yet had chances to research and understand clearly about them.

Sixthly, people ought to pay attention to develop and diversify tourist market based on detailed research about culture and taste of tourists all over the world. To assure the of investment resources on tourism advertisement, provinces must have a strategy to focus on potential markets. It is necessary to understand of features of tourists with high affordabilities and long-stay from developed countries like western Europe, northern America, northern Europe, Russia, etc…. Meanwhile, domestic tourists also should be paid attention on.

To receive 50 million international tourist arrivals in 2030, tourism offices of provinces that have geological products need to commit to carrying out these solutions effectively. Their growth speed is expected to be higher than the whole national average speed. Especially, Quang Ninh, Cao Bang, Ninh Binh, Quang Binh are targeted to have growth speed up to 20% per year.

Seventhly, great attention should be paid to the process of building up specical regulations on punishing those who violate tourist products, images or brands intentionally. All acts of vandalism on natural sceneries, environment must be control strictly to support the national sustainable development.

6. CONCLUSION

Tourism in Vietnam has grown rapidly over the past decade and it will continue to grow strongly as international visitors explore the country's diversity of natural and cultural heritages. While this highly anticipated growth will provide many opportunities for local economic development, the effects of sudden growth can also exert challenges to heritage conservation.

Thus, generally, tourism must be managed according to the same principles of sustainable development along with geological tourism in particular which means that advancements in economic development must go hand in hand with environmental health conservation. With the idea of having been initially formed, tourism and especially geological tourism can bring Vietnam the recognition as a model country in the exploitation of nature.

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POLICIES OF MINERAL ACTIVITIES

MINING REGULATIONS AROUND THE WORLD AND LESSONS FOR VIETNAM

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Abstract: *This article will briefly go through the mining practices and mining regulations around the world and compare those with current situation in Vietnam, thus, analyze and highlight the critical points, and suggest future changes.*

Keywords: *mineral law; mineral royalties; tariff; fees; environmental tax; mining industry; regulations*.

1. OVERVIEW

The mining industry is one of the most ancient business activities in history. From the oldest operations in Africa 40,000 years ago, throughout the human beings revolution, especially along with the prosperous Mediterranean civilization, mining activities have been transformed impulsive events to a worldwide critical industry *[1]*. The industry utilizes the natural resources of that region or nation to sell them in the form of raw materials or proceed into various types of products that are valuable for domestic and international trading.

In 2018, the mining industry contributed over USD 700 billion to world revenues. The top leading countries in this industry are China (accounting for 12% of the global mine productions), Australia (around 6%), Russia (~2%), the United States of America, Canada, Indonesia, Peru, South Africa, Mexico, Ghana, etc. In particular, China, a major market of Vietnam's mineral export, ranks at the first place of mining and producing coals and gold. Despite such huge GDP contributions, the mining sector can turn an economic spark into a disaster. The mineral resources are located from the surface to the depth of more than 400 meters underground. To extract the minerals, forests are removed and land/soil is dogged, definitely impacting the ecosystem in that area. Besides, mineral resources are unrenewable and unrecoverable. Thus, overexploiting natural resources will not only lead to ecological imbalance and environmental degradation but also hidden the living quality of the residents. Hence, the policymakers must take full consideration of the environmental protection and the sustainable factors before passing any acts or incentives to this industry.

In Vietnam, the natural reserves are moderately generous and diversified in types and species, including coals (e.g.: coke coal, charcoal, etc.) and other non-metal minerals (e.g.: lime, sands, limestone, rocks & stones - tungsten, marble, mineral water, and rare earth minerals, etc.), precious metals and gemstones (e.g.: gold, platinum, silver, gemstones, etc.), and metal minerals (e.g.: iron ore, bauxite, chromite, copper, titanium, etc.). Unlike in many other countries, the mining industry in Vietnam is still a rising sector to the economy. Following the global trend of mining productions, this industrial segment in Vietnam has also experienced a continuous decline since 2017, attributing to the controversial matter that whether the current Law Acts and the applicable taxation system create constraints to mining operations.

Therefore, to justify whether the current policies in Vietnam, which are applying to the mining segment, are appropriate, this article will brief through the mining policies and conditions in some other countries and those in Vietnam, compare different practices, thus, draw the potential lessons learned as in the conclusion.

2. MINING INDUSTRY AROUND THE WORLD AND THE GOVERNANCE SYSTEM

2.1. Mining practices in Vietnam and around the world

Mining operations have become a critical economic segment to over 180 countries around the world. The weight of national GDP contributed by the mining industry runs a wide range among countries, particularly among the top leading countries, such as China, Australia, the United State of America, Canada, Indonesia, Peru, South Africa, Mexico, Ghana, etc. The International Council on Mining and Metals (ICMM) has evaluated the significance of the mining sector's contribution to national economies through the Mining Contribution Index (MCI), a combination index of the national GPD contributed by mining and the weight of mineral export. In particular, those countries which lead the mining sector do not necessarily mean that their economies are depending on mining operations. The mining industry is critical but is not a major economic driven for the top 4 countries, China, Australia, U.S.A, and Canada.

The graphs below illustrate the export contribution by the percentage of metallic minerals, metals, and coal, the mineral contribution as GDP to national economies, and the GDP by countries of top high-income countries, middle-low and low-income countries, including Vietnam. The statistics are gathered between 2000 and 2016.

Based on the graphs above, it can be seen clearly that mining was a primary economic factor to Mongolia and Congo, where mineral export was accounted for more than 80 % of the total export value in 2016 and the GDP made up by this segment remained at the Top 2 over years, especially Mongolia. On the other hand, China, Canada, and Russia economies were not driven by mining production and export. Australia remained at the middle group with mineral export making up more than 50 % and mining production valuing at 10 % of the Australian's GDP in 2016.

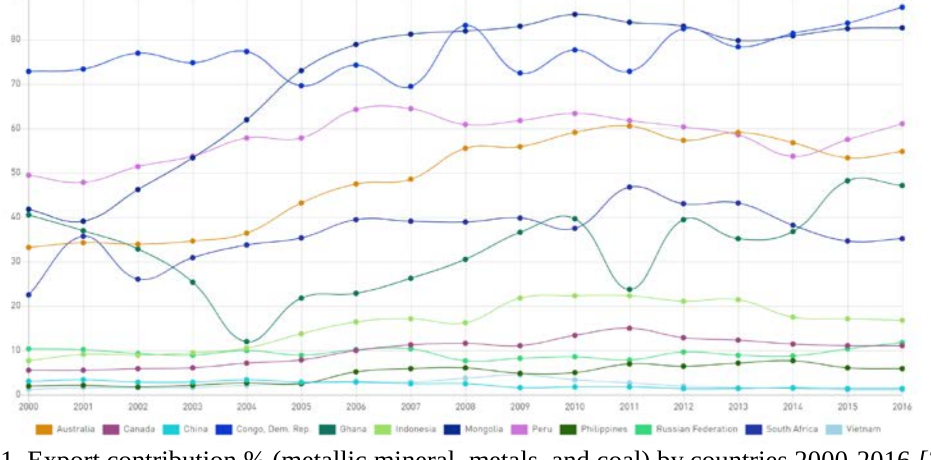

Fig 1. Export contribution % (metallic mineral, metals, and coal) by countries 2000-2016 *[27]*

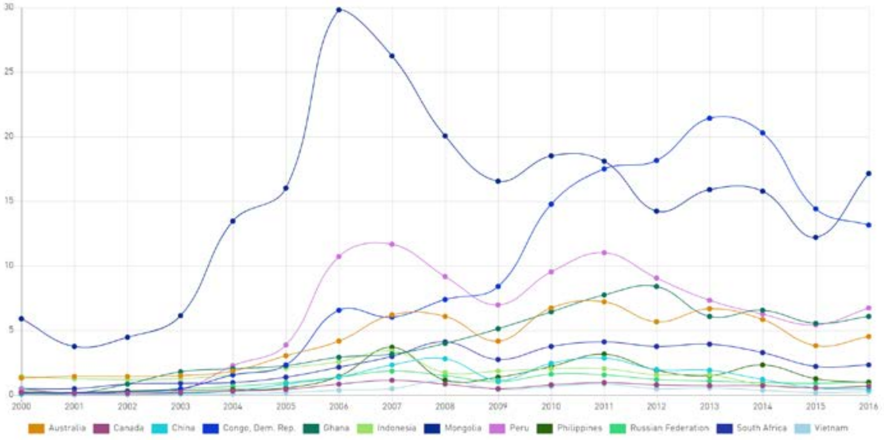

Fig 2. Mineral Rent (as % GDP) as countries 2000-2016 *[27]*

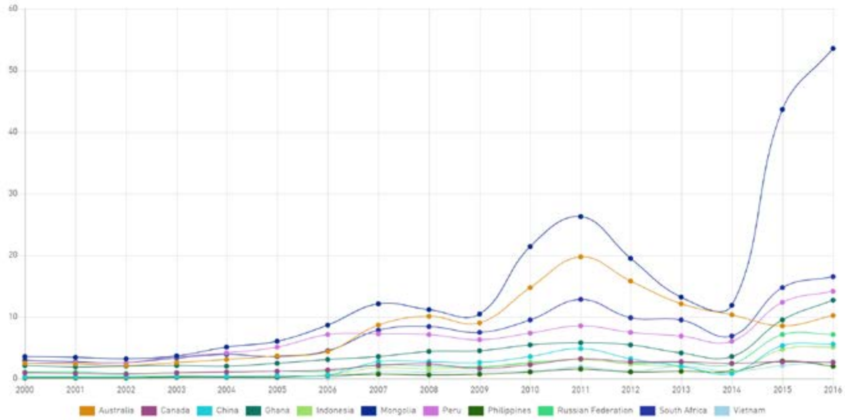

Fig 3. Mining production value (as % of GDP) by countries 2000-2016 *[27]*

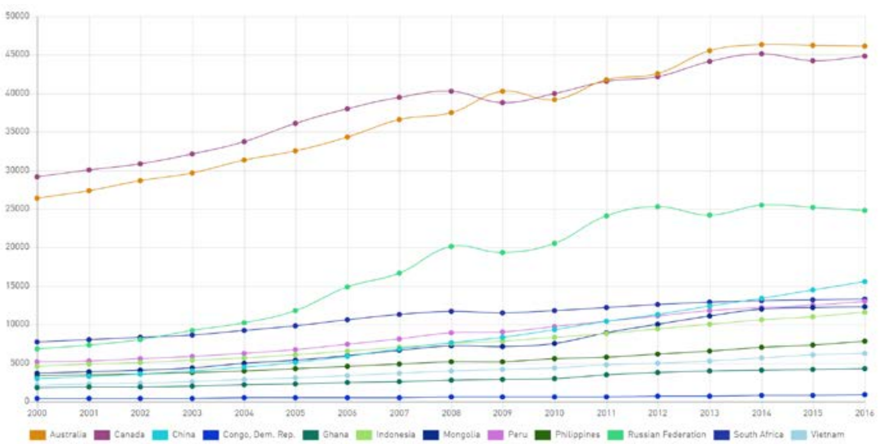

Fig 4. GDP Per Capita ('USD) by countries 2000-2016 *[27]*

The general decline of mineral productions started in 2015 and is expected to continue afterward. As the result, the GDP contributed by mining segment is about 5 % - 7 % among the top leading countries with high-income economies, such as China with 5 % (equivalent to USD 680.5 billion), Canada – 5 % (equivalent to USD 97 billion), and Australia - 5.6 % (equivalent to USD 84 billion), while the mineral export in Australia weighed down to 35 % and that in Canada climbed up by almost 8 % as in 2018-2019. Despite such downward trend, the low and middle-income national economies have become even more depending on mining operations, particularly, the mineral exporting values in Mongolia and Congo was more than 90% of the total exports during 2018-2019, meanwhile, the mining GDP was accounted for more than 60 % total GDP of Mongolia and approximately 32 % total GDP in Congo. Other notable changes in the weight of mining production are the percentage of mineral exports climbed up to 60 % in Peru and South Africa.

Besides China and Australia, India and Southeast Asia countries, such as Indonesia, Philippines, and Vietnam, are the rising nations that own various types and species of mineral resources and play at critical positions in the Asia-Pacific regional mining market. In Vietnam, the mining industry contributed 6.72 % to the total GDP (equivalent to VND 405.8 trillion or approximately USD 17.5 billion) in 2019 *[10]*. Comparing with other adjacent countries, the mining industry has not become an economic driven to Vietnam yet. In fact, several industry experts and policymakers claim that the current governance holds the main constraint toward the developing capacity of this economic segment. There are, however, many disputed opinions over this matter whether the tax rates and royalties recharged over mining production are duplicate and unreasonable. As Vietnam’s Law Acts that apply to the mining segment will be reviewed by the Government in 2020, Section 2.2 will present the current governing systems in Vietnam and some comparable countries as a scientific foundation for the policymakers and experts to further assess the mining conditions, thus improve the mining policies.

2.2. Current policies assessment on the mining industry in Vietnam versus in other countries

The mineral laws and taxation systems that apply to the mining industry are varied around the world. Since this industry involves high-potential risks and complicated factors that both, directly and indirectly, relate to the human lives, the ecosystems, and the socio-economic conditions, it is very difficult for the Governments and policymakers to establish a straight forward and effective governing system. An effective and reasonable regulation system shall gain good control over the mining practices for the Government but still have adequate room for the private-owned and foreign investment factors, at the same time, assure green business practices and sustain the environmental conditions. In these developed and leading countries, such as China, Canada, U.S.A, Australia, Russia, etc., the regulation systems are considerably more advanced than those in the developing countries, better balancing between the needs and purposes as mentioned. However, it does not mean that these countries’ regulations are less complicated; neither their tax rates nor fees are low and reasonable. In fact, there is a group of countries that hold heavy tax rates charged on the mining industry with a tax range of 40 % - 60 %, and Australia set 54 % as the total taxes, royalties, and fees in 2016, very tough tax barriers toward the Australian’s mining operations even after the Australia abolished Carbon Tax in 2014 *[17]*. Next, among these developing countries or the nations that have not yet widely established mining operations, there are two significant similarities. In particular, they are (1) the domination of Government over their economies and (2) the unpersuasive and ineffective governance system. And Vietnam is not an exception.

At first sight, an industrial segment with State-owned domination seems to push the miners more compliant practices with the established Laws. However, such dominating attempts cause several constraints toward the economy in general and the mining segment in particular. Firstly, nationalizing creates a bureaucratic business system that involves unforeseen overhead costs, including slow processes and expenses for the administration procedures. Some examples of failed nationalizing attempts in the mining industry involve Nigeria - a hundred percent State-owned industrial nation, South Africa, Zambia, Venezuela, India, Indonesia *[2]*. Secondly, the contribution of the mining industry to the economy, in general, is unreliable. The Philippines is one of the nations that have a rich variety of mineral resources and pass flexible policies. Even though every part of the country is allowed to conduct mining, the contribution from this industry to the Philippines' total GDP was only less than 1 % and only 2 % to its employment rate in 2019. And last but not least, nationalization creates limited room for the private sector and reduce the goodwill of foreign investors. This is not a good sign especially for under-developing and developing countries since the domestic technology and machinery are unavailable to catch up with the industrial demand.

Currently, the mining industry in Vietnam is structured with 55 % Stated-own market share, 36 % domestic private-own, and only 9 % involving foreign investments. Since 2015, the Vietnamese Government has been introducing several incentives to lower the taxation barriers, thus, attract more foreign investments, including both monetary funds and technologies, thus, drawing hopes to the mining industry. However, like those in other developing countries, such as Indonesia, India, etc., Vietnam's taxation policies are still a controversial matter.

Overall, the taxes related to the mining industry involve (1) direct royalties and taxes, (2) financial-operating taxes and fees, (3) overhead fees.

(1) Direct royalties and taxes usually include Mineral Royalties (being charged directly at different rates on different types of minerals);

(2) Financial-operating taxes and fees involve Corporate Income Tax (CIT), Value Added Tax (VAT) or Goods and Services Tax (GST), pre-production fees (e.g.: License application fees, expenses from inspection, mineral reservation measurement, and exploration activities), processing fees, and Customs Duties (including both export duty and import duty that relate to the mining business);

(3) Overhead or other fees include the Environmental Protection Taxes (e.g.: Carbon tax, fees of pollutant treatment, wastewater treatment fees, etc.), administration fees, and optional contributions to Community Funds;

Depending on the policymakers, these taxes and fees shall be established and allocated in different clutters.

Firstly, direct royalties - Refer to the table below for the previous tax rates as in 2012 and the current rates applicable around the world:

Comparing to most countries that are displayed on the table, Vietnam establishes mineral royalties 10 times higher than the rates in others over a decade, regardless of the monetary value of each currency. As at the viewpoint of private miners who are mainly small to medium size companies and still play minor roles in Vietnam's economy and the foreign investors, high tax rates on minerals shall moderately reduce their goodwill.

Table 1. Mineral royalties and tax rates around the world

Year 2012 *[8]*							Current Rates
No.	**Countries**	**Name of Tax/Law**	**Applicable Range**	**Tax Basis**	**Tax Rate**	**Incentives**	**Direct mineral royalties & tax rates**
1	Argentina	Mining Royalties	Regional	Mineral values on the surface	3%	N.A	3% *[24]*
2	Australia	State Royalties	State	Sales Revenue	7%- 10%	Yes	2.5% - 8.2% *[13][18][19]*
		Minerals Resource rent tax	Federal All States	Sales Revenue	22,5%		Removed in 2014 *[18]*
3	Brazil	Compensation for the Exploitation of minerals resources	Federal	Sales Revenue	2%	Yes	0.2% - 3.5% *[5]*
4	Canada	Mining tax	State	Sales Revenue Profit	13% 5%-16%	Yes	1% - 20% *[31][12][9]*
5	Chile	Specific Mining tax	Federal	Profit	0% - 14%	Yes	25% CIT or 27% PIR *[24]*
6	China	Resource tax	Municipal	Product Unit	2 yuan-8 yuan/ton	Yes	1%- 10% depends on types of product *[15]*
		Compensation for Mineral Resource	Municipal	Gross Sales	0,5-4%		N.A
		Royalties of Exploitation Right	Municipal	Mining Area	100 yuan/km^2		N.A
8	Indonesia	Royalty	Federal	Selling prices	3% - 7%	N.A	13.50% for coal *[14]* 3%- 5% *[21]*
9	Philippines	Royalties to mineral reservations	Federal	Sales Revenue	5%, 1%	Yes	4%; 6% *[32][29]*
		Excise tax	Federal	Product Unit	0 PHP/ton		PHP 150/ton *[32][29]*
		Royalties to indigenous cultural communities	Federal	Sales Revenue	1%		N.A
13	Congo	Mining Royalty	State	Sales Revenue	3%	Yes	0.5%- 10% *[27][28]*
14	Ghana	Mining Royalties	Federal	Sales Revenue	5%	Yes	5% *[24]*
15	Kazakhstan	Mineral Taxes	Federal	Types of minerals	0%	Yes	0.25%- 5.7% *[38]*
16	Peru	Mining Royalty	Federal	Net Income	1% - 12%	N.A	1%- 12% *[26]*
17	South Africa	Mining Royalty	Federal	Gross Sales	0,5%- 7%	N.A	0,5% - 7% *[27]*
18	Tanzania	Mining Royalties	Federal	Sales Revenue	3%	N.A	6% *[7]*
19	Vietnam	Mineral Royalty Tariff	Federal	Sales Revenue	5%-30%	Yes	15%- 50% *[33][37]*

Secondly, among the financial-operating taxes and fees, the Corporate Income Tax (CIT) and the VAT/GST are most visible for comparison. Refer to table 2.2-2 below for the CIT and VAT/GST applicable to the mining industry in Vietnam and some other countries.

Table 2. Current CIT and VAT/GST rate applicable to the mining segment in some countries

	Vietnam	**China**	**Australia**	**Canada**
Corporate Income Tax (CIT)	30.0% [*]	25%	30%	26.70%
VAT/GST	VAT	VAT	GST	GST
	10%	9%- 13%	10%	0%-10%

Source: Vietnam: [33][37]; China: [3] [4] [15]; Australia: [13][18][19]; Canada: [31][12][9]

[*] By June 2019, the Vietnamese Government decided to reduce the Corporate Income Tax rate from 32 %-50 % to a standard rate of 30 %. In comparison with the 3 leading countries in this industrial segment, Vietnam sets up tax rates as high as the other 3 developed countries.

Besides these most obvious comparable types of tax, Canada is outstanding from the rest countries by giving 100 %-150 % deduction on the pre-production fees and up to 65 % processing allowance rate as incentives granted to the industry *[31]*.

And thirdly, the overhead fees - these fees are pretty difficult to compare as they tie to the culture and economic practices of the region/states or country. Thus, to have a comprehensive understanding of current taxation practices in Vietnam, let's compare Vietnam's practice with that of the most compatible country. Based on several factors, such as the adjacent geographical location, culture, and economic similarities, China is the most compatible nation and plays a potential mirror role for Vietnam to follow. On the economic term, the People's Republic of China, or China, had been known as a nation with both social living and economy being dominated by the Government and controlled through the domestic networks. In the 2010s, China's Government revised and restructured the requirements to pull down the tariff barriers, thus, expanded rooms for the private and the foreign factors to growth, making China the most attractive destination for international businesses.

Reflecting through the development of China, Vietnam still struggles at a mid-stage of figuring out a pathway for the economy in general and the mining capacity in particular. Thus, let's evaluate Vietnam's journey through understand the taxation systems that are applying to the mining industry in Vietnam and China as illustrations under the table 3 below:

To evaluate easily, the taxes and fees displaying on table 3 are organized according to current Vietnam's tax and regulation system. Regardless of the particular tax rates or fee values, overall, Vietnam at the moment has 17 types of taxes and fees with the charged rates varying among different substances that are released at different polluting levels, while China holds a more straight-forward recharge system.

In particular, at the Vietnam side, there are 2 highlighted groups, which are related to (1) the mining license and (2) the environmental protection, shall display risks of duplicate payable requirements. Even though Vietnam's tax and fees system are heavy, the results are still far from expectations. Over the last decade, Vietnam has experienced various cases of infamous mining practices, including illegal mining activities that lead to environmental degradation (e.g.: the mining case carried out by Nui Cao Investment and Mining JSC in Da Lat and Central Highlands of Lam Dong (2011 - 2016), or the recent over mining case of an Indonesian company PT. Vietmindo

Energitama, known as Vietmindo in 2019, etc.). The ambiguous regulations and complicated tax calculations have played an undeniable role in those uncontrollable and infamous practices.

Table 3. Current taxation system applicable to the mining industry in Vietnam and China

	Vietnam	China
Types of tax		
Mineral tax	x	x
Custom Duty	x	x
CIT	x	x
VAT/GST	x	x
License Tax (1)	x	
Environmental protection funds (2)	x	
Fees		
Fees for utilizing geological and mineral documents	x	
Investigation and exploration fees	x	
Assessing mineral reserves fees	x	
Assessing environmental effects fees (2)	x	
Environmental protection fees (2)	x	*x [*]*
Environmental protection fees for wastewater treatment (2)	x	*x [*]*
Fees for assessing the construction design and project investment	x	
Others		
Application fees for mining license (1)	x	x
Deposit for the environmental restoration (2)	x	
Real estate rental fees for mining activities	x	x
Authorization fees for granting mining license (1)	x	x
Bid auction	x	x

Source: Vietnam: [10][20][33][37]; China: [3] [4] [15]

On the other hand, China, instead of charging the environmental taxes and fees *[*]*, has implemented an alternative way - reducing 15 % from CIT for those mining companies who committed in waste management and pollution monitoring. This new practice will apply from 1st January 2019 to 31st December 2021. This alternative method has not only brought back favorable environmental results but also been considered as an incentive to encourage the miners to align with greener business practices. Prior to 2018, China held a tax and fee system as similar and complex as the Environmental Taxation Laws of Vietnam. By 1st January 2018, the China Government has issued a new Environmental Protection Law, which allows the local authorities to entitle 100 % of tax collection (while previously 10 % would go to the Central Government), thus enforce a standardized tax rate on all kind of pollutants, regardless the emission amounts, on local/municipal level.

In addition, the environmental penalty will be the most serious fine if the organization commits any polluting activities. As a remedy, the operations will receive a 25 % tax deduction if they ensure the pollution rate 30 % - 49 % under the standard rate besides the 50 % fee deduction if any environmental fees still exist. These new policies are expected to encourage the manufacturers, not only in the mining segment but also in other economic sectors, to install new technologies and proactively comply with the Environmental Acts.

These new regulations have made China's taxation system more transparent and understandable than previously and brought China a positive outlook on both short-term and sustainable long-term development. Especially given the post-pandemic period, these incentives and policy evolutions play critical roles in promoting economic recovery and preventing any potential crises.

3. CONCLUSION

Vietnam ranks in the third place among the South East Asia - Pacific countries and at the 37th place worldwide countries who lead the mining segment. However, like many other developing countries, Vietnam has been facing several struggles while attempting to promote and monitor mining activities. With the continuous attempts of the Government, it's high hope for Vietnam to become the next terra nova of international businesses. Therefore, to execute this ambitious development plan, Vietnam's Government would need to conduct a comprehensive review and make necessary revise on the current tax and tariff system to make them more transparent and understandable to both domestic and international investors while gaining adequate control of the authorities.

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POLICY TAX FOR ENVIRONMENTAL PROTECTION IN SOME COUNTRIES IN THE WORLD AND LESSONS LEARNED FOR VIETNAM

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***Abstract**: The environmental protection tax policies in countries around the world often have two main goals, which are to encourage polluters to reduce the amount of waste discharged into the environment and to increase the revenue of the state budget through the introduction of environmental costs included in the price of products following the "Polluters pay" principle. Currently, many countries collect taxes related to environmental protection for products and goods when used, which will cause bad impacts on the environment. Vietnam has also been applying environmental tax policies, especially the introduction of the Law on Environmental Protection Tax No. 57/2010 / QH12 dated October 15, 2010. However, besides positively and effectively affecting the country's economic, political and social life, Vietnam's environmental protection tax policies still have limited problems regarding taxable subjects; Time of tax calculation; Tax calculation framework. Therefore, the article will analyze environmental protection tax policies in some countries in the world, thereby drawing lessons for Vietnam in developing and implementing environmental protection tax policies to achieve the set goals.*

Keywords: *environmental protection tax; environmental protection tax policies.*

1. OVERVIEW

Environmental tax, alternative names energy & fuel tax, green tax, air pollution fees, or environmental renovation fee, etc.), is one of the economic measures that in some countries are regularly used as direct revenue to the State budget to carry out the socio-economic development and environmental protection targets.

On the one hand, this policy encourages the polluters to cut down the number of wastes discharged into the environment by capitalizing the environmental utilization fees into production costs based on the «People who discharge pollutants and who utilize the environment need to payback» principle.

On the other hand, the environmental tax policy is an effective tool to prevent pollutants and regulate the beneficial interests between businesses and society. Hence, it emphasizes healthier social relations, promoting the sense of savings, minimizing the wastes of natural resource exploitation and usage, and strengthening the solutions to protect the environment.

Many countries currently collect environmental taxes on goods and products that will negatively impact environmental conditions. Vietnam has also been applying the environmental tax policies, especially with the induction of the Environmental Taxation Law No. 57/2010/QH12 issued on October 15, 2010. Besides the favorable results on the economic, political, and social life, in Vietnam, the environmental tax policies still show many limitations, including taxable objects, time to calculate taxation, tax calculation framework, etc. Therefore, in the following articles, we will analyze the environmental tax policies in some countries worldwide, hence concluding lessons about developing and implementing the environmental tax policies to achieve the targets in Vietnam.

2. THE ENVIRONMENTAL TAX POLICIES IN SOME COUNTRIES AROUND THE WORLD

2.1. The environmental tax policies in Switzerland [1]

According to the Environmental Performance Index (EFI) in 2018 regarding the global ranking concerning high-prioritized environmental issues resolution, Switzerland is the leading country with a score of 87.42/100. To achieve such results, Switzerland has implemented the environmental policies since 2007, right after the global financial crisis. Particularly to the Green Economic Action Plan by the Swiss Government, the plan involves:

- Green-up the taxation and charging system through the environmental taxes:

- Like those in most OECD countries, the energy taxes usually account for a huge proportion in the environmental tax. In Switzerland, energy taxes are mainly contributed by the on-land transportation sector with more than 45 % and steadily increasing over the past 20 years. Such differences are due to two opposite trends: (i) the number of vehicles increased by 21 %, and (ii) Sum of the energy consumption is reduced by nearly 4 %. The structure of the environmental tax in Switzerland is illustrated under the table 2.1 below:

Besides the environmental tax, Switzerland also collects other environmental-related fees, including fees for aircraft landing and waste stream charges.

Table 2.1. The structure of the environmental tax in Switzerland

No.	Taxation Components	Proportion %
1	Petrol/Gasoline tax	50
2	Motor vehicles tax	20
3	Traveling distance & large-weighed trucks	15
4	Carbon tax (tax on CO_2) on the fuel used for heating and productions	5
5	Tax on volatile organic compounds (VOC)	5
6	Combustible wastes, and urban wastes, etc.	5
	Sum	100%

(Source: Collection by the author)

According to table 2.1, we can see that the environmental tax policy in Switzerland covers 3 main categories, which are energy, transportation, and wastes. In particular:

i) Energy taxation: The most remarkable energy tax is the gasoline tax and the Carbon tax. All of the energy sales revenue is subjected to the value-added tax (VAT) rate of 8 %. The Carbon tax is levied on fossil fuels (e.g., heating oils, natural gas, charcoal, coke, etc.), used for heating, lighting, and generating electricity in the heating and operating welding and resembling systems. The CO_2 tax rate is determined by the weight (in tons) of raw materials and the CO_2 content of each type of energy. The CO_2 tax rate in 2014 (60 CHF/ton) was twice as the rate in 2008 (36 CHF/ton); by January 2016, the rate was 84 CHF/ton (equivalent to EUR 77.00). Companies that produce greenhouse gas (GHG) will be considered for exemption from the Carbon tax if they commit to reducing GHG emissions until 2020 continuously.

ii) Transportation taxation: The motor vehicle owners must pay an annual tax amount to the authority at which they reside. The federal tax on motor vehicles accounts for 20 % of the total environmental tax revenue. The tax rate depends on either the vehicle's weight, its distribution, or both of them. Electric vehicles or energy-efficient vehicles are eligible for tax discounts or exemptions in some regions. Some states, such as Geneva or Obwalden, grant some incentives if the purchasers consume less-polluting cars. Besides, to encourage residents to use public transport instead of private cars, the Government deducts the costs of traveling by public transport from the annual costs. Furthermore, Switzerland Government grants annual tax deductions for bicycle commuters.

In 2001, large-weighed trucks or heavy-goods carrying vehicles are subjected to taxes. The tax rate is calculated based on traveling distance and weight of vehicles and is distinguished by the emissions following the European standards. Tax revenues are used to build national railway tunnels and solve the noise problems from the roads. Moreover, implementing transportation taxes contributes to the changes in traveling methods from roads to railways. Such revenue sources will be used as compensation to the residences for noises from roads and emphasize resolutions for security, safety, and environment.

iii) Taxation on the wastes discharged: Since 2000, Switzerland has restricted burying flammable and biodegradable municipal wastes. The environmental protection act states that the municipal wastes must be managed following the principle of polluting process; through a bin-liner based fee, the residents will have to pay additional fees for each plastic bag used. To encourage recycling, the Government applies recycling surcharges on each glass and battery item, plastic bottle (PET), aluminum can, and food container. As the prepaid recycling fees are also applicable to plastic bottles, aluminum cán, and food cans, the recycling rate has increased significantly (the rate of recycling PET bottle has risen to 80 % in 25 years). For electrical and electronic equipment, manufacturers and importers need to pay for the recycling surcharges for the equipment that will be circulated later.

2.2. The environmental tax policies in Sweden [2][3]

Along with its Nordic neighbors, Sweden was the first country of the European Union that applies taxes, fees, and other economic measures to protect the environment. According to a 2004 OECD member country assessment, Sweden was the most economically active country in environmental protection. Among various economic measures, environmental tax is one of the most significant methods in Sweden. The Carbon tax, sulfur tax, and nitric oxide (NO) charges were executed from the early 1990s; until the late 1990s, reform of landfill tax and green tax was accomplished. Several types of taxes and fees that are related to the environment were growing quickly and gradually completed.

According to the statistics gathered by the Department of Environmental Protection in 2005, Sweden collected about Cuaron 68 billion annually (equivalent to EUR 7 billion) from taxes and fees related to the environment, with a majority (about 95 %) coming from transportation taxes, energy resource taxes, CO_2 tax, sulfur tax, and collected fees from natural resources exploitation. The environmental tax in Sweden tends to increase gradually during 2005-2015; energy tax accounts for the largest proportion (nearly 90 %) of the overall environmental taxes. Environmental taxes make up about 3 % in Sweden’s GDP. The taxation collecting procedures in Sweden are indicated in table 2.2.

Table 2.2. The procedures for applying environmental taxes in Sweden

No.	Types of environmental tax	Effective year	Remarks
1	CO_2 tax; Sulfur (S) tax and NO charging fees	1990	
2	Landfill and green taxes	1991	
3	Tax rate based on emissions (if measurable)	1991	
4	Fees charged on the NO_x content from fixed pollution sources	1992	Mainly from the power plant
5	The tax rate on lead gasoline should be greater than that on no-lead gasoline	1994	
6	Increase the tax rate on CO_2, NO, sulfur oil, and plant protection products	2004	

(Source: Collection by the author)

Currently, Sweden is building a "Green taxation" system, collecting environmental taxes instead of hitting on income tax, especially aiming at the tax of using energy sources, thus, observing the pollution emissions and carrying environmental protection. The main purpose of implementing the green tax collection is to reduce CO_2 emissions and prove energy efficiency. Collecting environmental taxes instead of income taxes improves the efficiency of taxation, known as the compound interest. From 2010 to 2020, the Swedish Government expects to transform Cuaron 30 billion (equivalent to EUR 3.3 billion) from income taxes to the green taxes.

The current environmental taxes in Sweden address 3 major components: taxes on energy sources, Carbon (C) tax, and sulfur (S) tax. Fuel, oil, coal, and natural gas are all subjected to the energy tax; however, electricity and industrial manufacturing are exempted from this kind of tax. This tax rate varies among different regions in Sweden; especially, the Northern's tax rate is lower than in other regions. Besides, the Government has imposed special non-quota taxation on nuclear electricity and hydroelectricity.

Implementing environmental taxes improves environmental conditions through changes in people's behavior and an increase in tax revenues. To minimize expenses and optimize profits, the manufacturers will try to reduce their emissions and gain more net benefits. Over these years, the air quality and emissions in Sweden have been dramatically improved; for example, during 2004-2015, the amount of NO_x emitted decreased by 60 % compared to that in the previous period, and sulfur emissions from diesel engine vehicles fell by 75 % on the average. It can be concluded that in Sweden, the environmental tax is one of the most effective economic tools representing the "green tax, clean tax" policy and that it brings a huge revenue to the Federal budget while reduces CO_2 emissions and increases using renewable energy. During the period of applying the environmental tax policies, especially in the period of 2005-2015, the emission decreased by 9.2 %, and the amount of renewable energy consumed increased by 25 %.

2.3. The environmental tax policies in China [3][4]

China now has 4 taxation laws related to environmental protection, including resources tax, consumption tax, tax on vehicles and ships, and other transportation tax. These taxation laws play a role as a guide for people to use, reasonably exploit resources, and use energy. Like many other countries around the world, China, besides collecting environmental taxes, also implements several tax incentive policies to encourage energy savings, such as preferential VAT rate on some items that use clean energy or promote the regeneration of wastes and used raw materials, exemption from corporate income tax granted for enterprises that replace their technologies with the friendly environmental technology or the energy, water, resources-saving systems.

On the other hand, China has also adopted numerous financial policies to promote energy saving and environmental protection. Consumers who purchase energy-efficient products will be entitled to financial sponsorship of 50 % costs; else, special funds will be established to serve the environmental protection, for instance, funds for the usage of renewable energy, funds for the use of biogas, etc. Particularly to the year of 2004, China's Ministry of Finance has been coordinating with a national committee to pass the regulations on the procurement of energy-saving equipment among the Government agencies.

In 2018, China started executing the Environmental Taxation Law, which was approved by December 25th, 2016 and officially effective by January 1st, 2018, as a replacement for the old surcharge fee policies, which were in use over the past 40 years. This is the first independent tax law in China's green tax system; it plays a very critical role in reducing pollutions and building a civilized ecological environment. The taxation subjects include non-business units and manufacturing organizations that directly release pollutants into the territorial environment and the territorial waters according to China's jurisdiction (Article no. 2, the Environmental Taxation Law).

Residents do not fall under taxable subjects. Thus, the taxable subjects include air pollutants and pollutants in water, solid waste, and noises. Regarding the tax collection level, according to the Environmental Taxation Law, there are 4 major types of polluting activities, which are activities causing air pollution, water pollution, solid waste discharged, and noise pollution. All of them are subjected to tax collection. Each pollutant is subjected to different tax rates, depending on the geographical conditions and economic status. For instance, China collects environmental taxes on 44 air pollutants released by the manufacturing facilities and factories. These taxable substances involve sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), carbon disulfide (CS_2), etc. The tax rates fall between 1.2 - 12 yuan and between 1.4 - 14 yuan per polluted water unit. China does not prescribe fixed tax rates for each air pollutant and uniformly applies throughout the country under the following mechanism "The central government regulates the minimum tax rates, then the local authority will determine the official tax rates accordingly".

The method to calculate taxes is mentioned in the Article 8, 9, and 11 under China's Environmental Taxation Law. It involves 3 steps: (i) Calculate the number of emissions in each air pollutant by dividing the number of pollutants for the pollution value as per specific content in the Law of Environmental Protection, (ii) Sort by the pollution level from high to low, and (iii) Determine the tax amount by the total tax amount on 3 substances that have the highest pollution levels. Also, the new law strictly regulates over water management in rural areas, at which water pollution level is extremely high, but none of the management activities are effective. The law also states clearly that China Government supports the construction of water and waste treatment facilities in rural villages and requires the standards in using fertilizers and pesticides to comply with the national requirements of environmental protection. The law also raises the penalties for polluting practices. Moreover, the localities have the right and authority to determine the tax rates based on the Central Government's scope set. All environmental taxes are now transferred to the local budget, while previously 10 % of them are required to submit to the Central.

China's Environmental tax policies on emissions have obtained multiple results. By the end of the third quarter of 2018, the total environmental tax declared was 21.84 billion yuan and 6.86 billion yuan were exempted. The amount of environmental tax collected on wastes is 13.5 billion yuan, accounting for 89.8 % of the total taxation amount, and 85.7 % of the pollutants are sulfur dioxide, nitrogen oxide, and dust in general. Collecting environmental taxes has contributed to control the pollution emissions. Among the big cities of China, Beijing, Tianjin, and Hebei, after implementing the environmental tax collections, have reduced the amount of SO_2 by 22,000.00 tons (22.7 %) and cut down the amount of NO 35,000.00 tons (13.1 %). Nevertheless, according to the experts, by implementing the new Law, China improves the quality of environmental management through direct budgeting management, thereby expecting to regain control over toll collections, intransparent usage, and incorrect charges by the localities.

2.4. The environmental tax policies in Singapore [3]

Singapore, a country of 100% urban area with a dense population, is famous for its greenest, cleanness, and beauty. To achieve such results, Singapore has adopted plenty of policies related to environmental protection. Since the 1970s, Singapore has established the Ministry of Environment and the Department of Pollution Prevention to accomplish the plans to control air pollution, water pollution, and solid waste management. Lately, both organizations undertook additional responsibilities - monitoring and handling toxic substances. Two critical areas addressed by the Singaporean Government and the most famous successes are drainage system management and solid waste management. In particular, these addressed areas include: providing a comprehensive draining system to collect and properly treat the domestic wastewater and the production wastewater and organizing an effective managing system to manage the solid waste.

The Singaporean Government first launched the Green Plan in 1992 and continued with a revised Plan in 2012. Such plans aim to track down the population of unstable animals and plants, thus establishing new natural parks and connecting with the existing parks. Moreover, Singapore issues the environmental laws, including: (i) The environmental and public health act: this Act addresses the issues of noise, public sanitation, solid wastes, hazardous wastes, and the control over food businesses, burial and cremation, and swimming pools management, (ii) The environmental pollution control law: this Law governs those issues related to the environmental pollution control and associate activities, (iii) The draining system act: this Act regulates the construction, the maintenance, and the improvement of sewers and underground draining systems that serve the water treatment, commercial emissions, and associate activities, and (iv) The import-export and transition of hazardous wastes Act: this Act covers the import-export and the transit of hazardous wastes and other emissions.

Singapore is actively taking further steps to reduce greenhouse gas emissions upon the commitment signed during the Climate Change Conference in Paris. On June 3rd, 2013, the Singaporean Government announced that they would begin recording the number of carbon emissions released in the whole country and the amount of carbon that has been absorbed by the flora system.

Besides, Singapore's environmental tax policies have grown dramatically. There are 3 main categories under their tax and fees system: the pollution fees charging on wastewater, the energy & fuel taxes, and the taxes on solid waste.

The fees charging on wastewater: tariffs on pollution hit on the biochemical oxygen demand (BOD) and total suspended solid substances (TSS) and applies to all industrial facilities. The tariff rates are determined based on the amount of wastewater and the concentration of pollutants. The allowable amount of BOD and TSS in the public systems is 400mg/liter. Any facilities with the BOD concentration level falling between 401mg/liter and 600mg/liter must pay a fee rate of SGD 0.12/m^3. If the concentration level is 1,601-1,800 mg/litre, the rate will increase to SGD 0.84/m^3. If the contaminant level is 601-1600mg/liter, the rate will rise by one level per 200mg/liter. Such policies' limitations are that the same amount is chargeable to all, regardless of the facilities' sizes and ages.

The energy & fuel taxes: the taxes are collected based on the sulfur content of goods and products. The taxable subjects include gasoline, oil, and coal. In Singapore, the tax rate charged on gasoline is SGD 0.4/litre - equivalent to VND 6,400/liter.

As in 2019, Singapore has been planning to implement the first Carbon emissions Tax in Southeast Asia, a strategy that will increase the energy fees and force more than 30 energy plants to take responsibility for causing pollution. Following this new strategy, the tax rate will increase to SGD 10.00 - SGD 20.00/ton of CO_2 (equivalent to USD 7.00 - USD 14.00/ton) and the rate on five other greenhouse gases. Such changes are also equivalent to USD 3.50 - USD 7.00 increasing per barrel of oil, boosting the electricity prices up by 2 %-4 %. This strategy is the most economical and equitable way to reduce greenhouse gas emissions; thus, polluters will need to take necessary actions to protect the environment. The collection from this tax will be a financial source to support cutting down the industrial emissions in Singapore.

3. CURRENT SITUATION OF VIETNAM'S ENVIRONMENTAL PROTECTION TAX POLICIES [5] [6] [7]

To carry out sustainable development and environmental protection, Vietnam has initiated many taxes and fee policies, including:

i) The environmental tax: this tax law is effective from January 1st, 2012. The taxable subjects are substances that can cause pollution, including petrol, oil and grease, coal, HCFC liquid solution, plastic bags, herbicides, pesticide, preservative products, and unusual warehouse sterilizers. This taxation law demonstrate the use of taxes in protecting the environment, controlling polluting substances and goods, contributing to change people's awareness, and promoting sustainable economic development following the trend around the world;

ii) Special consumption tax: this tax is imposed on several goods that need to be restricted from further production and consumption, involving tobacco, gasoline, automobile vehicles, beer, wine, air conditioning, etc. As a result, the harmful effects on the environment have been minimized;

iii) Royalties (Natural Resource Tax): The royalty rates are distinguished by groups and types of resource; the rates can be from 1 % (for surface water that is used to produce clean water) to 20 %, 30 %, and 35 % (for bird's nests and other rare and precious timber, etc.). Such tax rates have impacted the exploitation, the economical and efficient usage of resources, and the protection of the ecological environment. The natural resource tax is also a very important tool for the governing bodies to emphasize the management and supervision procedures over the exploitation activities;

iv) Other fees, such as fees recharged on wastewater and rubbish, environmental protection fees imposed in mining activities, etc.

We can conclude that the current tax provisions related to the environment, as in the Vietnamese taxation system, have created revenues for the State budget and improved the environmental awareness and behavior of both organizations and individuals. However, these impacts are still as limited as the tax policies' role in protecting the environment. The major existing limitations are:

(i) Incomplete and unfair taxable subjects: the Environmental Taxation Law indicates 8 groups of taxable subjects, such as oil, grease, coal, plastic bags, restricted herbicides, etc. However, some various products and goods potentially cause pollution that has not yet been listed to the law. These products include industrial emissions, cigarettes, radioactive waste, toxic substances (e.g., inorganic acids, caustic soda, plant protection chemicals, organic solvent, mercury, etc.), electronic goods - which generate electronic waste, rubber (e.g., tires, tubes, etc.), and polymer, etc.

ii) The tax rates are not responsive to the number of pollutants. According to the IEA statistics, total CO_2 emission from burning fuels in 2016 was 187.1 million tons, of which 113.2 million tons from burning coals (equivalent to 60 %), 51.6 million tons from petrol (28 %), and 22.3 million tons from natural gas (12 %). Hence, the main proportion of Vietnam's pollution is from coal burning, instead of petrol using. Furthermore, according to the U.S Energy Information Administration (USEIA), as with the same energy unit (Kcal, mmBtu, or GJ), the emissions from coal-burning are higher than from oil-burning, particularly to each component as following: 2.3 times higher for SO_2, 32.7 times higher for dust, 6.3 times higher for CO_2, and 2.3 times higher for mercury.

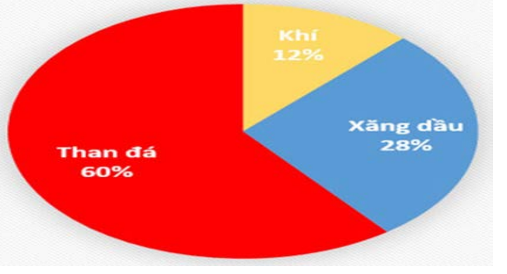

Fig 1. The contribution proportion in CO_2 emissions in 2016 [7]

Nevertheless, the statistics provided by the Ministry of Finance shows that the total revenues from collecting the environmental taxes in 2016 were VND 41.924 billions, of which gasoline tax accounted for VND 41.062 billion (equivalent to around 98 %), while the tax on coal only contributed VND 806 billion (less than 2 %). Hence, the tax rate was unfair if gasoline emissions contributed only 28 %, but the segment would need to pay for 98 % of the total environmental taxes.

Fig 2. The contribution proportion in the environmental tax revenues in 2016 [7]

On the other hand, the tax collection component that is effective by January 1st, 2019 shows the unit price of VND 4,000/litre for gasoline, VND 2,000/litre for diesel oil, VND 30,000/ton maximum price for coal. Converting to the number of carbon emissions released, the tax rate required for gasoline is USD 74.9/ton of CO_2, USD 32.7/ton of CO_2

for diesel oil, and USD 0.5/ton of CO_2 for coals. It means that the current environmental tax rate for gasoline is 156 times higher than that for coal and the rate for diesel oil is 68 times higher than that for coal.

iii) The environmental tax policies consistently serve the environmental targets and goals: since the introduction of the environmental tax in 2012, the total revenue collected from this tax has increased by 6 times in comparison with the amount of VND 11,000 billion at year zero, up to VND 69,000 billion as per expectation in 2019; in particular, gasoline and oil account for more than 90 %. According to the latest statistics by the Ministry of Finance, the total environmental expenses are VND 72,422 billion from 2013 to 2018.

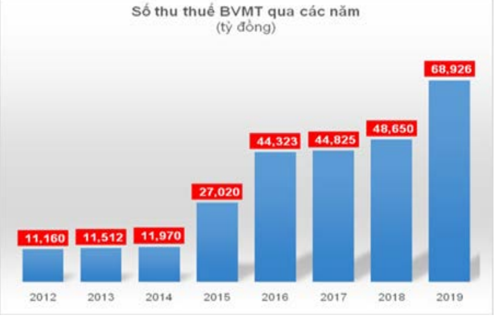

Fig 3. Revenue collected from the environmental tax during 2012 - 2019

(Source: The Ministry of Finance)

According to the approved State budget in 2019, the estimated revenues from environmental tax collection were VND 68.926 billion. This means that within 7 years, the revenues have increased more than 6 times, equivalent to 35% growth. Up to now, the environmental tax policies have been applied for quite a while, especially the Environmental Taxation Law has been executed for 7 years, an adequate time length to comprehensively evaluate the effectiveness of this tax law. However, based on the current stage of pollution and the highly devastating environmental conditions, we can conclude that the environmental tax policies are still incompatible with environmental protection targets.

4. LESSONS LEARNED AND RECOMMENDATIONS FOR VIETNAM

4.1. Lessons learned for Vietnam

Based on the studies of several environmental taxation policies in some countries over the world and based on the current implementation of the environmental tax policies in Vietnam, we can suggest some lessons for Vietnam as below:

- The main purposes of collection taxes related to the environmental protection are: (i) to cut down the number of emissions causing environmental pollution, (ii) to contribute to the sustainable socio-economic development, (iii) to reduce the energy consumption, especially the consumption of non-renewable energy, and (iv) to establish a budget for the socio-economic development and the environmental protection;

- The application of the environmental tax and protection fees policies depends on the particular conditions in each country; however, such policies are currently applied in most countries, especially in OECD member countries. The applicable policies involve: (i) The environmental taxes, (ii) The natural resources tax, (iii) Recharge fees on wastewater, wastes, and noise pollution, and (iv) Tax on energy/fuel, green tax, tax on vehicles, etc. [7]

- To encourage people to cut down the emissions and pollutants that are discharged into the environment, the policy planner should transfer the cost of utilizing the environment into the production costs following the principle “Polluters and beneficiaries pays back for what they use”;

- The taxable subjects must fully comply with the tax policies based on the mentioned principle and the tax rates are varied responsively to the seriousness level of the consequences.

- The taxation revenues should be used to support and grant incentives for the environmental projects, the protection strategies, and the development of renewable energy to draw more attention and participants, including both businesses and individuals, through publish and transparently implement the plans and strategies and ensure the effectiveness, to spend on researching and studying the supporting mechanism through taxation and fees policies in application onto the businesses, which commit to execute the environmental protection plans and demonstrate favorable results.

4.2. Some recommendation in applying the environmental tax policies in Vietnam

From the lessons concluded above, in addition to assessing the current situations of implementing the environmental taxation policies in Vietnam, the policymakers should pay more attention to the following issues:

i) Additional studies about the taxable subjects are necessary (besides the identified 8 items). The supplement substances include chemical fertilizers, detergents, growing stimulants, coal & gasoline, natural gas, disposable plastics, prepackaging products, plastic membrane, plastic sheets, polyethylene plastic rolls, etc. It is also necessary to revise and develop more comprehensive and detailed regulations on the taxable subjects and non-taxable subjects to ensure tax management procedures, avoid fraudulent and errors in tax declaration, and promote the environmental protection acts.

ii) To establish the tax rates, it’s necessary to review, calculate, and evaluate the polluting level in respondents to each type of goods; the tax rates are determined based on scientific foundations, proving that they are according to the environmental results.

iii) Review and revise (if applicable) the provisions under tax policies, the nature of which is similar to the environmental tax, special consumption tax, or any other environmental recharging fees to ensure the comprehensiveness and uniformity, avoid duplication, and especially align with the principles and purpose of each type of tax.

iv) Regulations about the use of tax revenue in protecting the environment should be specified. All taxes collected are concentrated and serve the reimbursement in general in the State budget, particularly for environmental protection purposes. Such a viewpoint, manner, and goals of using tax to protect the environment shall be clarified in the tax policies. On the other hand, it’s necessary to specify the details of the expenditures incurred for the environmental protection, involving those happened for encouraging the friendly environmental applications, technologies, and the incentives and discounts on the eco-friendly goods, allocating the investments to different infrastructure works, hence, promptly recovering the environmental conditions from degradation.

v) Research and establish Carbon tax: in the long run, it’s required to conduct researches on the carbon tax - the tax on CO_2 emissions that are released from the process of burning carbon-containing fuels. A carbon tax is expected to be an important taxation content to reduce carbon emissions. Nowadays, more and more countries recognize this tax as a critical solution against environmental pollution in general and climate changes, particularly the visible threats toward human life and natural ecosystems on Earth. The carbon tax is a new kind of tax; even though we do not have any experience with this tax, we cannot skip such trend. The carbon tax is a tool to adjust the external costs to internalize the negative external costs on a global scale, related to CO_2 emissions, production costs and effectively reduce the amount of CO_2 emissions. Taxing carbon amounts in burning fuels will fasten the search for alternative sources of clean energy.

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LEGAL PROVISIONS ON MINERAL ACTIVITIES - SITUATION AND SOLUTIONS

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Abstract: *Mineral activities play a particularly important role in socio-economic development. However, the current economic management in mineral activities has many limitations such as wasting, depleting minerals and causing losses to the state budget. The main cause of the above limitations is the promulgation and organization of the implementation of the law on economic management in mineral activities, which is still inadequate, inconsistent and has not kept up with the actual developments. In order to ensure sustainable socio-economic development, Vietnam needs to have a synchronous legal system of economic management in mineral activities, in accordance with practical development requirements, which also can help ensure the harmony of benefits of all involved parties as well as resolve the conflict between socio-economic development and environmental protection.*

Keywords: Law; Economic management; Mineral activities.

1. INTRODUCTION

Mineral activities in Vietnam have been started since the last years of the 20th century[1]. Results of surveys, assessments and mineral exploration have been conducted, showing that Vietnam has various mineral resources. The output value of the mining industry (excluding oil and gas industry) accounts for about 4 % - 5 % of the GDP. The industry contributes directly to the state budget with fee for the grant of mining rights, natural resource tax, environmental protection fee (excluding oil and gas industry) average from VND 16,000 to VND 20,000 billion per year, in which natural resources tax is from 10,000 to 11,000 billion VND[2]. The oil and gas industry has contributed to the average annual GDP of about 10 % - 13%[3]. Thus, mineral activities have a strategic role and mineral activities are resources for socio-economic development. In addition to the achieved results, there are still some shortcomings in mineral exploitation activities such as: uncontrolled exploitation of natural resources, unorganized exploitation of natural resources is the cause of the waste of natural resources, adversely affecting infrastructure, destroying the environment and causing many social evils for the locality[4].

2. CURRENT SITUATION OF LAW ON ECONOMIC MANAGEMENT IN MINERAL ACTIVITIES IN VIETNAM

One of the reasons for the above limitations in mineral activities is the legal system. The law on mineral activities is

[1] http://baochinhphu.vn/Khoa-hoc-Cong-nghe/Chia-se-thanh-tuu-moi-nhat-ve-cong-nghe-va-quan-ly-dia-chat-khoang-san/349594.vgp (Accessed 25 April 2020)

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considered to have slow progress in implementation and not very high feasibility[5]. In order to ensure that the law is the main management tool for mineral activities in the current period, the limitations of the law on economic management in mineral activities need to be analyzed from two perspectives: provisions of the laws and implementation of the laws.

2.1. Provisions of the laws

According to the provisions of the law on mineral activities in Vietnam, the inadequacies of the law are reflected through the following three issues:

- *Firstly*, the legal provisions on mineral activities are incomplete or not specific. Currently, mineral activities' legal issues are stipulated in the Law No. 60/2010/QH12 on Minerals (Mineral Law) and law enforcement documents. Besides the achieved results, such as creating more transparency in licensing mineral exploration, mining licensing; create favorable conditions for businesses in mineral activities; increase revenues for the state budget... the Mineral Law also has limitations such as (1) No specific regulations on joint ventures and associates in mining activities; (2) There is no synchronized regulation with the law on investment to control when there is a change in capital of the business owner who has been granted a mineral exploration and exploitation license; (3) Responsibilities of individuals and organizations engaged in mineral exploitation after being granted with exploitation permits to monitor and supervise actual mining output and fluctuating mineral reserves during mining process. specified in the Mineral Law. On the other hand, some issues have not been specified by the Mineral Law, such as: (1) There is no clear regulation on the responsibilities of individuals and organizations that exploit minerals in their activities, environmental renovation and restoration; (2) There is no clear regulation on responsibilities in coordinating mineral management in adjacent areas among provinces (planning, monitoring, etc.)[6].

Secondly, the Mineral Law provisions regarding the responsibilities of individuals and organizations conducting mineral activities are not specific. For example, stipulating the responsibilities of individuals and organizations that exploit minerals in protecting the interests of localities and people where minerals are exploited. According to the Mineral law: "*Partially cover investment costs for upgrading, maintaining and building technical infrastructure facilities used in mining activities and building welfare works under the law for localities in which minerals are exploited.*[7]" The use of the word "*partially cover*" has created the arbitrariness of individuals and organizations engaged in mineral exploitation in upgrading, maintaining and building technical infrastructure used in mineral activities. This will cause adverse effects on the local socio-economic development and the people's lives where the minerals are exploited.

- *Thirdly*, there is irrationality in the Mineral Law regarding the grant of mining rights. Responsibilities of individuals and organizations engaged in mineral exploitation in making payment of charges for granting mining rights are prescribed: "*Organizations and individuals licensed for mining shall pay a fee for the grant of the mining right. The State may collect the fee through or not through auction.*[8]" Thus, it can be seen that state agencies can collect mining rights fees without having to go through auction. This

[5] http://baokiemtoannhanuoc.vn/kiem-toan-trong-nuoc/nhung-bat-cap-trong-cong-tac-quan-ly-tai-nguyen-khoang-san-tu-goc-nhin-kiem-toan-140858 (Accessed 25 April 2020)

[6] https://baotainguyenmoitruong.vn/nhung-bat-cap-can-duoc-dieu-chinh-237112.html (Accessed 25 April 2020)

[7] Article 5 of Law No. 60/2010/QH12 on Minerals

[8] Article 77 of Law No. 60/2010/QH12 on Minerals

provision of the Mineral Law will prevent mineral activities from operating according to the market economy. This will affect the transparency of mineral activities in Vietnam. In addition, the mineral law specifies: "*Auction of the mining right in unexplored areas*.[9]" and "*Mineral exploration means activities to identify mineral deposits and quality and obtaining other information for mineral mining*."[10] Based on the provisions of the mineral law, it is clear that the area of mineral exploration will not be eligible for *auction of* mining rights. On the other hand, the rules analyzed above conflict with: "*The fee for the grant of the mining right shall be determined based on the price, deposit, quality, kind or group of minerals, and mining conditions*."[11]

2.2. Implementation of the law

In addition to the above-mentioned inadequacies of the legal provisions, the limitations of the law in mineral activities are also revealed in the process of applying the law in practice:

- *Firstly*, the activities of disseminating laws on minerals still face many shortcomings. In the recent period, disseminating laws on mineral activities to the people, to individuals and organizations conducting mineral exploration and exploitation activities has not received appropriate attention. In addition, the training activities on state management skills in mineral activities have not been conducted regularly. This situation has affected people's awareness and enterprises' awareness of the law on mineral activities[12]. This problem is the cause of law violations in mineral activities. On the other hand, this problem will create difficulties and complicated to seek the people's consensus where minerals are exploited.

Secondly, the review, adjustment, and approval of planning activities in mineral activities did not meet reality requirements. Although the mineral activity planning has been regulated from Article 10 to Article 15 of the Mineral Law, mineral activity planning has caused limitations in practice. Mineral planning is not yet linked to the national planning and there is no link in mineral planning in the region. Specifically, in a province there is a overlap between mineral planning and local socio-economic development planning. For example, the planning of zoning for exploration, exploitation, processing and use of titanium ore by 2020, with a vision to 2030 under Decision No. 1546/QĐ-TTg (03/09/2013), has overlapped with tourism projects, afforestation projects, industrial zones have been approved to invest in Binh Thuan[13]. In addition, the general planning and the development planning of construction materials are not suitable for the planning period according to regulations (Khanh Hoa). In some cases, coastal industrial zones overlap with national mineral reserve planning (Quang Nam).

- *Thirdly*, inadequacies in management work in the provinces. Land management in many provinces has not been good, which has significantly affected mineral activities. The situation of people encroaching, claiming compensation in licensed mines is quite common. This problem has made mineral activities more expensive and extended the clearance time to investors. On the other hand, in some provinces, mineral licensing

[9] Article 79 of Law No. 60/2010/QH12 on Minerals

[10] Article 2 of Law No. 60/2010/QH12 on Minerals

[11] Article 77 of Law No. 60/2010/QH12 on Minerals

[12] http://baoninhthuan.com.vn/news/86077p0c155/nhung-vuong-mac-qua-thuc-hien-luat-khoang-san.htm (Accessed 25 April 2020)

[13] https://baotainguyenmoitruong.vn/binh-thuan-nhieu-bat-cap-trong-trien-khai-quy-hoach-tham-do-khai-thac-ti-tan-231392.html (Accessed 25 April 2020)

procedures still take a long time, not suitable for many types of minerals (exploiting minerals to make common construction materials and exploiting at household scale). Therefore, it leads to the situation that organizations and individuals mining minerals are not public and illegal.

- *Fourthly*, licensing mining minerals not according to the plan. In some provinces, unlicensed mining licensing is quite common; license for mineral exploitation without mineral reserves approved by competent state agencies. The order and procedures for granting mineral mining licenses are not in compliance with the regulations: granting mineral exploitation licenses to companies when they have not yet fulfilled the obligation to pay the first granting of mining rights (Kon Tum, Nghe An); time of receiving dossiers, appraising dossiers, granting of mineral exploitation permits do not comply with the regulations (Quang Tri). Licensing gold mining is not in accordance with Directive No. 02/CT-TTg (09/01/2012) and Directive No. 03/CT-TTg (30/03/2015) (Quang Nam). The mines have been licensed by the provinces but do not carry out mineral exploitation activities (Quang Nam, Binh Thuan)...

- *Fifthly*, activities of determining the cost of mineral potential assessment and mineral exploration still face many shortcomings. Implementing activities of determining costs, evaluating mineral potentials, costs of mineral exploration in provinces have not yet been implemented in accordance with the Decision No. 04/2018/QĐ-TTg (23/01/2018); Some organizations and individuals engaged in mineral exploitation activities have complied with the obligation to pay the State's evaluation and exploration expenses later than the regulations. The cause of the above problems is that the provisions of the law are not suitable for reality.

- *Sixthly*, the auction of mining rights is still slow compared to the actual requirements. Since the Law on Minerals took effect, auction work under the Ministry of Natural Resources and Environment's authority has taken place very slowly compared to the actual requirements. The cause of the above problem is that the auction object is the unexplored mine that contains many risks and the regulations on the number and conditions of auction participants are not suitable for reality. On the other hand, the heterogeneity in the planning of mineral exploration and exploitation areas in terms of geographical names and coordinates also significantly affects the auction of mining rights.

- *Seventhly*, inspection activities have been carried out but have not gone into the depth of technical content specialized in mineral exploitation; inspection activities have not strictly controlled actual mineral exploitation output. Illegal mineral exploitation still takes place in many provinces. Inspection effectiveness is not high, not detected many errors, and some companies illegally exploit minerals, exceed their capacity and exploit them outside the licensed areas. Local state agencies have not yet entirely performed their functions in inspecting and preventing illegal, illegal exploitation in the area. Many violations discovered through inspection were not sanctioned according to regulations, and there were no measures to handle when the company re-violated (Hai Phong, Quang Nam).

3. BASIC SOLUTIONS TO IMPROVE THE LAW ON ECONOMIC MANAGEMENT IN MINERAL ACTIVITIES IN VIETNAM

For mineral activities to ensure the strategic meaning and socio-economic development strategy, it is necessary to synchronize the following basic solutions:

3.1. Provisions of the law

- *Firstly,* the competent state agencies should supplement the missing provisions in the Mineral Law. State agencies, together with social organizations, individuals, and organizations involved in mineral activities, should systematically review the provisions of law to supplement the Mineral Law provisions, such as the provisions on cooperation in mineral activities. The review of the Mineral Law provisions not only identifies the legal gaps in minerals but also ensures the compatibility of the mineral law with other provisions of the law such as the law on investment, environmental laws, tax laws, etc.

- *Secondly,* the competent state agencies need to quickly specify the provisions of the law. Delayed promulgation of documents guiding the Mineral Law's implementation is also one of the reasons for the slow implementation of the Mineral Law. It creates difficulties for provinces in the management of mineral activities. Through the Mineral Law provisions review, the competent state authority should urgently issue-specific guiding documents so that the mineral legislation can be quickly applied to mineral activities. By assessing the Mineral Law provisions, the difficulties and obstacles of the provinces will be removed.

- *Thirdly,* the competent state agencies should issue stricter regulations to protect the lawful rights and interests of localities and people where minerals are explored and exploited. As analyzed above, some of the Mineral Law's current provisions have not really strictly tied the responsibilities of individuals and organizations conducting mineral activities. Therefore, it is necessary to amend and supplement the Mineral Law provisions to closely bind individuals and organizations' responsibilities carrying out mineral activities to construct infrastructure, environmental protection, and address social issues where minerals are exploited. This helps promote local socio-economic development and contributes to improving the lives of people in mining areas.

- *Fourthly,* the competent state agencies should improve the law provisions on charges for granting mining rights. The Government should have regulations to promote mineral exploration activities in order to determine the exact reserves and quality of minerals. Based on the information gathered from mineral exploration activities, competent state agencies should organize a public and transparent auction of mining rights. Besides, to avoid wastefulness and loss of state minerals, it is necessary to abolish the regulation of allowing the auction of mining rights in areas without mineral exploration (specified at Point a, Clause 1, Article 79 of the Law on Minerals).

3.2. Implementation of the law

*First, the competent state agencies, especially local state agencies, need to promote and improve the law dissemination activities' effectivenes*s on minerals. Thus, the law on minerals can be applied in mineral activities and create the people's consensus in mineral activities. People and individuals and organizations conducting mineral activities must have a certain understanding of mineral laws. Therefore, provinces that have mineral activities should take appropriate measures to promote and improve mineral dissemination activities' efficiency. Also, officials in localities with mineral activities should regularly be trained and fostered mineral management skills.

Second, the competent state agencies and the subjects involved in mineral exploration and exploitation should strictly comply with the legislation's provisions on minerals. As analyzed above, some law regulations on minerals have not been strictly and fully implemented in mineral activities. This has affected the efficiency and effectiveness of the legislation on minerals. Therefore, the most competent state agencies, especially localities with mineral activities, need to strictly and thoroughly implement the provisions of the mineral legislation, such as mineral activity planning, strengthening local management (especially land management), license for mineral activities, accelerate the auction of mining rights under the authority of the Ministry of Natural Resources and Environment.

- *Thirdly*, the competent state agencies should improve the system of state management agencies on minerals; strengthening the effectiveness and efficiency of inspection activities with respect to mineral activities. It is necessary to improve the professional skills for the contingent of officials performing mineral inspection and examination activities and ensure the inspection of the depth of specialized technical content so that it can be quickly detected and handled promptly and legally in cases of violations of the legislation on minerals. In addition, in the course of performing their functions and tasks, other state agencies also need to pay due attention to mineral activities. For example, the state auditor may organize thematic audits of mineral activities, etc.

4. CONCLUSION

Developing the mining industry must go hand in hand with security, national defense, environmental, landscape historical and cultural relics protection. Additionally, it is also important to harmonize the benefits gained from mineral exploitation and processing between the State, enterprises, and people where minerals are mined and processed. Simultaneously, the exploitation of mineral resources must take into account the country's immediate and long-term needs. As a result, the foremost action needs to be taken to improve the legal environment of mineral activities, which includes provisions of the mineral law and the implementation of the law.

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LEGAL STATUS OF STATE-OWNED ECONOMIC GROUPS IN VIETNAM

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Abstract: *The state-owned economic groups such as Vietnam Oil and Gas Group (PetroVietnam) or Vietnam National Coal - Mineral Industries Holding Corporation Limited (VINACOMIN) having the main business with a high level of specialization were established to dominate the economy. However, it is nearly 20 years since the release of official legal documents regulating the state-owned economic groups in Vietnam, some of which have been relatively effective while some have not achieved their goals and responsibilities and have to be reverted to the corporation model.*

The paper analyzes the legal nature of state-owned economic groups of Vietnam and proposes solutions to improve the law on state-owned economic groups, facilitating the development of these groups to become the core force of government economy.

Keywords: *State-owned economic group; Legal status, Law on enterprise.*

1. INTRODUCTION

With the policy of "Forming some strong economic groups (EGs) on the basis of state-owned corporations, with the participation of various economic sectors and multidisciplinary businesses, including the main business sector, highly specialized and plays a large dominant role in the national economy", the government has created a legal framework through the issuance of legal documents such as the 2003 Law on State-Owned Enterprises and Decree No. 153/2004 /NĐ-CP on State Corporations and the transformation of State Corporations under the parent-subsidiary company model; Decree No. 139/2007/NĐ-CP, Decree No. 141/2007/ NĐ-CP, Decree 101/2009/NĐ-CP on "Pilot establishment, organization, operation and management of state-owned economic groups" and Decree No. 69/2014/NĐ-CP on "State economic corporations and state corporations", which has more specific provisions on establishment, reorganization and termination of operation; organization, operation, management and administration in economic groups; management, supervision of the state owner for the economic corporations.

However, after more than 15 years of operation, some state-owned economic corporations operate relatively effectively while some state-owned economic groups have not achieved the set goals and tasks and have been converted to operate under the general model, such as Vietnam Construction Industry Group, Vietnam Urban and Housing Development Group, Vietnam Shipbuilding Industry Group. The basic reason are that: (1) the criteria for assessing conditions for establishment and termination of operations of state-owned economic corporations are qualitative and non-specific, especially the critical criteria for deciding the operational efficiency of state-owned economic groups; (2) the provisions of the management and the orientation of the parent company with subsidiaries easily lead to the management of the parent company covering all activities of the subsidiary and are understood in the form of "seeking opinions" of parent company, losing the initiative of subsidiaries, especially in investment and business activities; (3) the regulations on the organizational structure and supervision of the owner for the parent company are cumbersome, the supervision and internal control of the economic group are still limited, resulting in no detection promptly to take measures to prevent and minimize losses in the course of production and business activities.

The paper analyzes the legal nature of state-owned economic groups, thereby proposing some solutions to complete the legal framework for state-owned economic groups and facilitate the development of state-owned economic groups to become the core force of the state economy.

2. THEORETICAL SEGMENT IN VIETNAM

2.1. The concept of state-owned economic groups

According to Clause 1, Article 4 of Decree No. 69/2014/NĐ-CP on state-owned economic corporations and state-owned corporations, state-owned economic groups are groups of companies, including parent companies, member enterprises and joint-venture companies. Following Clause 3, Article 4, Decree No. 69/2014/NĐ-CP, state-owned economic corporations have no more than three levels of enterprises and the structure is as follows: (1) Parent company (level I enterprise) is an enterprise in which the State holds 100 % of charter capital or holds dominant power. Parent companies are organized in the form of one-member limited liability companies owned by the state or joint-stock companies or multi-member limited liability companies with dominant shares or contributed capital from government; plays the leading and dominant role of member enterprises in economic groups; (2) Subsidiary companies of level I enterprises (level II enterprises) are enterprises controlled by the parent company. Class II enterprises are organized in the form of one-member limited liability companies, limited liability companies with two or more members or joint-stock companies; (3) Subsidiary companies of level II enterprises (level III enterprises) are enterprises controlled by level II enterprises. Class III enterprises are organized in the form of a single-member limited liability company with two or more members or joint-stock companies. In addition, members of SEGs also have associates, organized in the form of limited liability companies or joint-stock companies.

From the above concept, it can be understood that state-owned economic corporations are a combination of production and business including enterprises having stable and long-lasting relationships with each other in various forms, in many fields, with the main link being public parent company - subsidiary. The parent company and its subsidiaries (subsidiaries) have legal status, the parent company is the associate nucleus, often in control and control of subsidiaries' activities. The affiliates also have interconnections, which derive from the benefits and strategies of each company. SEG operates in one or more different industries within a country or countries.

2.2. The system of legal documents governing the activities of state-owned economic groups

Since the idea of setting up a state-owned economic group to pilot, the system of documents for adjusting state-owned economic groups has been constantly revised, supplemented and perfected to create a legal corridor for state-owned economic groups to operate effectively.

After the 2013 Constitution was adopted and came into effect, the system of documents regulating state-owned economic corporations, in particular, and enterprises in our country, in general, has achieved a certain degree of completeness and rigor, on the one hand, ensuring self-right due to the business of enterprises, on the other hand, ensuring the management role of the state for the operation of the economy and the management of SOEs as the owner. Currently, the system of legal provisions on state-owned economic groups includes: (1) The 2014 Enterprise Law with the requirements on establishment registration for member enterprises (chapter II), on the organization and operation of one member limited liability companies (chapter III), SOEs (chapter IV), joint stock companies (chapter V) are parent companies and member companies; (2) Decree No. 69/2014/NĐ-CP stipulating the establishment, reorganization, termination of operations in the form of state-owned economic corporations, organization, operation, management and administration within economic groups, and management and supervision activities of the state owner for SEGs are prescribed in Decree No. 69/2014/ NĐ-CP; (3) The decree on the charter of the state-owned economic corporations for each specific corporation stipulating the relationship between the parent company and its subsidiaries, the management and supervision activities of the state owner with the state-owned economic groups and the relationships arising between the owner and the parent company or member companies, between member companies; (4) The 2014 Investment Law, the 2005 Commercial Law, the 2015 Civil Code, the 2004 Competition Law will adjust corresponding social relations in the fields of investment and commercial activities, contracting, competition.

3. LAW ON OPERATION OF STATE-OWNED ECONOMIC GROUPS

3.1. Regulations on the establishment and termination of operations of state-owned economic groups

3.1.1. Regulations on the establishment of state-owned economic groups based on the core formed from corporations

According to Article 9 of Decree No. 69/2014/NĐ-CP, dated July 15, 2014, where a corporation is selected as the core to form a SEG, the following conditions must be met: (1) Business is profitable for three (03) consecutive years preceding the selected year; (2) The financial situation is assessed by the owner at the level of security; (3) The level of human resources and labor productivity is higher than the average of other businesses operating in the same industry or field of activity; (4) Advanced equipment and technology level; modern management; (5) Effectively manage shares and contributed capital in other businesses; (6) Operating nationwide and abroad.

3.1.2. Provisions on termination of operation in the form of state-owned economic groups

According to Article 12 of Decree No. 69: (1) EGs must cease operations in case the parent company is dissolved, goes bankrupt or no longer meets the conditions specified in Article 9 of this Decree or the parent company suffers merger, consolidation with other enterprises where the State does not hold dominant shares, contributed capital.

The order and procedures for termination of operation of a SEG in case the parent company is dissolved or goes bankrupt comply with the law on dissolution and bankruptcy. In the case of an economic corporation, the corporation no longer meets the conditions specified in Article 9 of this Decree and is subject to the Master Plan on reorganization and renewal of enterprises with 100% state capital already approved by the Prime Minister.

Thus, the regulation of conditions, procedures for establishment, and termination of operation of a State-owned economic corporation are strict. However, the criteria to assess conditions for the establishment and termination of a state-owned economic corporation's operation are qualitative and non-specific, especially important criteria, deciding the performance of state-owned economic groups such as advanced equipment and technology level; modern management, effective management of shares, capital contributions in other businesses, qualified human resources, experience and ability to conduct business in the main industries and related industries. The designation of profitable business only for three consecutive years is also a condition to be studied carefully for SEGs because the amount of resources used by these corporations is considerable, leading to inefficient use of resources. In addition, there is no specific guidance in the evaluation of conditions for establishing SEGs, especially in the case of SEGs established from corporations.

3.2. Provisions on management and administration in state-owned economic groups

3.2.1. Provisions on management and administration principles in state-owned economic groups

The management and administration principles of state-owned economic groups are prescribed in Article 13 of Decree No. 69, according to which there are three principles of management and administration in state-owned economic corporations: (1) Management and administration through a parent company; (2) Management and administration through forms of investment and association; agreements and cooperation on the use of common services throughout economic groups and corporations; to implement the general regulations, standards and norms in economic groups and corporations not contrary to law provisions; use each other's products and services according to market principles; (3) Other modes as prescribed by law and in accordance with the Charter of member enterprises.

3.2.2. Defining the functions, rights and obligations of the parent company's management and administration organization

According to Article 14, the parent company represents the economic corporations to perform joint activities of economic groups in relation to domestic and foreign third parties or other activities as agreed with member enterprises and regulations. of relevant laws; The parent company uses the rights and obligations of the owner, shareholders, and members of the member enterprises to coordinate and orient activities: (1) Use the management and operating apparatus of the parent company or establish a separate unit to study and plan the strategy of the group; (2) implement economic contracts, associated contracts with subsidiaries and associated companies to coordinate and direct the Group's operations; (3) establish uniform rules within the corporation.

3.3.3. Provisions on obligations of the parent company

According to Article 16 of Decree No. 69, the parent company has the following basic obligations, including: (1) Being responsible to the owner for ensuring the business objectives of the main line of business and other goals owned by the owner regulations; Under the supervision of the owner of investment portfolios and investment projects; (2) Managing the portfolio at the parent company to ensure investment conditions and industry structure as prescribed; monitor and supervise the portfolio of the parent company in subsidiaries; track and supervise the business lines of subsidiaries; (3) Provide information and report the prescribed content; (4) Establishing a service organization for group members; (5) Other obligations as prescribed by law.

The regulations on management and administration of the parent company in SEGs are much more complete than previous legal documents, especially the parent company's core role in SEGs. State ownership carries out its management through the parent company. However, the regulations on the management and orientation of the parent company with subsidiaries easily lead to the management of the parent company covering all activities of the subsidiary and are understood in the form of "seeking opinions" from the parent company, losing the initiative of subsidiaries, especially in investment and business activities. This orientation should be done through the representative of the owner's equity in subsidiaries which will be more effective.

3.3. Regulations on investment restrictions and business sectors within economic groups

According to Article 17 of Decree No. 69:

- Controlled enterprises are not allowed to contribute capital to or purchase shares of enterprises holding dominant rights in the same economic group. The dominant enterprises in the same economic group are not allowed to contribute capital or buy shares to cross-own each other;

- The outward investment of the parent company operating in the form of a one-member limited liability company owned by the State shall comply with the Government's regulations on state capital investment in enterprises and management of financial management for enterprises in which the State holds 100% of charter capital;

- The parent company, member enterprises of the economic corporations register their main business lines and related industries and are subject to the owner's supervision of the investment, capital contribution ratio and investment efficiency in the business line, main business and related trades. Parent companies and member enterprises of economic groups shall not be allowed to deal in unrelated industries.

- The representative of the state owner approves or assigns the authorized representative at the enterprise to exercise the rights of controlling shareholders or members to (1) Vote by approving the decision on business lines major; (2) Decide whether or not to adjust the main business lines; (3) Supervise the business of related industries.

The restriction on investment and business lines in the direction of the main business lines and related business lines will ensure safety and efficiency in the state owner's use of resources. The Decree also stipulates the approval of business decisions of major business lines. However, there is no regulation on supplementing state-owned economic groups' business lines to promote the strengths and expand the scale of the multi-institutional economic corporations to become a multinational, transnational corporation, in line with the trend of globalization of the economy today.

3.4. Provisions on organizational structure and supervision of owners

Organizational structure of the parent company

According to Article 4, Article 18 and Article 33 of Decree No. 69, the parent company in SEG is organized as a one-member limited liability company or a joint-stock company. The organizational form for each form of company is determined following the Enterprise Law 2014. The rights, functions and standards of the members of the organizational structure are stipulated in Decree 69.

Provisions on supervision of owners for operations of state-owned economic groups: Principles of supervision of owners of economic groups: implementation through supervision of parent companies in economic groups. Content of supervision: (1) Monitoring business activities, including: Objectives, directions, business strategies of economic groups; Portfolio, main business lines and related fields; investing in risk areas, industries, areas and projects; Development strategy, investment plan, financial plan, production and business plan of the parent company; results of implementation of objectives and tasks assigned by the owner; (2) Supervising the organization and personnel, including the implementation of owners' decisions on establishment, reorganization and termination of operations in the form of economic groups or corporations; the implementation of the Charter of the parent company; the observance of other decisions of the owner and the relevant provisions of the Charter...; (3) Financial supervision: The preservation and development of equity in the parent company; situation and results of production and business activities; the situation of mobilization and use of mobilized capital; bond and stock issuance status (if any); financial evaluation criteria of the group and of the parent company.

Assign and decentralize the implementation of supervision contents: The parent company is subject to the supervision of line ministries: Ministry of Finance, Ministry of Industry and Trade, Ministry of Natural Resources and Environment, Ministry of Planning and Investment, Ministry of Home Affairs, Ministry of Labor - Invalids and Social Affairs The contents are stipulated in Decree No. 69 or the Charter of organization and operation of state-owned economic groups.

Method of supervision: (1) Direct supervision through inspection, supervision and evaluation by the owner's representative agency on the performance of an economic group, or through public audit parent company and subsidiaries, associates; Indirect supervision through the reporting regime of the Board of members or authorized representatives at the parent company or through the implementation of periodic and irregular reporting regime of the parent company.

Regulations on organizational structure and supervision of owners to the parent company in form are strict. However, the regulations are cumbersome and, the internal supervision and control of Economic groups are still limited, leading to failure to detect timely to take measures to prevent and minimize losses in the course of production and business activities. The mechanism of operation of controllers in state-owned economic groups is not effective. Regulations mandating the entire management of state capital through a representative can lead to risks that are difficult to control. The assignment and decentralization of management and supervision are overlapping and complicated, reducing the effectiveness of supervisory activities. The basis for checking and supervising is a system of direct or indirect reports under the Government's regulations to reduce the quality of supervision and effectiveness of related management decisions.

4. SOLUTIONS TO COMPLETE LAW ON SEG

4.1. Complete the regulations on the establishment of state-owned economic groups

Our state-owned economic groups are established by restructuring, from groups of companies with similar interests, same industries and fields, but not by a voluntary association between companies to gain economic benefits. In general, this can result in unprofitable business and inefficient use of economic resources.

Therefore, when considering and allowing corporations and state-owned enterprises to go up to become Economic Groups, in addition to the agency assigned to elaborate a scheme to submit to the Prime Minister, it should be assigned to a specialized agency for inspection activities and business capacity of Corporations and SOEs which want to become Group. This will create strong state-owned economic groups, worthy of the leading role in the country's economic activities.

It is necessary to have specific provisions with quantitative criteria on the establishment of SEGs. For the economic corporations to operate and fulfill the duties and functions set out by the Party and the State, there must be strict regulations and conditions for establishing SEGs, forcing corporations and SOEs to become corporations to have strong economic potential, high competitiveness, reputation in the market, and have good corporate governance system. These criteria need to be specified according to specific levels and detailed instructions so that relevant objects can understand and properly implement. In this way, state-owned economic groups are really leading spearheads, playing a leading role in the national economy, effectively using large state capital.

4.2. Complete regulations on organization and management of state-owned economic groups

The law on state-owned economic groups has to create favorable conditions for the development of businesses and, at the same time, ensure the State's management orientation of the group's activities. It should be specified according to specific levels and detailed instructions so that related subjects can understand and properly implement. In this way, state-owned economic groups are really leading spearheads, playing a leading role in the national economy, effectively using large state capital.

There should be specific legal provisions for the State to perform its role in creating and maintaining the legal, economic and social environment necessary for the establishment and operation of corporations through economic policies, state management tools to influence the operations of state-owned economic groups in order to promote positive aspects and limit negative aspects in the operation of economic groups.

It is necessary to include the provisions of the SEG model in highly legal documents such as the Law. Subsequently, the bylaws may be guiding decrees and additional decrees. The operation of state-owned economic groups is regulated in Decree No. 69, mainly aiming at managing the state owner over the corporation. In the coming time, it is necessary to add in the Enterprise Law an additional chapter for the general economic corporations model (state-owned economic corporations and private economic groups), strict regulations on operation mechanism, supervision apparatus, management machine ...

4.3. Regulations on strict supervision of corporate governance structure

The governance apparatus in SEG plays an extremely important role because it is the "backbone" in the activities of corporations. For the management apparatus of state-owned economic groups to operate reasonably and effectively, we must formulate legal regulations on monitoring mechanisms in a comprehensive and strict manner.

Although Decree 101/2009/NĐ-CP was issued as a legal framework governing the establishment, operation and management of state-owned economic groups, which was established in pilot, and later, Decree No. 69/2014/NĐ-CP, the regulations on monitoring mechanism of governance apparatus in the economic corporations are still very limited.

The regulation of the Supervisory Board should be amended and improved. For example, the appointment of the Supervisory Board should be revised because of the lack of objectivity, transparency and honesty in the process of supervising, controlling activities and decisions of the Board of Directors. The Chairman of the Board of Directors. The law should state that the owner is the entity that has the right to appoint members of the Supervisory Board, members of the Control Board should not be members of the Board of Directors. Such provisions will ensure the objective transparency during the Supervisory Board's working process when overseeing the activities and decisions of the Board of Directors.

There should be regulations on strict supervision mechanism for agencies and important titles in the management apparatus of the economic corporations such as closely monitoring the activities of the Board of Directors, Chairman of the Board of Directors, director or general director, chief accountant in the parent company, and subsidiaries; stipulating personal responsibilities for each subject associated with their jobs, decisions, tasks and powers.

Further strengthening the mechanism and organization of managing corporations, such as increasing the number of independent members of the board of directors; set up the Government's collective evaluation mechanism on the operation of the board of directors of the corporations;

The audit of state capital in economic groups should be strengthened, requiring mandatory audits for all companies of state-owned economic groups. Quarterly financial figures of SEG companies, and summarized financial data of an entire Group, must be clear, public and transparent, so it is required to disclose these financial figures on official Vietnamese speech agencies such as video or newspaper, for the people and the State to supervise the financial use in these companies and economic corporations.

To be transparent in the management of state capital in economic groups, it is necessary to enhance the capacity and powers of the State Audit, so that the frequency of auditing of state corporations and corporations is shortened. There is a need for coordination between state auditors and organizations providing audit services, restoring internal audit activities in dominant SOEs or single-member limited liability companies.

4.4. Completing the regulations on the operation of state - owed economic groups

Perfecting the laws on economic corporations in the direction created in the mechanism to encourage and attract the voluntary participation of enterprises in SEGs, restrict the establishment of SEGs subjectively and willfully by mandatory administrative decisions;

The law should strictly regulate on project investment in SEGs. Responsibilities of state agencies competent to supervise the use of capital of state-owned economic groups must closely monitor the list of investment projects and sources of capital mobilized for investment; efficiency of capital investment outside enterprises; debt management situation and debt solvency. It is advisable to specify that the parent company does not interfere with the business of subsidiaries and affiliates. The parent company points out the general development direction of the whole group in the future. The parent company allows its subsidiaries and affiliates to actively use their allocated capital to invest and trade in the businesses that the company is allowed to do business.

Subsidiaries are allowed to proactively build the company's business strategy and implement it themselves, not necessarily through the parent company. The parent company will assign targets to subsidiaries, member companies, like to achieve a certain amount of profit, and expand the market in a certain period, forcing these companies to comply. If the company does not meet the target, it will be punished according to legal sanctions, or the parent company is allowed.

To enhance the responsibility of the job and not rely on superiors for the leaders, employees in subsidiaries and member companies, the law should strictly regulate personal responsibilities. Personal responsibility should severely punish leaders for setting an example for subordinates if they fail to fulfill their assigned tasks. Also, leaders of employees in the company doing wrong, not in accordance with the law, of course, must be punished by the law.

The law for state-owned economic groups should stipulate that there is a salary for doing business in companies in the group system in addition to the basic salary following state regulations. Business salary shows that if you do well, your business salary will be high, and vice versa. The quality of work of employees and salary ratings should be evaluated according to A, B, C, D every month. Those who work well get high salaries according to the ranking order. This will stimulate enthusiasm in the work of employees.

5. CONCLUSION

Currently, state-owned economic groups with large capital, holding dominant position in economic sectors, are considered a new trend. However, the provisions on state-owned economic groups are still ambiguous, causing difficulties for the transformation of SOEs' business operations, affecting or hindering the development of corporations. Therefore, the provisions of law need to be further improved, creating conditions for state-owned economic groups to have a healthy operating environment.

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ATTRACTING INVESTMENT CAPITAL FOR STATIC TRANSPORTATION INFRASTRUCTURE DEVELOPMENT IN HA NOI

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Abstract: *Static transportation in urban areas is an important part of the urban transportation system and an essential service of each urban center. Land use planning provides the basis to decide the reasonable size of the system of vehicle terminals and parking lots in urban areas. Due to the lack of financial resources, the static infrastructure of road transportation in Hanoi does not catch up with its growing number of vehicles and the need to connect with surrounding provinces.*

Keywords: *Static transportation infrastructure; Hanoi; Investment capital.*

1. THE STATUS-QUO OF STATIC INFRASTRUCTURE OF ROAD TRANSPORTATION IN HANOI

Static transportation is a part of the transportation system that serves vehicles, passengers, or goods during the non-moving period. Accordingly, static transportation includes a system of transportation hubs of different modes of transport (railway stations, waterway terminals, aviation terminals, road transportation terminals, parking lots, garages, starting and ending points, transit points, and stops along the route) (The Ministry of Transport, 2016). In recent years, the increasing parking demand puts great pressure on Ha Noi while the city still lacks specific planning on parking terminals, spare land fund. The solutions proposed are temporary and passive ones. Many exploited parking lots and spots in Ha Noi are only temporary. Few well-built car parking lots are big enough (Tran Thi Lan Huong, 2011). Most importantly, the area of parking lots does not meet the increasing transportation needs of people living and working in the city. In addition, the number of bus stations and transit points should also be put under consideration to meet the increasing demand for inter-provincial transport of passengers and goods of Hanoi, the key transport hub of the North region.

- ***Coach bus station***

- Inter-provincial coach bus stations: Ha Noi currently has 08 main coach bus stations with a total area of about 17.6 hectares, including Giap Bat Station, My Dinh Station, Yen Nghia Station, Gia Lam Station, Nuoc Ngam Station, Son Tay Station, Troi Station, and Phung Station.

- Intra-provincial bus stations: Hanoi has 03 main provincial bus stations, which are Co Do Station (Ba Vi District), Duc Khe Station (My Duc district), Thuong Tin Station (Thuong Tin district). Besides, there are also some small pick-up and drop-off points in Ha Noi, which came into existence a long time ago and are temporary. Those points are mainly located in the districts of Ba Vi, My Duc, Phu Xuyen, Soc Son, Thuong Tin, and Ung Hoa. The total area of those intra-provincial bus stations is about 0.65 hectares (Center for Transportation Development Consulting, 2012).

The eight inter-provincial coach bus stations and 3 intra-provincial bus stations basically meet the transport needs. However, those stations do not satisfy the travel demand of people during holidays, especially the Tet holiday. Some stations are not ensured in terms of size, convenience, and location in the inner city, thus, obstructing traffic.

- ***Truck terminals and yards***

In Ha Noi, there are 04 truck terminals with a total area of about 5.74 hectares and 06 truck yards, with a total area of about 5.28 hectares.

Table 1. Truck terminals and yards in Ha Noi

No.	District	Terminal Name	Area (m^2)
	Truck Terminal		**57.400**
1	Bac Tu Liem	Xuan Phuong Terminal	2.900
2	Gia Lam	Yen Vien Terminal	6.500
3	Thanh Tri	Ngu Hiep Terminal	41.000
4	Hoang Mai	Thanh Tri Terminal	7.000
	Truck Yards		**52.850**
1	Hoang Mai	Tam Trinh Yard	1.000
2		Den Lu Yard	4.600
3	Long Bien	Gia Thuy Yard	1.800
		Long Bien Yard	1.450
4	Thanh Tri	Lien Ninh Yard	19.000
5	Dong Anh	Hai Boi Yard	20.000
6		Doc Van Yard	5.000
	Total		**110.250**

Source: Hanoi Department of Transportation (2018)

In general, truck terminals have been arranged based on the city's plan while truck yards sprang up spontaneously and are located in the inner city, thus, causing the traffic jam.

- ***Public parking lots and spots***

The population of over 7.6 million people puts enormous pressure on transportation authorities and the city government. The burning issue of daytime and overnight parking lots and spots requires urgent and long-term solutions to accommodate the increasing demand for parking in Ha Noi (Ha Noi Institute of Construction Planning, 2018).

The network of public parking lots and spots is unevenly distributed, mainly concentrated in the inner city's districts and area from the city center to The Beltway 2. The lack of public parking lots, spots and their poor service quality cause difficulties in management, loss of urban beauty, and affecting traffic order and safety.

By June 2018, there were a total of 577 parking lots and spots with the area of about 34.04 hectares in 12 districts of Ha Noi. Specifically, the area of parking lots was about 20.81 hectares, while that of parking spots was about 13.23 hectares.

With the area of about 34.04 hectares, accounting for 0.11 % of the land area of Hanoi's districts, public parking lots and spots can meet only 8-10 % of the total parking demand in the inner city. The remaining 90 % is settled with parking spots in apartment buildings, yards of offices, schools, vacant land of projects, private houses, etc.

The land fund for static transportation is accounting for 0.11 % of the total area of Hanoi's districts, which is lower than the requirement of 2-3 % of the area of Hanoi's districts. There is a lack of parking lots and spots in the city center. The network of parking lots and spots is unevenly and unreasonably distributed. Besides, many illegal, unlicensed parking points sprang in Ha Noi (Pham Thi Tuy, 2009).

- ***Parking lots, bus freight stations***

The quality of buses operating on some routes is not guaranteed. Bus stops, pick-up and drop-off points are not appropriately arranged. Transport infrastructure does not catch up with the vehicle growth rate. The land fund for building starting and ending points for buses is insufficient. By 2015, Ha Noi had 92 bus routes, meeting only 8.4 % of transport demand, while the requirement by 2020 is 20 %.

Table 2. Bus parks in Hanoi

No.	Bus Park Name	Location	Area (m^2)	Capacity	Management unit
1	Lạc Trung Bus Park	Hai Ba Trung District	16.935	200	Hanoi Bus Enterprise
2	90 Nguyen Tuan Bus Park	Thanh Xuan District	36.985	128	10-10 Bus Enterprise
3	Cau Buou Bus Park	Thanh Tri District	11.220	86	Cau Buou Bus Enterprise
4	Yen Vien Bus Park	Gia Lam District	23.000	68	Yen Vien Bus Enterprise
5	Den Lu Bus Park	Hoang Mai District	12.000	156	Thang Long Bus Enterprise
6	Nam Thang Long Bus Park	Bac Tu Liem District	15.000	129	Hanoi Electric Vehicle JSC.
7	Lien Ninh Bus Park	Thanh Tri District	9.000	106	Lien Ninh Transportation JSC.
8	Newway Bus Park	Cau Giay District	15.000	175	Newway Transportation JSC.
9	Tan Dat Bus Park	Cau Giay District	12.000	103	Tan Dat Center
10	Gia Lam Bus Park	Gia Lam District	5.000	52	Hanoi Passenger Car JSC.
	Total		**156.140**	**1.203**	

Source: Ha Noi Transportation Corporation (2018)

In general, the land fund for static transportation (bus stations, parking lots, and spots) accounts for a low proportion, which is only 0.11 % in the center of Hanoi. The licensed public parking lots meet only 8-10 % of the actual demand. There is still a lack of parking lots and spots in terms of quantity and area. There are illegal and unlicensed parking points. Most parking lots and spots are non-mechanized and unevenly distributed.

2. THE STATUS-QUO OF ATTRACTING INVESTMENT CAPITAL FOR DEVELOPING STATIC ROAD TRANSPORTATION INFRASTRUCTURE IN HANOI

2.1. Policies to attract investment capital for parking projects

To solve the problem of static transportation, Ha Noi has been studying some specific mechanism to encourage private investors to participate in underground and smart parking lots.

For years, Ha Noi has been interested in developing policies to attract a private investor to invest in building underground and smart parking lots. Ha Noi City's People Committee issued an undertaking of building 07 underground parking lots in Quan Ngua Sports Complex, Thu Le Park (Ba Dinh District), Vietnam-Soviet Friendship Cultural Palace, Hanoi Opera House Square, State Bank Square (Hoan Kiem District), Youth Park (Hai Ba Trung District). However, no large-scale underground parking lot has been built yet. There are some smart high-rise parking lots with modest areas in Tran Nhat Duat and Nguyen Cong Hoan streets.

According to calculations, the cost per unit of the underground parking project is very high, and if the project is only for parking, the payback period can be up to 50-70 years. Therefore, most private investors do not see the attractiveness of such projects. According to estimations, the investment project of the building parking lot at 295 Le Duan Street and Vietnam-Soviet Friendship Cultural Palace cost VND100 billion and VND1000 billions, respectively. If investment capital is recovered only by collecting parking fees at the current level issued by the city, it is possible that investors may not recover their money in 100 years (Pham Thi Tuyet, Vu Trong Tich, 2016).

In order to increase investment in parking lots, Ha Noi has passed the Resolution of "Priority is being given to developing mass public transport system, encourage investment in construction and operation of parking lots for cars and other motor vehicles, apply high technology in management and administration of transportation system". Specifically, enterprises are exempted from land rents for ten years and can borrow money from the city's Development Investment Fund. The breakthrough is that the city allows the use of 20-30 % of the parking lot construction area for commercial business. Particularly, socialization projects will be considered for land rental support after the first ten years of operation. Enterprises investing in static transportation can also borrow money from the city's Development Investment Fund with preferential interest rates. In case of borrowing money from credit institutions, enterprises will be supported by the city's budget up to 50% of the interest rate for the first five years of the project, depending on the nature of each project approved by competent authorities (Bulactial, A., & Dizon, F., 2013).

2.2. Investment in bus stop development in the form of PPP

The current bus routes can meet only 5 % of the transport demand of people in Ha Noi. One of the factors that make people hesitate to use public buses is the inconvenient bus stop system under weather conditions in Ha Noi. In order to quickly renovate bus stops, the Ha Noi People's Committee has allowed enterprises to invest in 600 new bus shelters in the form of public-private partnerships (PPP). Enterprises will invest 100 % of the funding to build, operate, and maintain the entire work of those 600 bus shelters within 20 years. Among those 600 bus stops, 235 shelters will be newly built, and 365 existing ones will be replaced. Enterprises will install 1.200 advertisement panels at median strips with a width of more than 2 meters, 25 wifi-connected touch screens at some bus shelters at suitable locations for travel information searching, and advertising (Barter, P. A , 2011).

2.3. Investment in coach bus terminal development

Ha Noi plans to invest in 05 inter-provincial coach bus terminals at Co Bi, Dong Anh, Noi Bai, Southern Bus Terminal, and Son Tay with the total area of about 41.95 hectares during the period from 2018 to 2025. The total estimated investment amount is about VND2.300 billion. Ha Noi City People's Committee approved in principle to allow Hoang Ha Trading - Construction Consultant Joint Stock Company to study and propose the Dong Anh Bus Station Project in the form of socialization and compliance with the Hanoi construction master plan.

Ha Noi plans to invest in 05 truck terminals in Yen Vien, Southern Terminal, Co Bi Terminal in the East, Khuyen Luong, and Ha Dong with the total area of 57 hectares and total investment capital of about VND270 billion. During the same period, Hanoi will invest in 04 logistic center projects, including Eastern, North-Eastern, Southern, and Northern logistic centers, with the total area of 39 hectares and an estimated investment of VND1.950 billion.

Regarding public bus stations during 2025-2030, Ha Noi will invest in 12 coach bus station projects in satellite towns including Phung, Western, Cam Thuong, Xuan Khanh, Bac Hoa Lac, Nam Hoa Lac, Xuan Mai, Mieu Mon, Phu Xuyen, Mai Dinh, and Tan Minh stations with the total area of 57 hectares and investment amount of about VND3.254 billion.

General investment assessment - Over the last eight years since 2008, when Ha Tay Province was merged into Ha Noi, the investment in coach bus stations in Ha Noi is relatively slow. Those stations do not meet the needs of the society and are not commensurate with the size and population of the capital. Since 2008, only one Station, which is the Yen Nghia Bus Station, has been built using Korean ODA (Sachs Tillmannet al, 2007).

The state budget for investing in terminals and parking lots has not been given adequate attention, while the development of investment is based on socialized capital and ODA. The scale of investment is not synchronized; the facilities of some bus stations do not meet the needs of people. There is a lack of parking lots and support services for bus stations.

3. SOLUTIONS TO ATTRACT INVESTMENT IN DEVELOPMENT OF STATIC TRANSPORTATION INFRASTRUCTURE IN HANOI

The investment capital for the construction of a static transportation system, particularly parking lots and yards, is enormous while the payback period for those projects can last for 10-50 years. Projects, especially bus stops and yards far from the central area, may contain risks. Investment capital for static transportation system can be mobilized through the following capital sources:

- State budget and city's budget, including ODA, non-refundable aids, which are allocated to state enterprises to invest in the construction and operation of public parking lots and spots. Capital from urban development investment funds is for urban infrastructure.

- Credit loan: State offers long-term capital loans with a preferential interest rate, giving investors enough time to recover their money and pay interest to the banks; concessional loans of international organizations are guaranteed by the State through projects approved by competent authorities. Attracting foreign investment from other countries and international organizations should be based on foreign investment law (Sachs Tillmannet al, 2007).

- Attracting the participation of all economic sectors: With the policy of socialization of parking terminals, lots, and spots, urban centers can attract private capital sources through equitizing parking terminals, lots, and spots, mobilizing enterprises to invest in different types of investment to encourage all economic sectors to participate in building static transportation system.

Another form of capital mobilization is "exchanging land for infrastructure". Accordingly, investors will bear all expenses from site clearance compensation to construction. After the project is completed, it will be transferred to the local government for management. In return, the investors will be entitled to exploit certain local designated lands. Specific mechanism and policies include:

- Investors are allowed to use a part of the total construction area to exploit commercial services to improve the efficiency of land use.

- Land rent exemption: Land rent exemption is applied to the whole coach bus station or the mandatory service works including pick-up and drop-off areas, car waiting area for passenger pick-up, passenger waiting room, the working area of the management apparatus, ticketing area, restroom, in and out the driveway, internal road inside bus terminal, lands for planting trees and flowers gardens.

- The state budget, including preferential credit loans and funds from a domestic and foreign organization, non-governmental organizations, and international organizations, is prioritized for investment in developing static transportation.

- Enterprises will receive import tariff incentives from the local government budget for imported equipment and technology lines, which have not been manufactured domestically or the similar domestically manufactured ones do not meet technical standard requirements that directly serve the construction projects of underground parking lots.

Investors may transfer or sell their operation rights of part of the parking area during the project life. The transfer should comply with regulations on real estate trading.

- Public parking terminals may offer additional services such as repairing, maintenance, petrol stations, and ancillary services, etc., depending on the location, the size of the terminal. Those additional services will be integrated during project formulation and approved by competent authorities.

- Proactively propose parking lot fees and charges (not exceeding the regulated ceiling price).

- Corporate income tax incentives.

- Local governments support the investment in the construction of infrastructure works: For underground construction projects, there will be investment support or direct investment from the state budget for technical infrastructure works (roads, electricity, water supply, and drainage) outside the fence but connected to the general technical infrastructure of the area.

- In case the local government has not been able to balance the fund to support the above works according to the project schedule, the investor may mobilize other lawful capital sources to ensure the project schedule. This fund will be deducted from the amount that the investor must contribute to the state budget.

The development of static transportation infrastructure plays an important role in the overall transportation system management strategy, especially in Vietnam's large cities like Hanoi, which have huge transportation demand, traffic density, limited land funds and expensive infrastructure investment.

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STATE MANAGEMENT ON MOBILIZATION AND UTILIZATION OF INVESTMENT CAPITAL FOR ROAD TRANSPORT INFRASTRUCTURE CONSTRUCTION AND DEVELOPMENT IN HANOI: SOME EXPERIENCES AND LESSONS LEARNED

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Abstract: *With the potentials and advantages of a big city, which is the economic, political and social center of the country, Hanoi has undergone a dramatic urbanization process over the past years, and the city's road transport infrastructure has been developed. After ten years since 2008, the expansion of the administrative boundaries of Hanoi with a new scale, position and development conditions has brought about great opportunities for Hanoi to develop quickly, comprehensively and sustainably. The capital city of Vietnam has been able to bring into full play its strength for horizontal and vertical socio-economic development. The resources and strengths on land, people, culture, history, the technology of each locality have been exploited efficiently. The most outstanding development in terms of quality and quantity, which must be mentioned, is the strong development of the transport infrastructure.*

The investment in transport infrastructure is clearly shown by the target of area for transport with an average annual growth of 0.28% of urban land. Accordingly, the site for transport infrastructure development reached 7% in 2010 and 8.96% in 2017. The number of traffic jam points decreased from 124 in 2010 to 37 in 2017, while the number of traffic accidents also fell from 2,252 in 2013 to 1,448 in 2017. The results mentioned above have contributed to reducing traffic pressure for the Capital, traffic jams and traffic accidents. They are strengthening the traffic connection between Hanoi and other provinces and cities in the region, positively promoting socio-economic development and the overall construction and development of Hanoi after ten years of expansion.

Nevertheless, Hanoi's urban transport infrastructure in general and roads, in particular, still have many congestion points, isn't commensurate with the demand for the Capital's socio-economic development and the target of making Hanoi a civilized capital and a sustainable city. The rapid urbanization, mechanical population growth and massive increase of means of transport lead to overloading in urban transport infrastructure and traffic jams. The transport infrastructure system has not met the requirements of rapid urban development. Socialization policy in investment in transport infrastructure has been slowly and non synchronously implemented. One of the reasons for this situation is that the state management on investment capital for the construction of road transport infrastructure is still inefficient. There is a burden placed on the limited government budget while other capital sources do not meet the requirements, although attention has been paid to them.

1. CHARACTERISTICS OF INVESTMENT IN ROAD TRANSPORT INFRASTRUCTURE

Infrastructure is a compound word with two components: infra (bottom) and structure. This is a comprehensive concept that includes technical infrastructure and social infrastructure. In detail, Transport infrastructure is an integral part of technical infrastructure. In other words, transport infrastructure is a system of transport works built to serve the movement of people, goods, services and means of transport. Transport infrastructure is often assessed based on a network, meaning that the connection between different modes of transportation, including roads, waterways, airways and railways, forms a complete and mutually interactive system.

Besides having general characteristics like those of other investment activities, investment in road transport infrastructure has its specific features.

Firstly, although investment in transport infrastructure brings about many socio-economic benefits, it requires a tremendous amount of capital, which is difficult to be recovered. Therefore, the primary capital source for this kind of investment comes from the government budget, which accounts for about 60-70 % of the total investment capital. As investment projects in transport infrastructure typically need large capital amounts, long construction periods while they do not bring about high economic benefits to investors and are difficult to be recovered, they are not attractive to private investors. Although transportation works serve the travel needs of the whole society and are exploited by all economic sectors, few people are interested in investing in repairs and maintenance of those works. Therefore, part of the government budget is annually extracted to finance new construction, rehabilitation of transport works, improving the national traffic infrastructure system.

Although investment in transport infrastructure construction does not bring direct benefits to investors, its socio-economic benefits cannot be measured. This investment is considered as an investment in social welfare, serving the need of the entire community.

Secondly, road transport infrastructure requires a huge investment capital amount which has a long payback period or, sometimes, is irrecoverable. Road transport works are often monolithic, conducted in a large area of not only one locality but also other localities. Due to complex natural and technical factors, the requirements of high durability, long-term intensive use, those works are often costly. Furthermore, road transport works have to be built synchronously from roads to sidewalks, lighting systems, trees, traffic signs, a drainage system to ensure safe and efficient traffic. As some works are located in areas with high population density and many current construction works, site clearance is complicated, requires long clearance time and Capital. As a result, investment capital in transport works is often considerable.

Road transport works are invested for public purposes, serving the movement of people and business firms. With tremendous investment value, low or without revenue, those works have a long payback period and even are non-recoverable from the use of such works. This is a prominent feature and also the reason why road transport infrastructure is mainly financed by government budget and not attractive to private investors.

Thirdly, investment capital for urban transport infrastructure often has high risks, depending on capital mobilization measures and policies. As long-term capital in general and capital in road transport infrastructure development, in particular, are invested for an extended period, the level of risk is high in terms of interest, inflation and changes in policies. In addition, because those investments are long-term and used for different types of works, contractors often have to spend their own money to perform the work before receiving investors' Capital. As a result, debts and capital appropriation in road construction happen quite often.

Since transport works are large public properties located outside, they are directly affected by natural conditions. Accordingly, it is difficult to calculate the level of risk associated with those works. Especially under the context of climate changes, the measurement and calculation of the damage level of public transport works caused by natural disasters are difficult. It requires the investment of time, effort and money to prevent and overcome the consequences of those disasters.

Fourthly, investment capital in road infrastructure construction is often associated with development projects and mobilized from different sources. As road transport works are systematic and synchronous public properties under state management, the investment in those works is long-term synchronous strategies and centralized project management.

Investment capital for those works can come from various channels depending on the country's level of development, capital mobilization and management ability, the level of financial and monetary market development. For developing countries, this kind of investment capital mainly comes from the government budget. As investment in road infrastructure is associated with high risk, long payback period and low efficiency, it is not attractive to private investors. However, as the government budget is limited while investment demand keeps increasing, mobilizing other capital sources from private enterprises, foreign countries and ODA, etc., is significant.

Last but not least, the efficiency of investment in the construction of road transport infrastructure are combined socio-economic efficiency. As the general principles of using investment capital are efficient and profitable, attention should be paid to capital profitability. However, transport infrastructure in general and road infrastructure, in particular, are public goods managed by the State; their efficiencies include not only economic benefits like those from the typical investment but also socio-economic benefits.

When deciding for each investment project of road transport infrastructure, it is necessary to consider the project's efficiencies in a comprehensive way, including economic, social and even environmental efficiencies, immediate and long-term benefits, local and the whole society's benefits. For example, expanding a road will make it easier for people to travel, reducing congestion, travel time and cost, increasing working time, leading to higher productivity. Thus, the incomes of firms, the region and the country will increase. Therefore, the profitability of almost all investment projects in urban transport infrastructure is reflected in their social benefit, which must be higher than the capital investment cost.

2. STATE MANAGEMENT OF INVESTMENT IN ROAD TRANSPORT INFRASTRUCTURE FROM STATE BUDGET

State management on investment in road transport infrastructure is the continuous, organized and oriented impacts of state functional and authorized agencies on units and individuals carrying out the mobilization and utilization of investment capital under government mechanism and policies to develop road transport infrastructure efficiently. The state directly manages investment capital from the government budget and indirectly controls money from other sources through policies and facilitation mechanism to guide business firms and individuals.

At the city level, the People's Councils and People's Committees are the subjects managing investment capital in road infrastructure construction. For state-invested projects, the City People's Committee is responsible for managing projects under its determination. Those projects may belong to three groups (A, B and C) within the scope and the ability to balance the local budget after being adopted by the People's Council at the same level. For those projects, the City People's Committee manages the whole process of capital mobilization, allocation and utilization, from the determination of investment policy, project formulation, investment decision, contractor selection, construction, acceptance, handover to work using. For projects having many components, each component can be managed by the division and agreement between parties and by the investment decision-maker.

For ODA projects, the investor of which is the city, the City People's Committee is responsible for managing this capital source. However, those projects are also under the management of the donor. Hence, the management mechanism also has many distinct features.

For projects using other capital sources, including private Capital in the form of PPP, the City People's Committee will approve those projects based on the investors' capital investment capacity. At the same time, the implementation process will be decided by investors.

The City People's Committee will manage the investment policy and scale for projects, including enterprises using state-guaranteed credit capital, credit capital of state development investment and development investment capital of enterprises. The enterprises having those projects are responsible for implementing and managing the projects by relevant laws.

For any Capital or project, state management of investment in road infrastructure construction must meet the following objectives:

Firstly, it is necessary to effectively mobilize domestic and foreign capital sources to solve the budget problem for the development of the infrastructure system in general and road transport infrastructure in particular. With the characteristics mentioned above of infrastructure construction, while investment from state budget meets only part of the demand for investment in road infrastructure, capital mobilization from other sources is very important to make up the capital shortage in this field. Reality shows that the state budget plays an essential role as reciprocal capital and helps attract other capital sources for investment in road infrastructure development.

Secondly, it is necessary to ensure a reasonable allocation of investment capital for road infrastructure projects. With the process of economic development and urbanization, there is an increasing demand for road infrastructure development. However, there is often a gap between demand and capital sources to meet that demand. Therefore, balancing and rationally allocating capital sources to transport projects, which are urgent to serve the need of many people, with the right objects, amount and progress are not easy tasks and very important for state management. Besides, road transport infrastructure projects often require considerable investment amounts and strict technical requirements.

Thirdly, it is crucial to develop an efficient and synchronous road transport infrastructure system. It is the most important and ultimate goal of state management on investment in road infrastructure construction. Thus, the administration must ensure investment capital being used most efficiently with the lowest cost, the technical and artistic quality of road infrastructure works and their sustainability to serve people's needs. The fulfillment of this challenging goal depends on the leader's vision in planning and appraising capital plans. The effective implementation of the two objectives mentioned above will allow the successful implementation of this goal. Besides, the system of documents guiding the implementation of state legal regulations and policies related to the management of construction investment capital for road transport infrastructure issued by the city has subjective elements, directly affecting the operation and management process.

3. FACTORS AFFECTING THE MANAGEMENT OF ROAD TRANSPORT INFRASTRUCTURE CONSTRUCTION

The first factor is the system of the national and city's investment management laws and policies. Those legal documents are the guideline for investment capital management, which has a significant influence on managing the investment capital for road infrastructure construction in the city. They help management subjects and objects to actively exercise their rights, responsibilities and obligations in managing and implementing construction investment in road infrastructure projects.

The second factor is the application level of the modern management process in managing investment capital for the construction of road transport infrastructure, including investment capital planning, mobilizing, allocating and supervising the implementation process. A modern process can link all stages in the process. It increases the coordination among departments and the ability to check, monitor and detect inadequacies that need to be adjusted in each step of the management process, avoid group benefits in managing investment capital for road transport infrastructure. Also, the modern process allows the application of information technology in management, organization streamlining, time and cost-saving.

The third factor is organizing the state management apparatus on investment capital for the construction of road transport infrastructure. It is the decisive factor of management. From the city's management perspective, the capital management apparatus for investment in road infrastructure construction is the management entities operating according to their functions and powers. An exemplary apparatus is asynchronous and closely coordinating one to manage all the stages in activities related to road transport infrastructure construction. This apparatus has a qualified, professional and ethical staff.

The next factor is the city's strategy, planning and construction of road transport infrastructure. It is the basis for planning investment capital in road infrastructure construction, which is related to capital demand, developed and approved capital sources, capital mobilization solution, etc. The city's strategy, planning to build road transport infrastructure, needs to be carefully researched. Those strategies and plans which are visionary and detailed elaborated will make it easier for capital planning and bring about efficient use of investment capital for road transport infrastructure construction, meeting the city's development requirements. Moreover, they also help avoid losses and wastes in using investment capital, which reduces the efficiency of investment capital management in road construction.

The last factor is the city's social, political and economic characteristics and the nature of its road transport infrastructure. It is an objective factor directly affecting the demand and investment capital for road infrastructure construction. A city with an important political position in the country will be given priority over other towns and localities. Significantly, the city, which is the Capital, the economic, social and political centre of the country, will receive more incentives. The city will be given priority in allocating resources, including capital from the stage budget, for development, especially for road transport infrastructure construction.

4. EXPERIENCES IN STATE MANAGEMENT IN MOBILIZING AND UTILIZING INVESTMENT CAPITAL FOR ROAD INFRASTRUCTURE CONSTRUCTION

4.1. Experience of diversifying capital sources to supplement the investment budget for road transport infrastructure construction

Investment in construction, upgrading and renovation of infrastructure in general and road infrastructure, in particular, is always an urgent requirement for socio-economic development. However, the capital source financing this task is not small, while the state budget for this development is not enough. Therefore, the problem to be solved is how to mobilize many other additional sources for the construction of road transport infrastructure and efficiently utilized those sources. Those sources can be mobilized through (i) auction of land use rights and (ii) loans from financial institutions and residents.

4.2. Mobilizing investment capital for government budget from the auction of land use rights. It is an effective policy to create money for road infrastructure construction in some localities in Vietnam and some other countries with similar conditions

In Vietnam, the auction of land use rights is widely used as a financial mechanism in all provinces and cities, especially big cities, in creating significant investment capital for the construction of road transport infrastructure. Danang city is an example of the successful adoption of this policy. Right after Danang became a central-level city, the city's leaders have sketched its development strategy based on the principle of "infrastructure goes ahead" to create the turning point for economic development following the local potentials. The policy of "State and people working together" has created a synergy for Danang with the support of its people in exchanging land for infrastructure. It also brought about the successes in the construction of road infrastructure and a new look for the city.

Danang has invested in 280 projects to exploit land fund and land, the use rights of which are transferred to organizations and individuals, to be used as residential land, for production activities, tourism and land service. The total amount for exploiting land fund in Danang city during 2008-2010 was more than VND3,000 billion, which was contributed to the government budget and fully used to upgrade the city's infrastructure (Trương Minh Dục, 2013).

Some countries like India and Brazil have adopted similar policies and obtained remarkable results. In India, the Mumbai Metropolitan Region Development Authority, the land administration agency, sold 13 hectares of land in 2007 and earned USD1.2 billion, which was invested in developing the city's transportation network. According to the World Bank, this amount of money was more than three times the total value of bonds issued by all Indian urban government agencies since 1995. Similarly, in Brazil, some areas, which were bought by the government before planning infrastructure works in Aguas Claras, were resold at a price that covered 85 % of the total investment cost for the metro line in the area in the 1990s (World Bank, 2013).

The cases, as mentioned earlier, show the benefits when the government implement land management policy through the creation of a land fund to be exploited for transport infrastructure development projects. Predicting future development trend shows a vision in the process of urban planning in general and road transport infrastructure planning in particular, which is practical and a good experience for Ha Noi.

4.3. Borrowing from financial institutions and residents

In China, there is a substantial decentralization for local governments in finding a financial resource for investment in infrastructure development. In localities, domestic bonds and foreign loans are considered financial sources for infrastructure development projects. China also diversifies forms of financial mobilization from domestic enterprises. For example, the local government in Dongguan City, Guangdong Province, established a company mobilizing capital from various sources to build a road transport system. The interest payment is paid periodically, and the principal will be repaid by user fees when the project is completed and put into use.

To have investment capital for infrastructure development such as building bridges and tunnels connecting the banks of Huangpu River, the Shanghai government borrowed money from the World Bank and fees are collected after those works went into operation to pay back the loan. However, the Shanghai government brought the rights to operate those works from the World Bank after they were put into operation for a while. Instead of being directly collected by the government, fees are indirectly charged when people buy cars. In addition to borrowing from financial institutions, Shanghai has called on other organizations and localities to invest in Pudong with many preferential policies. Those flexible capital mobilization policies have helped the total investment in Pudong’s infrastructure reach more than 300 billion yuan, only about 10 % of which was from the government budget.

However, borrowing to develop infrastructure is not always a suitable method. Issuing municipal bonds to develop infrastructure in China is also a valuable experience. In November 2011, China’s Ministry of Finance officially allowed Zhejiang, Guandong, Shenzhen, etc., to freely issue municipal bonds with a term of between 3 and 5 years to mobilize idle domestic and foreign capital. However, this plan encountered adverse problems when those loans were used to pay for bad debts borrowed from banks, the maturity dates of which were coming, besides invested in new projects, leading to the risk of bankruptcy. Therefore, in June 2012, China’s Ministry of Finance decided to revoke the license to issue bonds of localities directly. From then on, localities must register with the Central Bank if they want to issue bonds. This case is a failure in mobilizing funds for the government budget that needs to be noted.

4.4. Experience in raising capital through investment funds

To meet the capital demand for transport infrastructure development, in addition to the capital allocated by the governments, some localities and countries have established funds to mobilize and use investment capital actively and effectively maintain transport infrastructure.

Local development investment funds (LDLF) are special financial institutions established at provincial and city levels to mobilize capital and sign contracts with the private sector to develop local infrastructure.

In Ho Chi Minh City, the Ho Chi Minh’s Urban Development Investment Fund is the first LDLF formed with charter capital from the city's revenues, including the sales of state-owned houses, land fund, money contributed by domestic and foreign organizations and individuals, etc. The city extracts a certain percentage annually from the revenues of the lottery, land use right transfer, sales of houses, liquidation of state-owned assets, charges, fees and surcharges by the provisions of laws to supplement charter capital. This fund is entitled to mobilize medium and long-term capital sources from domestic and foreign organizations and individuals and has brought into full play its effectiveness. It is rated as the most successful and sustainable financial LDLF in Vietnam and has contributed a lot to the development of Ho Chi Minh City's transport system (world Bank, 2013).

In some countries such as New Zealand, investment capital for transport infrastructure is mobilized from three main sources, including user fees, government revenues and fees from landowners. The national transport fund uses all the fees collected from traffic participants. New Zealand Transportation Authority (NZTA) manages this fund through the National Land Transport Programme (NLTP). This program includes some activities defined by national policies based on investment capital for transport. Those activities, such as local road upgrading, are often clearly defined (Kemp A. & V. Mollard, 2013).

Table 1. Investment funds for infrastructure development in some countries

Country	Fund	Source	Aim
Japan	High-speed Road System Development Fund	Taxes, fees, interest collected from projects with a high return on investment	Financing investment in road development, balancing benefits from projects with high capital returns to projects with low payback capability
The U.S.	Highway Trust Fund	Taxes and fees related to road users	Funding most federal transport projects (highways and public transport)
Bangladesh	Private Investment Promotion Fund	Government contribution, International Development Association (IDA), banks and non-bank credit institutions	Providing capital for the private sector to develop infrastructure
Russia	Investment Fund	Government contributions and other sources	Financing infrastructure projects and transport infrastructure projects

Source: Ministry of Transportation. Decision 4403/QĐ-BGTVT on approving the scheme to mobilize resources for investment in transport infrastructure development.

4.5. Experience in checking, controlling and evaluating the efficiency of capital utilization in the construction of road transport infrastructure

In South Korea, the Ministry of Strategy and Finance has developed a total project cost management system (TPCM). This system is based on the principle of "not being allowed to increase the construction scale through design modification except for unavoidable cases. The management agencies must consult with the Ministry of Strategy and Finance on adjusting project costs". This significantly changes the number of proposals to adjust project costs from management agencies. The number of recommendations to increase the total project cost reduced from

26.4 % during 1996-1999 to 4.4 % during 2000-2003.

Similarly, the Japanese legal system strictly regulating construction supervision and inspection includes the Law on Promoting Bids and Legal Contract for public works, Law on Public Finance, Law on promoting quality assurance of public works, etc. Regional development bureaus will compile technical standards used for inspection while the inspection contents in monitoring will be carried out by state officials (MLIT). Construction management at the construction sites contributes significantly to ensuring the quality of construction works. Construction management at construction sites includes supervision and inspection of construction work with contents by contract terms, construction progress and labour safety.

In some countries such as England, South Korea and Chile, the inspection and evaluation of project completion are done through post-inspection policy. Besides, in Chile and South Korea, officials play an essential role in checking project works completed compared to project plans. In England, project evaluation is to assess the impact of investment projects based on outputs. In addition, a special review mechanism is implemented to detect systematic factors affecting the cost and quality of projects. In those countries, investment projects must be audited, and a special mechanism to expedite project implementation will be applied if there is a fundamental change in costs, progress and estimated profit of the project. For example, projects in South Korea are automatically reassessed if the actual cost increases by more than 20%. In Chile, projects will be reevaluated if the lowest bid is at least 10% higher than the estimated price.

In China, monitoring public investment projects are carried out at many levels and different monitoring rounds. The purpose of investment monitoring by government agencies is to ensure the right investment, the right projects under regulation and efficiency. The agencies having the projects must arrange staff to regularly supervises their projects following legal regulations. The Development and Reform Commission at each level, with its own investment supervision department, is responsible for overseeing investment projects under its management. When necessary, a special task force may be established to monitor at project sites directly. The Development and Reform Commission established and chaired interdisciplinary investment monitoring teams with the participation of financial, anti-corruption and specialized agencies at the same level, related agencies and localities.

5. SOME LESSONS ABOUT STATE MANAGEMENT IN MOBILIZING AND UTILIZING INVESTMENT CAPITAL FOR THE CONSTRUCTION OF ROAD TRANSPORT INFRASTRUCTURE IN HANOI

From the experiences as mentioned above in state management in mobilizing and utilizing investment capital for the development and construction of road transport infrastructure, some lessons can be drawn for Ha Noi as follows:

First of all, it is necessary to diversify capital sources for the government budget to invest in the development and construction of road transport infrastructure as it requires a large amount of capital that both the central and local governments can hardly meet. Therefore, domestic and foreign localities advocate diversification of investment capital sources to supplement the government budget. Those capital sources may come from the auction of land use rights or loans from financial institutions and residents through issuing municipal bonds.

Mobilizing capital through land uses the right auction policy to invest in the development and construction of road transport infrastructure is an effective solution when there is a shortage of money from the government budget. It was successfully implemented in cities like Danang. With the policy of exchanging land for infrastructure, auctioning projects that use land on both sides of roads, Danang had obtained a large amount of capital to invest in infrastructure development, including the construction of road transport infrastructure. Selling public land like in India should also be taken into consideration to apply to Ha Noi in the current period. Borrowing from financial institutions or issuing municipal bonds is also a good solution to supplement the investment budget for the development and construction of road transport infrastructure. Reality shows that many cities such as Shanghai have successfully implemented this policy, bringing about an incredible amount of capital for the city's road transport development. However, attention needs to be paid to the proper and effective use of money mobilized through borrowing in general and issuing municipal bonds in detail to avoid risks of bankruptcy, as in the cases mentioned above of Zhejiang, Guangdong and Shenzhen.

Secondly, the establishment of investment funds is also a good lesson that can be applied to Ha Noi in investment in the construction of road transport infrastructure. The experiences, as mentioned earlier, show that although the names and types of funds are different from country to country, the sources of capital forming those funds come from government contribution (from the prescribed revenues like taxes and fees) and other payments from domestic and foreign firms, individuals and organizations.

Thirdly, the process of effective inspection, monitoring and evaluation is an essential requirement to carry out an investment project. Experiences show that closely monitored and inspected projects will avoid unnecessary mistakes and are more efficient. The systematic assessment with clear and transparent criteria will make it more convenient for the management process and help prevent losses, wastes and corruption.

In addition, practical experiences also show that countries with strict legal system and supervision in all stages of the road infrastructure construction process will be more efficient than other countries. Investment projects must be objectively, openly and transparently audited. The application of special mechanisms like those in South Korea and Chile to expedite project implementation when facing problems such as fundamental changes in costs, progress and profits of projects is also a good lesson for Ha Noi.

6. CONCLUSIONS

Constructing road transport infrastructure is an indispensable requirement in the development of the infrastructure system of each country in general and each locality in particular. Due to the characteristics of road transport infrastructure related to many objects and large capital amounts, the management role of the state is vital to ensure the harmony of interests for the State, the people and investors. The experiences of some domestic and foreign regions showed that diversifying investment capital sources, strengthening state inspection and supervision in capital mobilizing, allocating and finalizing is necessary to enhance the efficiency of state management of investment capital for building road transport infrastructure.

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FINANCIAL MANAGEMENT IN THE MINING INDUSTRY

MULTIDIMENSIONAL CHARACTERIZATION OF CORPORATE SOCIAL RESPONSIBILITY: A CASE STUDY OF COAL MINING FIRMS IN CHINA

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Abstract: *Corporate social responsibility (CSR) is well recognized globally as an important way of improving sustainability. In particular, the standard of Guidance on Social Responsibility (ISO 26000:2010) published by the International Organization for Standardization (ISO) can be considered a global consensus on the CSR, including its problems and issues. However, specific perceptions, conceptions and practices of CSR may show considerable discrepancies, apparently influenced by differing social, economic and cultural circumstances. In view of this, multidimensions of CSR are discussed in the context of CSR spatial diversity, temporal dynamics and universality. Based on factors such as general patterns of CSR issues, economic growth, social or societal development, a theoretical framework is developed. To illustrate the diversity, spatial dynamics, temporal dynamics and discrepancies of CSR in the coal sector in China, an extension matter-element assessment methodology combined with an analytic hierarchy process is applied, and the CSR levels of 16 coal mining firms during the five-year period from 2013 to 2017 are studied. The results show that the CSR performance of firms is influenced by the external business environment at specific times and the economic development level of the region in which they operate.*

Keywords: *corporate social responsibility; CSR universality; diversity; spatial dynamics; temporal dynamics.*

1. INTRODUCTION

Social responsibility has been the subject of research for a long time (Sheldon, 1923), and has been explained in terms of corporate social performance, stakeholder theory and even business ethics theory (Carroll, 1999). In brief, social responsibility can be defined according to the obligations or behavioral expectations of an organization or individual to society at large. This responsibility may entail active duties that directly contribute social goals, or may be inactive, for example avoiding participating in a socially disadvantageous act. Excellent organizations have an energetic influence on the world around them by strengthening their performance and improving social, economic and environmental circumstances at the same time (EFQM, 2015). In the last few decades, as economic globalization has evolved, the values of sustainable development have become widely accepted. Studies examining corporate social responsibility (CSR) have emerged in large numbers and various descriptions and definitions of CSR (Jankalová and Jankal, 2017) have been produced, as shown in Fig 1. Social interest theory (Schochet, 1979), stakeholder theory (Freeman, 1984; Viveros, 2017), corporate citizenship (Matten and Crane, 2005), business ethics (Epstein and Hanson, 2005) and other important researches have all contributed to the conceptual evolution of CSR. Although no unified definition of CSR has yet been produced, all of these perspectives have pointed out that companies must take into consideration the economic, social and environmental impacts of their business activities.

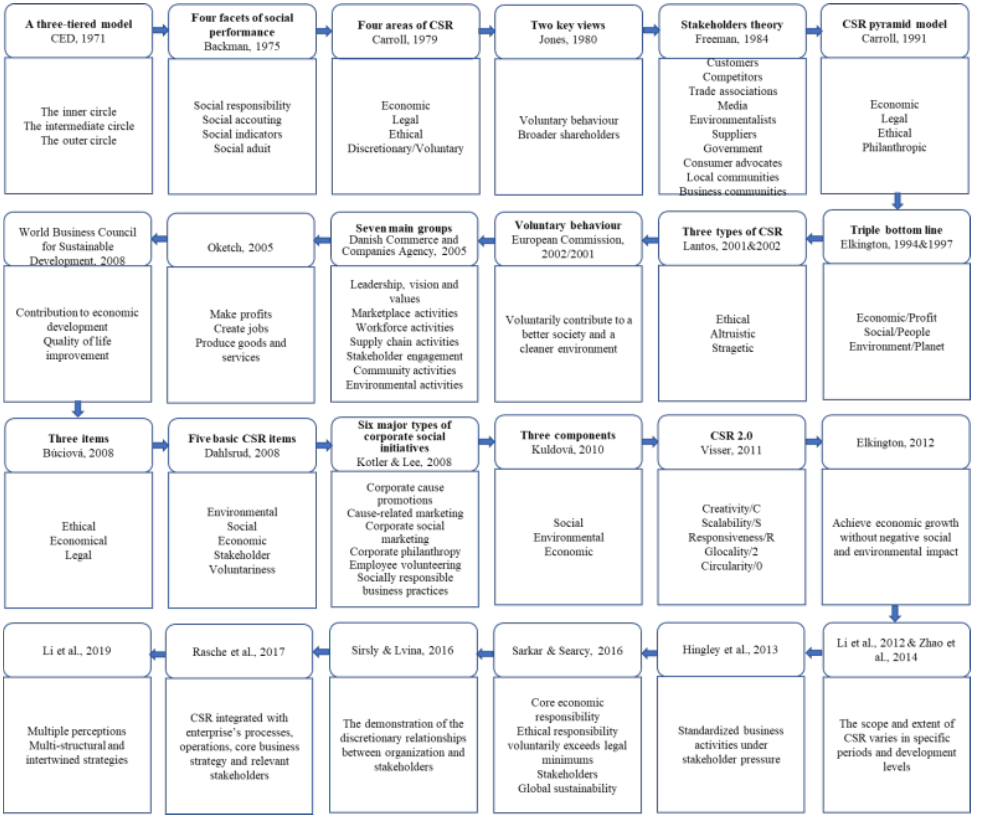

Fig 1. Descriptions and definitions of corporate social responsibility (CSR)

It is also accepted by organizations around the world that CSR can be used to address sustainable development problems, and could even be regarded as the only strategy to do so (Govindan et al. 2018). The United Nations Conference on Sustainable Development (UNCSD or Rio + 20), which was hosted in Brazil on June 2012, represented a significant milestone in the development of sustainability policy. The conference outcome document, The Future We Want (UNCSD, 2012), supported national regulations and guidelines and called on companies and private organizations to proceed with sustainable development initiatives that recognize the importance of CSR and to participate in responsible business practices. The conference series the International Conference on Sustainable Development in the Minerals Industry (SDIMIs) has also paid close attention to CSR. For example, for the purpose of responding to worldwide concerns about sustainability problems and challenges associated with the minerals industry, SDIMI 2017, which took place in Beijing (China), adopted the theme of sustainability for safety, health, environment and community in the mining and minerals industry. The International Council on Mining and Metals (ICMM) facilitates and catalyzes progress in social and environmental performance in the mining and metal industry. The organization brings together almost 30 large mining-related companies, such as BHP Billiton, Rio Tinto, Vale and other mineral giants, and more than 30 regional and commodities organizations, such as Euromines, Eurometaux, the National Mining Association (NMA), the World Gold Council (WGC) and the World Coal Association (WCA), focusing on the core issues related to sustainability and CSR, including tailings management, mining and communities, health and safety, economic development, biodiversity and climate change. One milestone in the development of CSR is the publication of the International Organization for Standardization’s (ISO’s) Guidance on Social Responsibility (ISO, 2010). The standard reflects the global consensus on CSR problems and their solutions among various kinds of stakeholders, and the concept and the principles of implementation of organizational social responsibility are broadened, which means the standard is highly international, rigorous and integrated.

Many standards, codes of conduct, initiatives and guidelines have been developed for the purpose of estimating the impacts of business on stakeholders, society and the natural environment, translating the CSR agenda into organizational actions, and offering certification relating to specific responsibility issues. There are currently approximately 300 CSR standards (Koerber, 2010), including the United Nations Global Compact (UNGC), the International Labor Organization (ILO) Standards, the Global Reporting Initiative (GRI) and Social Accountability 8000.

The Chinese government has published guidelines for the implementation of CSR measures by state-owned firms (SASAC, 2011). ICMM requires all its members to fulfill the Ten Principles and construct accountable and transparent reporting practices (ICMM, 2015). The UNGC (UNGC, 2014) and ILO (ILO, 2019) both focus on human rights, labor standards and discrimination elimination.

In particular, SA 8000, created by Social Accountability International (SAI) in 1997 on the basis of the association with the ILO, UNGC and national laws, is regarded as one of the world’s first independent workplace standards (Gilbert et al., 2011) and is the most widely accepted (Panda and Mishra, 2013), applying to 61 countries, 57 industries and more than 2 million workers (SAAC, 2019). SA 8000 focuses on improving working environments around the world and protecting the elementary human rights of workers, such as those related to health and safety, child and forced labor, discrimination, working hours and fair pay practices (SAI, 2020). Prior studies by Merli et al. (2015) and Santos et al. (2018) have employed the standard to investigate the implementation of certification in Italian companies.

Additionally, the GRI pays significant attention to environmental issues and sustainable development. By offering sustainability reporting guidance and support to organizations, GRI has contributed to the standardization of the sustainability reports and the sustainable global economy. Therefore, this seems to be the only global framework foundation for corporate responsibility reports (CRRA, 2011). The GRI has been employed by about 75% of Fortune Global firms in their sustainability reporting, and prior studies have found that GRI has yielded benefits in the improvement of human rights, labor and environmental and anti-corruption practices (Perez-Batres et al., 2010). Several scholars have used the standard to analyze CSR practices in different industry segments, such as the oil (Abhishek et al., 2018), gas (Gaudencio et al., 2020) and banking (Kumar et al., 2018; Novokmet and Rogošić, 2016) industries.

The ISO 26000 standard, under the auspices of the ISO, seeks to guide the development of proactive CSR-related activities. Seven core issues are identified in the standard, all of which encompass a variety of sub-issues, with the aim of helping organizations to identify their greatest impacts on society and providing solutions for these impacts. As defined by the ISO, CSR involves four dimensions: business, economic, social and environmental, and is aimed at benefiting individuals, communities and society as a whole. This standard, one of the most important documents on CSR globally, is widely used by both practitioners and academicians.

CSR is an evolving and dynamic phenomenon (Carroll, 1999; Matten and Moon, 2008; Song et al., 2020). It changes with time between industries and countries and even across a given period of measurement. Consequently, behaviors that were formerly innovative or even best practices cease to be appropriate to new problems that emerge. Taking a simple example, environmental concerns seem to be more important in the oil and gas sector than in the banking sector (Petit and Capelle-Blancard, 2017).

In view of the diversity within CSR, Činčalová and Hedija (2020) have researched on how different firms' characteristics affected their CSR activities, including the firm age, firm size, firm performance and board gender diversity. There are more opportunities (in terms of resources and space) for larger and older firms to perform better in the terms of diversity and environmental awareness (Withisuphakorn and Jiraporn, 2016). Smaller and younger businesses are more able to adapt to new trends and market environments, to build a good public image and to earn economic benefits from their CSR activities and inputs (Badulescu et al., 2018). Singh et al. (2017) have examined the association between CSR practices and firm value, and illustrated that the effect of CSR practices on firm value follows an inverted U shape over time, showing that the degree of influence of the CSR strategy on firm value increases steadily to a peak value in the first few years of the CSR program and then declines in subsequent years.

Diversity in corporate governance, and particularly board diversity (gender, nationality and management structure) of organizations, has a profound influence on firms' CSR strategies (Harjoto et al., 2015; Rao and Tilt, 2016; Zaid et al., 2020). Female managers may be more willing to accept the need to engage in CSR activities compared to male managers (Cabeza-García et al., 2017), and it has also been argued that a larger numbers of female board members usually represent a better team or make better operational decisions (Luckerath-Rovers, 2013).

Because the wider context changes and stakeholder perceptions evolve over time, CSR cannot be static. Lvina and Tetrault Sirsly (2019) have illustrated the dynamics of CSR and firm reputation based on a 5-year study of 285 major American firms, and found that this dynamic relationship is beneficial in improving firms' social performance and earning reputational benefits. Yin and Zhang (2012) have studied the main differences in CSR behaviors between Chinese and Western firms and analyzed different degrees of institutional dynamics in defining and practicing CSR in China, mainly influenced by the social ethical context and discretionary actions. However, this research only considered firms in the most developed regions in China, and differences between firm types (private, state-owned and foreign-invested firms) also have been ignored, leading to a lack of detail in the discussion.

CSR considerations are involved in topics such as sustainability, social issues, corporate governance, consumer protection, law and regulatory matters. Many individual scholars have also presented behavioral and evaluative models associated with CSR. Various aspects of CSR, including economic, environmental, community, workplace, welfare and health and safety considerations, have been applied in contexts such as the food chain, gaming companies, the textile industry and the healthcare sector (Forsman-Hugg et al., 2013; Kim et al., 2017; Li et al., 2020; Tomaselli et al., 2020). For all CSR dimensions, transparency and openness are found to be of great importance.

Clarkson (1995) has built the RDAP (Reactive-Defensive-Accommodative-Proactive) scale model to measure stakeholders' satisfaction and determine firms' levels of responsiveness. Zadek (2004) categorized CSR activities into five stages: the defensive stage, compliant stage, managerial stage, strategic stage and civil stage. Li et al. (2012) and Zhao et al. (2014) have studied dynamic models of CSR and attempted to characterize the diversity and dynamics of CSR according to the need for CSR, the way firms' CSR behavior varies with firms' nature and scale, and the economic circumstances within which firms operate. However, their case studies are limited and not strongly convincing. Costa and Menichini (2013) have proposed a multidimensional fuzzy logic methodology to assess the corporate social behaviors and stakeholder opinions, which could be applied to any type of firm and stakeholder. The limitation of the methodology is that the government and legal aspects have not been considered, and only economic, environmental and social performance aspects were included in the model. Ranängen et al. (2014) focused on a specific health issue associated with ISO 26000 in the context of the African Copperbelt, and demonstrated that ISO 26000 could be helpful for evaluating and improving health-related practices in the mining and minerals industry. Hedin and Ranängen (2017), Ranängen and Lindman (2018), Hilson et al. (2019), Frederiksen (2019), Tang et al. (2020) and Woźniak and Jurczyk (2020) have all contributed to CSR and CSR-related topics, in respect to motivation and barriers to CSR behaviors, community involvement and development, stakeholder interests, political effects, corporate governance structure design, and social and environmental issues in the mining sector. However, there is still a long way to go to achieve successful and integrated CSR fulfillment.

Until now, the majority of research contributions related to CSR are "maybe theoretical, maybe only concentrate on very specific issues of the CSR" (Engert et al., 2016). First, some studies focus either on the economic or environmental issue or on the policy and regulatory issue, resulting in a failure to explore and discuss CSR in a comprehensive manner. Second, several studies present research data that are not sufficiently convincing, or are only qualitative in nature. Third, many scholars with a strong interest in CSR issues neglect the inherent characteristics of CSR, such as CSR dynamics. Finally, limited research has been performed focusing on the range of application of CSR standards in the mining industry; CSR's possible benefits for mining firms and stakeholders are thus worthy of in-depth exploration. To address this gap in the research, the present study reviews its authors' previous theoretical framework on the universality, diversity and dynamics of CSR, selects appropriate CSR assessment indexes with reference to several widespread sustainability documents, and adopts an extension matter-element combined with analytic hierarchy process (AHP) assessment method in order to assess the CSR performance of Chinese coal mining firms. This assessment model is widely used and deals well with multidimensional, complex and subjective sustainability problems (Yan et al., 2014; Wang et al., 2018; Wang et al., 2019). The relationships between qualitative and quantitative assessment indicators of the comprehensive CSR evaluation can be clearly illustrated using extension theory (Cai, 1983). Simultaneously, the qualitative indices can be conveniently quantified by this model, which is able to evaluate diversified and fuzzy models. For these reasons, this extension matter-element model is utilized to assess CSR performance and demonstrate CSR dynamics in the present study. This research helps to identify theoretical and practical guidance, aiding firms to improve CSR performance and achieve environmentally friendly and sustainable development.

The remainder of this paper is structured as follows. First, we construct a multidimensional theoretical framework that includes CSR universality, diversity and dynamics. Then, a CSR evaluation indicators system is established, with consideration of some related documents, such as websites, guidelines, initiatives and academic literature. Finally, in order to further explore CSR dynamics, a case study of 16 Chinese coal mining firms is performed to facilitate a thorough discussion. The final section concludes the paper.

2. MULTIDIMENSIONS OF CSR

CSR can be regarded as a firm's social and environmental responsibility implementation associated with its operations (Cai, 1983) and generally contributes to the firm's profitability as well as to the community where the firm is located (Deegan et al., 2002; Holme and Watts, 2006). CSR commonly plays an important role in the success and survival of a firm, especially in terms of the firm's reputation. Because CSR is multidimensional, this study makes a detailed explanation from the following three perspectives on CSR—the universality, diversity and dynamics perspectives.

2.1. CSR Universality

As an essential part of the nature of corporations, social responsibility appears both objectivity and subjectivity. On one hand, factors such as corporate profiles, types or forms of business, business structures, industrial sectors and corporate life cycles have a big influence on objective aspects of social responsibility. On the other hand, subjective aspects include consulting with stakeholders when making decisions or planning activities of the business organization, allowing the organization to be influenced by stakeholder requirements and operational contexts such as the economic, social and even cultural environment. As pointed out by Carroll (1991), the four types of responsibilities-economic, legal, ethical and philanthropic-have always existed to some extent, although there has been variation in the public or stakeholders' perceptions and acceptance. The universality of CSR has also been noted by the Global Reporting Initiative's G4 Guidelines (GRI-G4) and International Organization for Standardization (ISO); both aim to promote the social responsibility and sustainability performance of organizations. The GRI-G4 guideline reflects contemporary and future trends in sustainability reporting, and guides all companies and organizations to disclose their social, economic, environmental and management performance, regardless of the firm type, size, sector or location. Similarly, in the ISO 26000 Guidance on Social Responsibility, the ISO states that its CSR guidance aims to serve and guide all types and forms of organizations, whether in the private, public, government or non-government sectors, whether big, medium or small, and whether in developed, developing or undeveloped countries. It is worth noting that all core subjects of the standard are relevant to all types of organizations, but not any part of it will be of equal relevance to every organization (ISO, 2010).

2.2. CSR Diversity

As an essential characteristic of all organizations, CSR has an inherently diverse nature. Its issues and future directions are determined by the profiles and attributes of individual corporations, including the business type, scale of organizations, and the external environment in which the corporation operates. According to the ISO, although all the key characteristics and relevant issues of social responsibility are reviewed and identified, the specific context, situation, resources and even the stakeholder interests of the company should be considered at the same time (ISO, 2010). Furthermore, not all CSR issues are relevant to every organization. In a word, CSR has a diverse nature, which means that particular situations can determine what CSR activities are performed. The GRI-G4 also points out that a “one size fits all” model does not work efficiently for all organizations, and has developed two “in accordance” criteria options with a number of supplementary materials to deal with specific circumstances and challenges. For example, for a small or inexperienced firm, it would be more advisable to choose G4’s “core” option rather than the “comprehensive” option, and the former could be developed into the latter in the future. Additionally, various targeted sustainability reporting requirements tailored to industry sectors have been proposed by the G4.

The diverse nature of CSR can be specifically discussed within four perspectives. First, CSR can be influenced by various kinds of corporate attributes, such as company size and age, external governance supervision, ownership structure, profit ability and market share. For example, the extent and level of CSR activities of multinational corporations differs from those of central government-owned corporations, local government-owned corporations and privately held corporations. Businesses with each kind of ownership structure will undertake CSR differently.

Second, differences among industries and business sectors can also cause CSR diversity. For the primary sector, secondary sector, tertiary sector and quaternary sector, economic activities involve raw materials extraction, manufacture, services and high technology, respectively. Industrial processes, products, services and experiences differ among these sectors and thus stakeholder expectations also vary.

Third, the type of business sector can also affect CSR diversity. Organizations from different sectors with variable missions, goals and objectives show different levels of ability in CSR.

Finally, CSR diversity is affected by both internal and external corporate operational contexts, which consist of national, legal, political, social, economic, cultural and technological circumstances. In particular, stakeholder perceptions and needs often have a close relationship with CSR performances. Some studies also suggest that multiple documents can be available with a variety of applicable scopes and levels of CSR, determined by corporations’ operating environments.

2.3. CSR Dynamics

CSR diversity can be viewed from a spatial dynamic perspective, but also shows temporal dynamics and dimensionality as human society evolves. As shown by Carroll (1991), economic responsibility, legal responsibility, ethical responsibility and philanthropic responsibility make up the four major kinds of CSR. These can be conceived as shaped like a pyramid, where economic responsibility represents the foundation or the bottom and philanthropic responsibility represents the top. The four responsibilities have always existed, in all places and times, to some degree. However, only in recent years have ethical and philanthropic responsibilities been recognized as having an increasingly important role.

The publication of the Guidance on Social Responsibility (ISO 26000) demonstrates that organizational social responsibility has developed from a focus on stability to the stage of institutionalization. As described by the ISO (2010), social responsibility is an organizational responsibility and entails respecting the national laws and international behavioral norms, associating the whole organization and individual and paying attention to its own and surrounding activities. Social responsibility is linked to the influence of an organization's operating decisions and activities on the economy, society and the environment, and also encompasses the contribution to sustainable development by transparent disclosure practices and ethical behaviors that take stakeholders' expectations and concerns into consideration. As identified by the ISO (2010), there are seven core issues within the scope of social responsibility: organizational governance; human rights; labor practices; the environment; fair operating practices; consumer issues (responsibility towards customers); and community involvement and development. The GRI-G4 feature a similar description, based on a "boundary" that organizations are requested to consider in order to identify where business activities' impacts occur, either within organizations, outside them or both, and how an organization contributes to economic, environmental and social conditions at the local, regional and global levels.

In addition, organizations' responsiveness to CSR is also time-dependent and temporally dynamic. For example, the scope, extent and ability of CSR change over time. Society and individuals have had various levels of concern with organizations' CSR activities at specific times.

From another perspective, both the corporate life cycle and levels of economic and social development have a significant effect on the corporation's attitude and reaction towards social responsibility and sustainability issues. Business life cycles denote the progression of a corporation and are commonly divided into four phases: launch, growth, maturity and decline. It is inevitable that the stage of the life cycle affects the motivation and capacity of a corporation to a certain degree, indicating its strengths and weaknesses, opportunities and challenges, development and management strategies, business goals and economic fundamentals. Similarly, the corporation's consciousness and implementation of CSR can also be influenced. In the larger context of the industrial or even national level, CSR also varies with stages of economic and social development, from pre-industrialization to industrialization to post-industrialization.

CSR is closely connected with stages of economic and social development, and related issues also appear to be dynamic with time, such as stakeholder concerns and expectations, business awareness and practices and CSR cognition and range.

3. CSR INDICATORS

It is acknowledged by the ISO 26000 that the use of indicators is one of the most common methods of assessing CSR performance. The main fundamental purpose of such indicators is to assess the performance of firms in fulfilling particular sustainable development standards, enhancing awareness on sustainability and CSR, and encouraging socially and environmentally responsible behavior. The main principles in the establishment of indicator systems are objectivity, simplicity and directness, because the sources of information are multiple and varied, such as personal interviews, websites, annual reports, CSR reports, literature etc. Because of the independence of data, these reports often appear to be subjective in nature. Furthermore, there is a lack of transparency in the CSR assessment processes used by rating agencies, which do not disclose their methodologies. Indicators also require concrete qualitative or quantitative information, which should not only be relevant to the performance results or outcomes of the organization but should also be comparable and ideally should be produced in real-time.

A system of indicators used to evaluate the CSR performance of mining and minerals firms has been produced and applied to Chinese firms in that industry by some of the current authors (Zhao et al., 2014). Based on that system and the above conditions, a modified CSR indicator system is illustrated in Fig 2. The three-layer indicator system consists of a composite/goal indicator, thematic indicator and individual indicator. Related initiatives and standards, CSR guidelines and research literature are important reference sources for the system, in particular the Social Responsibility Guidance (ISO, 2010), the Chinese CSR Guidelines (SASAC, 2011), the Prospectors and Developers Association of Canada's e3 Plus (PDAC, 2012), the GRI (2013), the UNGC (2013), the ICMM (2015) and the International Labor Standards (2019). In the indicator system, one composite indicator, seven thematic indicators and 30 final individual indicators have been selected and defined. The goal indicator is the overall CSR performance indicator, and can be employed to analyze CSR dynamics from both spatial and temporal perspectives. It is noted that there is a wide-ranging coverage of some highly acceptable initiatives (e.g., ISO 26000, ICMM 10 Principles and GRI-G4) for the seven thematic indicators. The documents of the individual indicators refering are given in Table 1.

Fig 2. Three-layer assessment indicator system for CSR performance

Table 1. Documents of CSR individual indicators

Indicator no.	Documents
C1	ISO 26000 (6.8.7); SASAC (9); G4 (EC1)
C2	ISO 26000 (6.8)
C3	ISO 26000 (6.8.7); G4 (EC1)
C4	ISO 26000 (6.8.7); G4 (EC1)
C5	ISO 26000 (6.4.6); PDAC (8); G4 (LA5); ICMM (P5); ILO (12)
C6	ISO 26000-(6.4.7, 6.8.5); PDAC (1, 2); G4 (LA9); ICMM (P3); ILO (8)
C7	SASAC (14); ICMM (P3); ILO (10)
C8	ISO 26000 (6.3.7); UNGC (P5, P6) G4 (HR3, HR5); ICMM (P3); ILO (3)
C9	ISO 26000 (6.4); SASAC (14)
C10	ISO 26000 (6.4.4); PDAC (8); ICMM (P3)
C11	ISO 26000 (6.4.6); PDAC (1, 8); G4 (LA8); ICMM (P4, P5); ILO (12)
C12	PDAC (6); G4 (LA1); ILO (9)
C13	ISO 26000 (4.6) PDAC (1); G4 (SO8); ICMM (P1); ILO (15)
C14	ISO 26000 (6.8.9); G4 (EC1)
C15	ISO 26000 (6.6.1-3); SASAC (8); G4 (SO4, SO5); PDAC (2); UNGC (10); ICMM (P1)
C16	ISO 26000 (6.7.5) ICMM (P2)
C17	ISO 26000 (6.7.4); SASAC (10, 13); G4 (PR1); ICMM (P4)
C18	ISO 26000(6.7); ICMM (P10)
C19	ISO 26000 (6.7.7); G4 (PR8)
C20	ISO 26000 (6.8); PDAC (7)
C21	SASAC (15); PDAC (6); ICMM (P9)
C22	SASAC (15); G4 (SO6)
C23	ISO 26000 (6.5.4)
C24	SASAC (8); PDAC (1)
C25	SASAC (8)
C26	ISO 26000 (6.5); PDAC (1); G4 (EC9)
C27	ISO 26000 (6.5.6); SASAC (11); PDAC (7); UNGC (9); G4 (EN31); ICMM (P6)
C28	ISO 26000 (6.5.3); ICMM (P6)
C29	UNGC (8); ICMM (P6)
C30	PDAC (7); UNGC (7); ICMM (P4)

4. EXTENSION MATTER-ELEMENT ASSESSMENT MODEL

The extension set theory and the matter-element method are the theoretical basis of extension theory. The matter-element model is made up of objects, characteristics and values, which are usually used to describe the content of and relationships among assessment indicators. Based on the value of the CSR performance assessment indicator system, CSR levels can be deduced using the extension set theory and the matter-element method. Additionally, the correlation function can guarantee a precise relative quantitative result. Using this method, an approach to assessing CSR performance and dynamics is established.

The application procedure of the extension matter-element evaluation model is as follows. First, the object evaluated (overall CSR performance) is ranked using five grades (Excellent, Good, Fair, Poor and Weak), and the ranges of data at all levels are determined by existing data and expert opinions. Then a multi-index system (with three layers) is assessed, which means the evaluation indicators are classified into corresponding levels. Finally, assessment results are calculated based on the value of the correlation function. The specific steps of the evaluation model are as follows.

Step1: Basic definition

Suppose object N has n properties c_1, c_2, …, c_n and the corresponding values v_1, v_2, …, v_n. Matter-element R is named n-dimensional matter-element, shown as:

$$R = (N, C, V) = \begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{bmatrix} = \begin{bmatrix} N & c_1 & v_1 \\ & c_2 & v_2 \\ & \vdots & \vdots \\ & c_n & v_n \end{bmatrix} \quad (1)$$

where R_i is a sub-matter-element of R, C is the eigenvector and V is the value of the eigenvector.

Step 2: Determine the matter-element assessed, the classical field and controlled field

Suppose

$$R_0 = \begin{bmatrix} N_0 & c_1 & v_1 \\ & c_2 & v_2 \\ & \vdots & \vdots \\ & c_n & v_n \end{bmatrix} \quad (2)$$

where N_0 is the matter-element assessed and v_1, v_2, …, v_n are the collected specific data for N_0 for c_1, c_2, …, c_n, respectively.

Suppose

$$R_j = \begin{bmatrix} N_j & c_1 & v_{j1} \\ & c_2 & v_{j2} \\ & \vdots & \vdots \\ & c_n & v_{jn} \end{bmatrix} = \begin{bmatrix} N_j & c_1 & < a_{j1}, b_{j1} > \\ & c_2 & < a_{j2}, b_{j2} > \\ & \vdots & \vdots \\ & c_n & < a_{jn}, b_{jn} > \end{bmatrix} \quad (3)$$

where N_j is the j levels, c_1, c_2, …, c_n are n kinds of properties of N_j, and v_{j1}, v_{j2}, …, v_{jn} are the ranges of N_j about c_1, c_2, …, c_n, respectively, that is the classical field.

Suppose

$$R_p = \begin{bmatrix} N_p & c_1 & v_{p1} \\ & c_2 & v_{p2} \\ & \vdots & \vdots \\ & c_n & v_{pn} \end{bmatrix} = \begin{bmatrix} N_p & c_1 & < a_{p1}, b_{p1} > \\ & c_2 & < a_{p2}, b_{p2} > \\ & \vdots & \vdots \\ & c_n & < a_{pn}, b_{pn} > \end{bmatrix} \quad (4)$$

where N_p is all the levels of objects to be assessed, and v_{p1}, v_{p2}, …, v_{pn} are the ranges of N_p about c_1, c_2, …, c_n, respectively—that is, the controlled field of N_p.

Step 3: Normalization

If any indicator value exceeds the controlled field, the correlation function cannot be calculated, then the matter-element and extension model is not able to assess the CSR levels. To address this limitation, the extension matter-element model has been developed (Li et al., 2013). The model is formed as follows:

$$R'_0 = \begin{bmatrix} N_0 & c_1 & \frac{v_1}{b_{p1}} \\ & c_2 & \frac{v_2}{b_{p2}} \\ & \vdots & \vdots \\ & c_n & \frac{v_n}{b_{pn}} \end{bmatrix} \tag{5}$$

$$R'_j = \begin{bmatrix} N_j & c_1 & <\frac{a_{j1}}{b_{p1}}, \frac{a_{j1}}{b_{p1}}> \\ & c_2 & <\frac{a_{j2}}{b_{p2}}, \frac{a_{j2}}{b_{p2}}> \\ & \vdots & \vdots \\ & c_n & <\frac{a_{jn}}{b_{pn}}, \frac{a_{jn}}{b_{pn}}> \end{bmatrix} \tag{6}$$

Step 4: Correlation calculation

$$D_j(v'_i) = \left| v'_i - \frac{a'_{ji} + b'_{ji}}{2} \right| - \frac{1}{2}(b'_{ji} - a'_{ji}) \tag{7}$$

$$P_j(R'_0) = 1 - \sum_{i=1}^{n} D_j(v'_i)\omega_i(X) \tag{8}$$

where $D_{j(v'i)}$ is the distance of the normalized matter-element assessment with respect to the new classical field, $P_{j(R'0)}$ is the comprehensive correlation degree of the j level and ω(X) is the indicator weight.

Step 5: Level determination

Suppose

$$P_m(R'_0) = \max\left[P_j(R'_0)\right] \tag{9}$$

where the matter-element assessed R_0 belongs to the m level.

$$\overline{P}_j(R'_0) = \frac{P_j(R'_0) - \min\left[P_j(R'_0)\right]}{\max\left[P_j(R'_0)\right] - \min\left[P_j(R'_0)\right]} \tag{10}$$

where max[$P_j(R_0$')] is the highest degree of correlation in all levels and min[$P_j(R_0$')] is the lowest degree of correlation in all levels.

Step 6: Weight computation

The analytic hierarchy process (AHP) developed by Saaty (1988) is well regarded among multi-criteria decision-making methods, mainly due to its understandable theory and convenient application (Wang et al., 2009). AHP is able to deal with hierarchy structures that combine both quantitative (objective) and qualitative (subjective) indicators. Therefore, AHP is applied to the CSR performance assessment, via the following specific steps of the model:

(1) AHP model construction

As shown in Fig 2, the model has been divided into three major levels: composite/goal indicator, thematic indicators and individual indicators.

(2) Judgment matrix construction.

Pairwise comparison is used to construct the judgment matrix, which is an important step to be completed by subject experts. The value of each element is judged from 1 to 9 and their reciprocals are used as a scale to define the judgment matrix A = $(a_{ij})_{n*n}$, as summarized in Table 2.

Table 2. Definition of judgment matrix scale

Scale	Definition
1	Two factors are equally important
3	The former one is slightly more important than the latter
5	The former one is obviously more important than the latter
7	The former one is strongly more important than the latter
9	The former one is extremely more important than the latter
2, 4, 6, 8	The intermediate values of the adjacent judgments
Reciprocal	If the importance of factor i to j is a_{ij}, then the importance of factor j to i is $a_{ji} = 1/a_{ij}$

Questionnaires are used to collect judgments from government officials, various NGO members, business technicians and managers and CSR-related scholars, and this information is used to construct the indicator judgment matrixes (shown in Table 3-10), which lay the foundation for the calculation of weights.

Table 3. A-B Judgment Matrix

A	B1	B2	B3	B4	B5	B6	B7
B1	1	1	1	2	2	2	3
B2	1	1	1/2	2	2	1/2	1
B3	1	2	1	3	2	2	3
B4	1/2	1/2	1/3	1	1/2	1/3	1/2
B5	1/2	2	1/2	2	1	1/3	1/2
B6	1/2	2	1/2	3	3	1	2
B7	1/3	1	1/3	2	2	1/2	1
λ_{max}=7.6508, CR=0.080<0.10							

Table 4. B1-C Judgment Matrix

B1	C1	C2	C3	C4
C1	1	3	3	1/2
C2	1/3	1	1/2	1/4
C3	1/3	2	1	1/3
C4	2	4	3	1
λmax=4.0813, CR=0.034<0.10				

Table 5. B2-C Judgment Matrix

B2	C5	C6	C7	C8	C9	C10	C11
C5	1	2	1/2	3	4	1	1/3
C6	1/2	1	1/3	2	2	1/2	1/3
C7	2	3	1	3	4	3	1
C8	1/3	1/2	1/3	1	2	1	1/2
C9	1/4	1/2	1/4	1/2	1	3	1/2
C10	1	2	1/3	1	1/3	1	1/3
C11	3	3	1	2	2	3	1
λ_{max}=7.7799, CR=0.096<0.10							

Table 6. B3-C Judgment Matrix

B3	C12	C13	C14	C15
C12	1	1/3	1/2	1/2
C13	3	1	2	3
C14	2	1/2	1	1/2
C15	2	1/3	1/2	1
λ_{max}=5.3810, CR=0.068<0.10				

Table 7. B4-C Judgment Matrix

B4	C16	C17	C18	C19
C16	1	1/4	1/2	1/3
C17	4	1	2	2
C18	2	1/2	1	1/2
C19	3	1/2	2	1
λ_{max}=4.0458, CR=0.017<0.10				

Table 8. B5-C Judgment Matrix

B5	C20	C21	C22
C20	1	1/2	2
C21	2	1	2
C22	1/2	1/2	1
λ_{max}=3.0536, CR=0.046<0.10			

Table 9. B6-C Judgment Matrix

B6	C23	C24	C25	C26
C23	1	1/3	2	2
C24	3	1	3	2
C25	1/2	1/3	1	1/2
C26	1/2	1/2	2	1
λ_{max}=4.1431, CR=0.054<0.10				

Table 10. B7-C Judgment Matrix

B7	C27	C28	C29	C30
C27	1	1/3	2	1/2
C28	3	1	2	3
C29	1/2	1/2	1	1/3
C30	2	1/3	3	1
λ_{max}=4.2606, CR=0.098<0.10				

(3) Consistency test

The ratio CR is used to test the consistency of the judgment matrix. If CR<0.10, the consistency of the judgment matrix should be accepted; if not, appropriate correction of the judgment matrix is needed.

$$CR = \frac{CI}{RI} \tag{11}$$

$$CI=\frac{\lambda_{max}-n}{n-1} \tag{12}$$

where CI is the consistency index, λ_{max} is the maximum eigenvalue of the judgment matrix and RI is the average random consistency index, as given in Table 11.

Table 11. Average random consistency index (RI)

n	3	4	5	6	7
RI	0.58	0.89	1.12	1.24	1.36

(4) Weight calculation

The latent root method is used to determine weight vectors.

$$AW = \lambda_{\max} W \quad (13)$$

where W is the eigenvector of judgment matrix A, and can be normalized to calculate the weight.

$$W_j = W_{Bj} * W_{Cj} \quad (14)$$

where $W_{C(j)}$ is the weight of the individual indicator relative to the thematic indicator,

$W_{B(j)}$ is the weight of the thematic indicator relative to the composite indicator and

$W_{(j)}$ is the weight of the individual indicator relative to the composite indicator.

The CSR indicators' cumulative weights are shown in Table 12.

Table 12. Indicators weights for CSR performance assessment

Scale	Definition
(C1, C2, C3, C4)	(0.062, 0.019, 0.029, 0.093)
(C5, C6, C7, C8, C9, C10, C11)	(0.020, 0.012, 0.032, 0.010, 0.011, 0.011, 0.030)
(C12, C13, C14, C15)	(0.026, 0.104, 0.042, 0.055)
(C16, C17, C18, C19)	(0.006, 0.026, 0.011, 0.017)
(C20, C21, C22)	(0.033, 0.052, 0.021)
(C23, C24, C25, C26)	(0.042, 0.081, 0.020, 0.033)
(C27, C28, C29, C30)	(0.045, 0.017, 0.013, 0.027)

5. CASE STUDY AND DISCUSSION

Since the 20th century, individual mining companies have made environmental management efforts that supported land reclamation and environmental management systems. In particular, mining activities significantly affect the local economy in areas containing plentiful mineral resources. Several Chinese cities are located in areas with abundant mineral deposits, such as Panzhihua and Daye. The coal mining sector is likely to deliver significant economic, social and environmental effects, and as a result CSR is extremely important in this sector. Coal production in China reached 37.50 billion tons in 2015, accounting for 47 % of the world's production; and China's coal consumption was 39.65 billion tons, accounting for 50 % of the world's consumption. Coal consumption accounted for 64 % of total energy consumption in China, which is much higher than the world average level of 30 % (2017). However, coal mining activities can inevitably disadvantage the local natural environment and occupational health and safety of mineworkers and local residents.

Therefore, we performed a case study of 16 coal mining firms in China using data for the period from 2013 to 2017, in order to demonstrate their CSR dynamics in detail. The 16 coal firms are all stock exchange listed companies, on the Shanghai, Shenzhen and/or Hong Kong Stock Exchange, as shown in Table 13.

Table 13. Sample firms and their profiles

No.	Firm Name	Firm Ownership	Registered Locale	Annual Profits (10^6 in USD)
1	Beijing Haohua Energy Resource Company Limited	Local government owned (LGO)	Beijing (Eastern)	0.55
2	China Coal Energy Company Limited	Central government owned (CGO)	Beijing (Eastern)	4.15
3	China Shenhua Energy Company Limited	CGO	Beijing (Eastern)	77.52
4	Henan Shenhuo Coal & Power Company Limited	LGO	Henan (Central)	-0.47
5	Inner Mongolia Pingzhuang Energy Resources Company Limited	LGO	Inner Mongolia (Western)	-0.03
6	Inner Monolia Yitai Coal Company Limited	Privately held (PH)	Inner Mongolia (Western)	5.15
7	Jizhong Energy Resources Company Limited	LGO	Hebei (Eastern)	1.07
8	Kailuan Energy Chemical Company Limited	LGO	Hebei (Eastern)	0.46
9	Pingdingshan Tianan Coal Mining Company Limited	LGO	Henan (Central)	0.68
10	Shaanxi Coal Industry Company Limited	LGO	Shaanxi (Western)	9.35
11	Shanghai Datun Energy Resources Company Limited	LGO	Shanghai (Eastern)	0.36
12	Shanxi Coal International Engergy Group Company Limited	LGO	Shanxi (Central)	0.19
13	Shanxi Lanhua Sci-tech Venture Company Limited	LGO	Shanxi (Central)	0.41
14	Shanxi Lu’an Environmental Energy Development Company Limited	LGO	Shanxi (Central)	2.25
15	Shanxi Xishan Coal and Electricity Power Company Limited	LGO	Shanxi (Central)	1.67
16	Yanzhou Coal Mining Company Limited	LGO	Shandong (Eastern)	5.28

According to the above steps, the extension matter-element combined with AHP assessment approach is used to evaluate the CSR performance of the selected firms based on data for the period from 2013 to 2017. The final results are shown in Table 14.

Table 14. CSR performance assessment results for 16 selected coal mining firms (2013 to 2017) (1)

No	Year	Coal Firm CSR Levels with Membership Degrees (Highest in Bold)					
		Excellent	Good	Fair	Poor	Weak	CSR Level
	2017	0.877	**0.933**	0.867	0.712	0.712	Good
	2016	0.755	0.882	**0.920**	0.830	0.713	Fair
1	2015	0.748	0.907	**0.943**	0.855	0.716	Fair
	2014	0.774	0.924	**0.932**	0.810	0.675	Fair
	2013	0.818	**0.959**	0.912	0.766	0.629	Good
	2017	0.828	**0.895**	0.887	0.764	0.627	Good
	2016	0.794	0.856	**0.867**	0.771	0.637	Fair
2	2015	0.764	0.844	**0.862**	0.800	0.701	Fair
	2014	0.799	**0.895**	0.882	0.782	0.658	Good
	2013	0.819	**0.915**	0.901	0.772	0.642	Good
	2017	**0.950**	0.868	0.747	0.604	0.461	Excellent
	2016	**0.864**	0.854	0.738	0.597	0.455	Excellent
3	2015	**0.897**	0.896	0.790	0.671	0.548	Excellent
	2014	**0.939**	0.885	0.790	0.656	0.515	Excellent
	2013	**0.927**	0.870	0.777	0.623	0.479	Excellent
	2017	0.782	**0.928**	0.920	0.791	0.647	Good
	2016	0.732	0.902	**0.940**	0.849	0.708	Fair
4	2015	0.561	0.738	0.828	0.804	**0.842**	Weak
	2014	0.683	0.841	**0.895**	0.851	0.763	Fair
	2013	0.685	0.859	**0.929**	0.884	0.770	Fair
	2017	0.867	**0.957**	0.872	0.708	0.568	Good
	2016	0.722	0.875	**0.880**	0.780	0.707	Fair
5	2015	0.696	0.829	**0.868**	0.796	0.796	Fair
	2014	0.715	0.879	**0.946**	0.859	0.726	Fair
	2013	0.723	0.884	**0.926**	0.848	0.718	Fair
	2017	0.922	**0.945**	0.844	0.679	0.538	Good
	2016	0.793	**0.966**	0.948	0.819	0.678	Good
6	2015	0.739	0.917	**0.955**	0.853	0.732	Fair
	2014	0.808	**0.969**	0.940	0.800	0.663	Good
	2013	0.865	**0.906**	0.844	0.733	0.606	Good
	2017	0.882	**0.942**	0.881	0.716	0.575	Good
	2016	0.748	0.887	**0.930**	0.840	0.715	Fair
7	2015	0.741	0.867	**0.894**	0.805	0.689	Fair
	2014	0.735	0.863	**0.884**	0.805	0.706	Fair
	2013	0.776	**0.929**	0.909	0.788	0.659	Good
	2017	0.828	**0.864**	0.817	0.707	0.587	Good
	2016	0.773	0.860	**0.862**	0.763	0.644	Fair
8	2015	0.692	0.790	**0.815**	0.776	0.735	Fair
	2014	0.729	0.854	**0.901**	0.844	0.720	Fair
	2013	0.751	0.866	**0.895**	0.823	0.697	Fair

No	Year	Coal Firm CSR Levels with Membership Degrees (Highest in Bold)					
		Excellent	Good	Fair	Poor	Weak	CSR Level
	2017	0.833	**0.890**	0.798	0.643	0.514	Good
	2016	0.763	**0.910**	0.888	0.762	0.648	Good
9	2015	0.614	0.766	**0.785**	0.702	0.720	Fair
	2014	0.739	0.859	**0.876**	0.772	0.636	Fair
	2013	0.761	**0.871**	0.864	0.752	0.619	Good
	2017	0.927	**0.944**	0.819	0.651	0.508	Good
	2016	0.826	**0.937**	0.913	0.769	0.626	Good
10	2015	0.704	0.865	**0.897**	0.815	0.757	Fair
	2014	0.767	0.914	**0.936**	0.835	0.693	Fair
	2013	0.827	**0.916**	0.862	0.717	0.578	Good
	2017	0.914	**0.964**	0.848	0.680	0.539	Good
	2016	0.836	**0.949**	0.909	0.756	0.615	Good
11	2015	0.790	**0.919**	0.881	0.780	0.657	Good
	2014	0.802	**0.916**	0.880	0.765	0.639	Good
	2013	0.831	**0.905**	0.879	0.745	0.607	Good
	2017	0.757	0.876	**0.887**	0.833	0.705	Fair
	2016	0.710	0.882	**0.904**	0.846	0.754	Fair
12	2015	0.486	0.671	0.734	0.707	**0.808**	Weak
	2014	0.577	0.747	0.792	0.769	**0.844**	Weak
	2013	0.689	0.861	**0.910**	0.863	0.780	Fair
	2017	0.882	**0.985**	0.866	0.698	0.557	Good
	2016	0.725	0.878	**0.904**	0.800	0.731	Fair
13	2015	0.758	0.920	**0.940**	0.840	0.704	Fair
	2014	0.763	0.919	**0.923**	0.831	0.698	Fair
	2013	0.845	**0.944**	0.870	0.743	0.608	Good
	2017	**0.911**	0.888	0.778	0.625	0.482	Excellent
	2016	0.770	0.930	**0.943**	0.811	0.686	Fair
14	2015	0.757	0.871	**0.878**	0.789	0.679	Fair
	2014	0.805	**0.919**	0.892	0.766	0.629	Good
	2013	0.836	**0.908**	0.858	0.733	0.590	Good
	2017	0.912	**0.953**	0.848	0.679	0.539	Good
	2016	0.775	0.898	**0.920**	0.819	0.677	Fair
15	2015	0.752	0.894	**0.918**	0.819	0.705	Fair
	2014	0.756	0.891	**0.904**	0.807	0.683	Fair
	2013	0.813	**0.949**	0.918	0.767	0.624	Good
	2017	**0.892**	0.874	0.792	0.689	0.567	Excellent
	2016	0.800	**0.897**	0.878	0.782	0.663	Good
16	2015	0.764	0.899	**0.915**	0.817	0.689	Fair
	2014	0.793	0.911	**0.914**	0.787	0.370	Fair
	2013	0.767	0.906	**0.932**	0.819	0.676	Fair

5.1. CSR Spatial Dynamics

In accordance with the regional classification criteria published by the Chinese government in 1986, China is divided into three major regions: the eastern part, where economic and social conditions are more developed; the central part, where economic and social conditions are developed; and the western part, where the economic and social conditions are less developed. This study sample consists of seven firms headquartered in the east, six firms headquartered in central China and three firms headquartered in the west. As shown in Fig 3, the overall CSR performance of firms located in the east is markedly higher than that of firms located in the other two regions, and the overall CSR performance of firms in the west is slightly better than that of central firms. The average CSR levels show a similar time trend for firms in all regions, reaching the lowest level in 2015, with performance improving year-on-year thereafter. The change in average CSR performance for firms in the central region is larger than that for firms in the eastern and western regions.

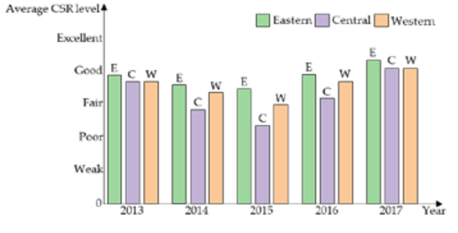

Fig 3. Spatial dynamics of CSR performance

In order to demonstrate the difference in CSR levels between firms in the central and western regions, the relationship between CSR performance and average annual firm profit is analyzed, as shown as Fig 4. It can be seen that firms with larger average annual profits generally performed better than that those with lower profits. Firm 10 in the western region had an average annual profit of USD 9.35 million, and its CSR level is also the highest correspondingly. Firm 5, based in the same region, is loss-making, with an average annual profit of negative 30 thousand dollars, and its CSR level is not satisfied. A similar trend is observed for firms in the central region. Firm 14's CSR level is the highest among the central firms, and it also has the highest average annual profit in the region, 2.25 million dollars. Firms 4 and 12 have worse CSR performance than other central firms and also have the worst average annual profit in the region, negative 0.47 and positive 0.19 million dollars, respectively. The positive correlation between CSR level and average annual firm profit may reflect that firms with larger profits attract higher levels of social attention, and so they have paid more attention to fulfillment of social responsibilities, and thus show better CSR practices.

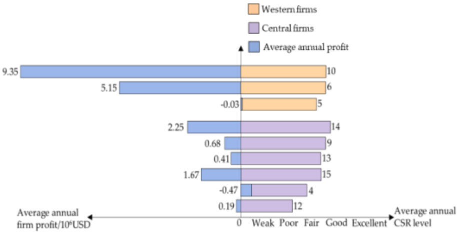

Fig 4. Firm CSR performance and annual profit

According to Fig 5, there is a certain degree of difference in CSR levels for firms with different types of ownership. In the eastern region, it is clear that the CSR levels of central government owned firms are higher than those of local government owned firms, and thus central government owned firms establish the benchmark for other firms to learn from and play an important role in national economic and social development. In the western region, local government firms seem to perform CSR better than the one privately held firm, reflecting the important role of local state-owned firms in reconciling continuous national economic development and quickly boosting development. Because the only firms in the central region are local government owned firms, we discuss only firms in the eastern and western regions here.

Fig 5. CSR performance and type of firm ownership

5.2. CSR Temporal Dynamics

It can be seen from Fig 6 that the CSR performance of the 16 selected firms shows a U-shaped pattern for the period from 2013 to 2017, generally reaching minimum values in 2015.

Firms 3 and 11 maintain excellent and good CSR performance levels, respectively, across the same period. The two firms therefore offer good examples of CSR practice for other firms. The CSR level of firm 16 improves steadily from 2013 to 2017. Except for these three firms, all firms show obvious inflation.

Examining these trends in closer detail, the CSR performance classifications of firms 2, 4, 6 and 14 are unchanged from 2013 and 2014. However, in the year 2015, declines appear for all firms. It is of interest to note that the CSR performance of Chinese coal mining firms in 2015 decreases to a greater extent. This year could be described as “a cold coal winter” due to the market environment, degradation of coal production, industry upgrade requirement and government policy (cleaner production and energy requirements, decreases in government subsidies), which have a large influence on CSR practices, especially those related to economic and environmental responsibility. After experiencing their only decrease in CSR performance in the five-year period, these firms’ CSR performance improved from 2015 to 2017, perhaps as a result of an improvement in CSR awareness and encouragement from the government and other stakeholders. For example, rising coal prices warmed up the whole industry and enabled the firms to move from loss-making positions into profitability, which directly contributes to their economic responsibility activities.

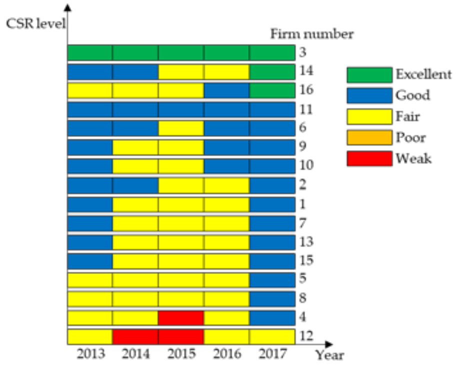

Fig 6. CSR performance temporal dynamics of 16 coal mining firms

For firms 9 and 10, CSR performance in 2014 was worse than that in 2013, and in 2016 their performance appears to be on an upward trend. The same circumstance applied to firms 1, 7, 13 and 15, and the improvement in CSR performance is observed in 2017. For firms 4 and 12, CSR levels reach particularly low levels in 2015, and then start improving from 2016.

Therefore, in addition to the firm’s location (including social-economic environment and development), the external business environment conditions at a specific period should also be considered as an important influence on CSR dynamics.

Generally, positive CSR performance could not only create financial benefits for firms, with the gains potentially outweighing the associated costs invested, but also contribute to public image, opportunity acquisition, competitive advantage and sustainable development in the future. By contrast, a negative CSR performance of the firm may result in disadvantageous outcomes, including the loss of firm reputation, increasing political/media pressure, stakeholder disappointment, unexpected fines and penalties and even the final bankruptcy of the business.

Therefore, firms are encouraged to formulate, implement and align CSR-related politics, strategies and activities in order to achieve both economic growth and sustainable development in a complex and competitive environment.

5.3. Results Comparison

In order to illustrate the significance of this study's results, we compare the CSR performance of firms with the recognized agency in China, Hexun. For the purpose of assessing the CSR reports of listed firms, the MCT-CSR (Macrocosm, Content, Technique) evaluation system developed by Rankins CSR Ratings (RKS) is used by Hexun. The main evaluation steps are: collection of CSR reports; classification; evaluation; scoring; ranking; and final disclosure online. The evaluation system consists of five major subject areas: shareholder responsibility; employee responsibility; supplier, customer and consumer responsibility; environmental responsibility; and social responsibility. Based on some of the same subject areas and focusing on the same Chinese context, Hexun's evaluation results are compared with those of this paper. Considering the change in CSR performance and firm characteristics, three representative firms are chosen.

First, Shenhua Group (firm 3)'s CSR report scores from 2013 to 2017 are shown as Fig 7. A large change takes place over this period, as shown by the Fig. In 2013 and 2016, the firm's scores are much higher than that in the other three years, 74.45 and 66.80, respectively. To illustrate the different phenomena discussed in the paper, specific indexes are employed to enable detailed description. Supplier, customer and consumer responsibility and environmental responsibility are two important indexes that are not strongly considered by Hexun, and the rationality of the transformation from the CSR report information into the Hexun evaluation criteria is not enough. Accordingly, scores for both of the aforementioned indexes are zero in the years 2014, 2015 and 2017, and the overall evaluation scores are very low for these years. In particular, the amount of charitable donations is treated as being of lower-class indexes and does not translate to a reasonable score in the Hexun evaluation system for the years 2014 to 2017, except for the year 2013. The index's transformed value is zero for the four consecutive years, but the minimum charitable donation is about 8 million dollars (2014), which exceeds the amount in the year 2013 according to the firm's CSR report.

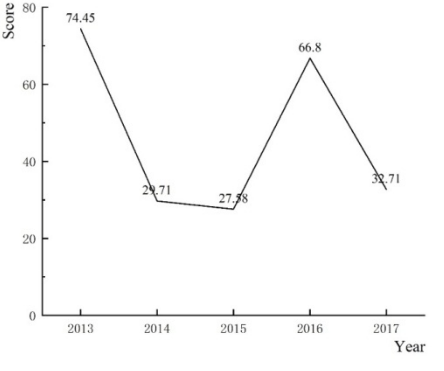

Fig 7. CSR report scores for Shenhua Group from 2013 to 2017

For Shanxi Xishan Coal and Electricity Power Company Limited (firm 15), a similar trend to that for Shenhua Group is observed, as shown in Fig 8, when comparing evaluation results for the firm for 2017. In the present study, the CSR performance of this firm is "good", whereas in the Hexun evaluation, the report score is only 21.48, which is a very low value, and the index values for the supplier, customer and consumer responsibility and environmental responsibility are both zero. The amounts of innovation investment, safety investment and charitable contributions also have no effect on the Hexun evaluation score, because the values of the three related indexes are zero in the Hexun system. However, the firm does invest in the environment, innovation, safety and social charity, all of which are referred to in the CSR report. This leads to the conclusion that the evaluation result of the model developed in the paper is more closely associated with the reality of the firm's CSR activities.

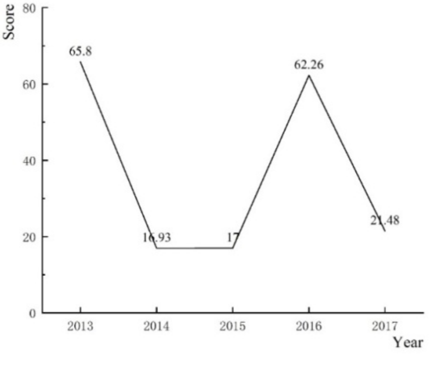

Fig 8. CSR report scores for Shanxi Xishan Coal and Electricity Power Company Limited from 2013 to 2017

For Shanxi Coal International Energy Group Company Limited (firm 12), the evaluation results from Hexun seem similar to the results of this study's model, always indicating a very low level of performance, as shown in Fig 9. It is noted that supplier, customer and consumer responsibility and environmental responsibility are again discarded. In fact, there is large difference between the evaluation result provided by Hexun and the actual CSR performance of the firm.

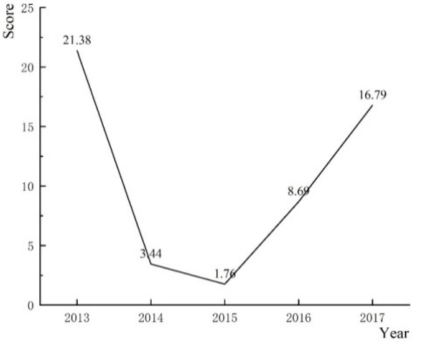

Fig 9. CSR report scores for Shanxi Coal International Energy Group Company Limited from 2013 to 2017

As the first agency providing CSR report evaluations for listed companies in China, Hexun's evaluation system is applied to every industry, including the banking sector, insurance sector, food sector, electricity sector, construction sector and mining sector. Due to the various firm types, firm sizes, locations and periods, some sectors may have a closer relationship with the system, and may benefit more from the system than others. For the mining sector, Hexun fails to consider supplier, customer and consumer responsibility or environmental responsibility, and unable to convert some index data into a convincing value. This paper has dealt with these shortcomings by using the applied assessment methodology, and this methodology has been shown to yield more realistic results. In this paper, the two types of data are combined together, and it is shown how qualitative indexes can directly affect results. There is a requirement to incorporate such data into the Hexun evaluation system in order to improve its accuracy.

6. CONCLUSIONS

The concept of social responsibility for individuals has existed for a very long time. The values of equity, sustainability, globalization and inclusiveness have all contributed to the conception of CSR. Modern CSR encompasses multiple dimensions, including universality, diversity and dynamics, influenced by a firm's ownership and locale, life cycles of the business, and the economic, social and cultural contexts in which the firm operates. Models utilizing a system of indicators can be developed to guide and evaluate the CSR levels of organizations. They can also be used to analyze the CSR strengths or weaknesses of different types of organizations, the temporal dynamics of an organization's CSR over time and spatial variations in organizations' CSR among locations. A large number of theoretical and practical research results have already been produced, with the effect of encouraging organizations to increase their sustainable development efforts. However, many studies have focused on specific CSR issues, and few have researched CSR from the perspective of universality, diversity and dynamics. Furthermore, quantitative and qualitative variables have not been brought together in a reasoned manner, and the failure to do so may lead to deviation from the accurate assessment of focal firms. It is also worthwhile to perform an in-depth exploration of how CSR and/or sustainability development documents are applied in the mining sector, though some relevant literature on this subject has been published.

To deal with these shortcomings in previous research, in the present study, multidimensional CSR characteristics have been discussed, including CSR universality, diversity and dynamics. On the basis of several widely used CSR-related documents, an assessment index system has been established. An extension matter-element combined AHP assessment model based on CSR indicators has been built and its application has been demonstrated in a case study of CSR issues in the coal mining sector. The main conclusions are as follows:

(1) Theoretical deficiencies in the research are addressed by the use of the two most globally accepted CSR standards, ISO 26000 and GRI-G4. CSR has always existed in organizations, regardless of the firm type, size, sector or location, but differences also arise with respect to specific CSR subjects and organizational CSR performance changes over time and operating locations. These factors can be described as CSR universality, diversity and dynamics.

(2) From the temporal dynamics perspective, the CSR performance of major firms in our sample declines and reaches their minimum values in 2015, and the reasons for this trend are posited to be the high prices of mineral raw materials internationally, market shrinkage and sales decreases. Since 2015, the studied firms have made great progress and their CSR ratings have improved continuously. This is especially for firms 4, 14 and 16.

(3) From the spatial dynamics perspective, the social-economic environment and its development have a positive correlation with firms' CSR performance. According to social and economic development in different regions of China, our findings indicate that the average CSR performance of firms in the eastern region (seven firms) is significantly higher than that of firms in the other two regions, and the average CSR performance of firms in the central region (six firms) is slightly lower than that of firms in the west (three firms).

(4) As a whole, central government owned firms located in the east have better CSR performance than that of local government owned firms in the five years studied, which may be due to their important role in national social-economic development. For firms in the west, there is a slight difference in the CSR performance levels of the local government firms and the privately held firms.

(5) Compared with the evaluation results of the widely recognized Chinese company

evaluation agency Hexun, the research approach in this paper performs better in combining quantitative indexes and qualitative indexes, and calculation results are more practical and convincing than those of Hexun. The calculation procedure used by Hexun does not appear to be satisfactory, especially in terms of the evaluation criteria for the incorporation of raw data into the Hexun model.

In summary, the present study contributes to the development of both CSR theory and practice. For coal mining firms in China, Shenhua Group, as one of the best-performing CSR practitioners, has established a good example for other firms, and could be a useful reference for firms seeking to fulfill their social responsibilities, but there is still a long way to go for Chinese firms to achieve their final sustainability goals, Shenhua Group included.

The present study has some limitations, the main one being the sample used, whereby only a small number of large listed coal mining firms were tested. A larger number of sample firms covering a wider range of industries could be used to obtain more interesting results and offer greater insight into the dimensions of CSR in future research. Additionally, some influencing factors are not considered in this study, for example board diversity (measured by female directorship or foreign directorship, for example). Consideration of other relevant indicators of CSR will also help to develop significant research results.

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ASSESSMENT OF QUALITY OF ACCOUNTING INFORMATION SYSTEM IN COAL MINING ENTERPRISES

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Abstract: *Accounting information plays an important role in operating and managing the business and production activities of an enterprise. An accounting information system includes accounting information; its quality depends on the accounting information system that creates it. Assessing the quality of the accounting information system in an enterprise is an assessment of the level of meeting the requirements for providing accounting information to users. Specifically, the evaluation is conducted by input information data to the processing and provision of output information in a full, timely and consistent manner with the requirements of internal and external users of the enterprise. In this article, the author reviews the current status of accounting information systems in coal mining enterprises, thereby assessing their quality and recommending improvements.*

Keywords: *Accounting information system, input data, output information, coal mining enterprises.*

1. INTRODUCTION

1.1. Concept and role of accounting information system

Accounting information in enterprises is the information that plays a vital role in the management and is collected, processed, stored, and provided by a system that is the accounting information system.

An accounting information system can be understood as an information system for collecting, processing, storing, controlling, and providing economic and financial information (including financial accounting and management accounting information) for users.

The accounting information system plays a significant role in processing, providing information, creating a bridge between the management system and the operational system for organizations and enterprises. Financial and economic information inputs for an accounting information system include statistics, summarization, and processing of data to produce necessary reports for leaders of organizations:

- Recording, processing, and storing data in an enterprise

- Preparing and providing information

- Supporting the management of production and business activities of administrators

- Supporting planning and controlling economic activities

- Establishing internal control system for all financial activities

1.2. Factors affecting the quality of an accounting information system

* *Objective factors:*

- Regulations, policies, and regimes related to accounting of the State, also known as the legal environment affecting the establishment of control process components.

- The development of information technology and the level of applied information technology affect the selection of accounting information systems.

* *Subjective factors:*

- Management structure is the factor affecting the determination of management levels using and exploiting information from the system, thereby designing decentralization in the use of data.

- The characteristics of the organization of production and business will affect the establishment of circulating the information in the system and the design of initial accounting documents in the production and business departments to report at each production and business department and basis to develop regulations on cost allocation for subjects.

- The requirement of enterprise management for accounting information requires the accounting information system to design the corresponding output information under these requirements.

- The manager's level, the operational level of the accountant and the level of information technology application are the factors affecting the establishment of the accounting information system in what manner? Detail to what extent?

1.3. Criteria for assessing the quality of accounting information system in enterprises

It is necessary to base on the accounting information standards to evaluate the quality of the accounting information. These standards are also the criteria for measuring the quality of accounting information and the quality of accounting information systems, including:

- Accuracy and objectivity
- Reliability and prestige
- Accessibility, security, and convenience
- Relevance
- Timeliness, completeness, and the quantity of information
- Intelligibility and consistency in information presentation
- Degree of responsiveness of accounting information to information users

In summary, assessing the accounting information system's quality is mainly based on the criteria for evaluating the quality of accounting information through the requirements for accounting information. However, according to studies on criteria to assess accounting information quality, the requirements mainly focus on the following aspects: Accuracy, objectiveness, completeness, timeliness, reliability, security, and relevance.

2. ASSESSMENT OF THE CURRENT STATUS OF THE ACCOUNTING INFORMATION SYSTEM IN COAL MINING ENTERPRISES OF VINACOMIN

Coal mining enterprises under VINACOMIN have been currently recording, processing, and providing accounting information on two systems: financial accounting information system and management accounting information system. In each of these systems, information is processed through three steps: data recording and processing; data reflection and storage; reporting and providing accounting information. Assessing the quality of accounting information system will focus on evaluating each subsystem with each step in the system as follows:

2.1. Financial accounting information system

Financial accounting information is recorded, processed, reflected, stored, and provided to users by the process, ensuring compliance with basic principles of accounting, following this structure below:

2.1.1. Organize data recording and processing

Based on the documents, the accounting department records and processes input data. In this stage, the accounting department receives and processes information from units such as on-site statistics, workshops, data from other companies departments, and external information, specifically by the following process:

ACCOUNTING INFORMATION SYSTEM	
(1) FINANCIAL ACCOUNTING INFORMATION SYSTEM	(2) MANAGEMENT ACCOUNTING INFORMATION SYSTEM
i. Record and process data. ii. Reflect and store data. iii. Prepare reports and provide accounting information.	

Fig1. Modeling of accounting information system in coal mining enterprises – VINACOMIN.

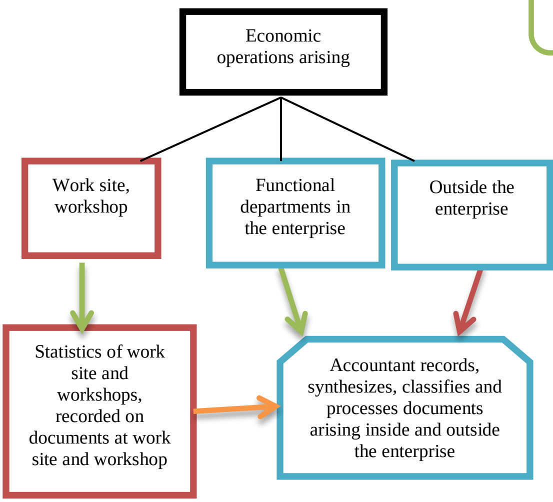

Fig 2. Process flow chart of recording and processing data of the economic and financial information system in coal mining enterprises – VINACOMIN.

However, because the accounting department does not directly record the initial accounting information, only synthesize based on the results recorded from the worksite and workshop statistics, so, the information control will be difficult and risky. Moreover, there is no IT application between the worksite and workshop statistics department and the accounting department to connect data, affecting the reflection, provision, and storage of information.

2.1.2. Organize data reflection and storage

Through the survey, the coal mining enterprises have been currently using the system of appropriate accounting documents.

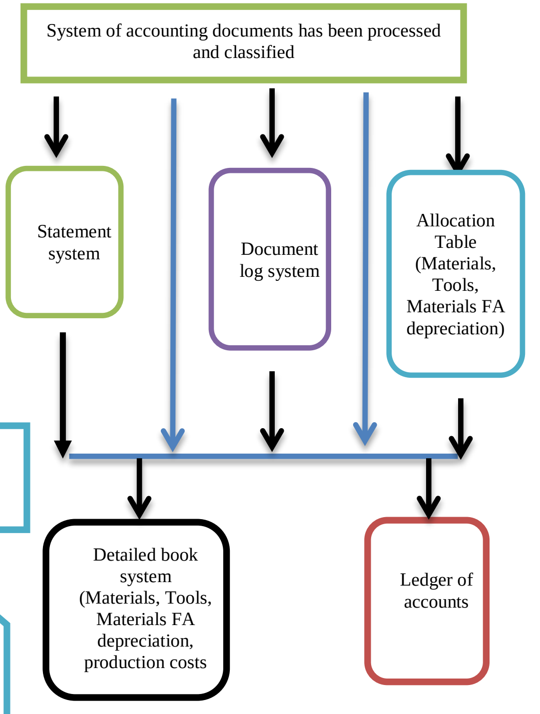

Fig 3. Organizational chart of reflecting, storing data of accounting and financial IS in CME –VINACOMIN.

Thus, the accounting book system is fully, systematically, and scientifically applied to ensure the Vietnamese enterprise accounting policy's principles and requirements under the applicable regulations.

However, the detailed tracking of the detailed book system in these enterprises has still had shortcomings, such as failing to meet all managers' requirements in providing information to support the managers to make quick and timely decisions and manage and monitor expenses incurred from the lowest-level cost centers.

2.1.3. Organize reporting and providing accounting information

Coal mining enterprises of VINACOMIN Corporation prepare accounting reports (financial statements) according to the accounting policy regulations. Besides, to reflect more detailed each main activity in the enterprises, the financial accounting system also provides and prepares many detailed reports on the actual situation of costs, fixed assets, debt receivables, payables, capital sources…

2.2. Management accounting information system

Although coal mining enterprises have currently seen the role of management accounting in the enterprises and have focused on the implementation of management accounting in the enterprises, its implementation is still difficult from the organization of recording, processing data to reflecting, storing data and making reports of providing accounting information, affecting the quality of accounting information. Specifically:

2.2.1. Organize recording and processing data.

The accounting management information at the coal mining enterprises of VINACOMIN is recorded and processed by many related departments, specifically as follows:

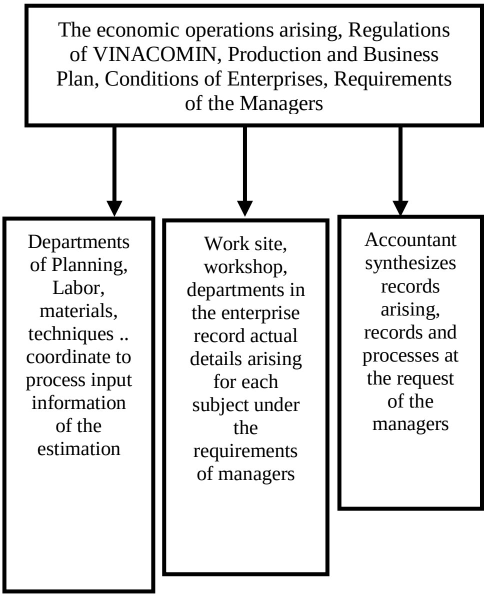

Fig 4. Organizational chart of recording and processing data of management accounting IS in coal mining enterprises - VINACOMIN.

2.2.2. Organize data reflection and storage

The initial (original) information recorded at the worksite and the workshop is usually collected to provide the accounting department to synthesize and reflect on the books. In addition, to serve the requirements of corporate governance, this information is also used to deliver relevant departments such as departments of planning, materials, labor, and wages, etc. for comparing and controlling the implementation situation against the plan and norms already established on the actual condition of management and use of materials and labor, etc. After being compared and checked, these information will be written and stored at relevant departments to make it available for managers to make decisions when needed. With the way of organizing the reflection of information by many different departments in the coal mining enterprises, the data upon provided is inconsistent, besides, , quick communication to managers when needed is limited.

2.2.3. Organize reporting and providing accounting information

In the management accounting reports system, there are some reports made and provided simultaneously with the financial reporting system and at the end of the accounting year. These are usually the reports uniformly prescribed in the whole Corporation, such as Report of production costs by factor; Report of selling expenses, business management expenses; Report of cost prices by stage; Report of fixed assets; Detailed report of revenues; Report of profits and losses of coal consumption, etc.

Besides, management accounting reports are mainly prepared to meet corporate governance requirements and business operations, so these reports are made weekly, monthly, and quarterly. Currently, coal mining enterprises in the Corporation have been focusing on making quick reports weekly, even daily, to meet the requirements of providing quick information for managers.

The management accounting reports in these enterprises are very diverse, made, and provided by many different departments, thus affecting the consistency in information provision. Also, when a summary report of operational functions is needed, it is required to have a stage of synthesizing these reports, thereby also affecting the quick and timely provision of information to managers.

2.3. Summary of quality assessment of accounting information system in coal mining enterprises - VINACOMIN

Through the survey to find out the current status of the quality of the accounting information system in coal mining enterprises of VINACOMIN, the author assessed this work as follows:

2.3.1. Advantages

Coal mining enterprises under VINACOMIN are currently applying a basic accounting information system that meets the requirements for providing information to managers to assist managers in making decisions on production and business.

The current financial accounting information system has been operating stably. The content and practice of accounting financial have been fully implemented to meet the requirements of the accounting information system follow the provisions of the accounting regimes, accounting standards issued by the Ministry of Finance as well as accounting regime applicable to VINACOMIN Corporation approved by the Ministry of Finance under Decision No. 2917/ QĐ-HĐQT dated December 27, 2006. Most coal mining enterprises have currently applied accounting software in financial accounting. Financial accounting information is recorded, processed, reflected, stored and provided to users in accordance with the process, ensuring compliance with the basic accounting principles.

Management accounting information system is available and put into operation, mainly implementing cost management accounting. However, this work is not carried out consistently in the accounting department. Still, it is applied by many related departments in enterprises such as the accounting, planning, cost management, materials, and labor and rolls t. The work contents are coordinated smoothly to meet some requirements of managers.

2.3.2. Restrictions of accounting information system

Besides the achievements, there are some shortcomings of the collection and processing sources leading to the fact that the quality of the information provided to managers has many restrictions, thereby affecting production and business activities.

- ***Restrictions from the financial accounting information system***

Firstly, regarding collecting and processing information

Most of the data units are collected mainly following the financial information collection system, the collected documents do not have specific targets for purposes of managers. There are no targets and contents in line with the characteristics of coal mining enterprises and there are no particular and specific records and books to track. Hence the information is not really suitable in the precise nature of the coal industry. Therefore, the detailed tracking for each subject has still faced a lot of problems. With direct costs, the careful tracking for subjects is generally fully reflected, but with indirect costs that need to be determined for each object, there are many shortcomings.

Secondly: Regarding the application of information technology

At the coal mining units of VINACOMIN, the application of information technology to the accounting department is only single. Still, there is no link, integration, and sharing of information among the relevant departments. When there is any requirement for providing quick information for managers, the current financial accounting information system fails to meet.

- ***Restrictions from the management accounting information system***

Although all units have applied management accounting system, the management accounting information system is not effective with many restrictions, thereby affecting the quality of accounting information, specifically:

Firstly, the management accounting information system is organized singly in related departments. Each department performs independently; there is no integration of information among these departments, so the different provision of information among these departments is inevitable.

Secondly, some basic requirements have been met but not fully promoted as useful tools for managers to make business decisions.

Thirdly, Not yet applied a modern information system suitable for the governance model that meets managers' targets.

Thus, all activities of coal mining enterprises are affected and controlled by Vinacomin. Therefore, the above restrictions are much influenced by this corporation.

3. RECOMMENDATION FOR THE IMPROVEMENT OF THE ACCOUNTING INFORMATION SYSTEM IN COAL MINING ENTERPRISES - VINACOMIN

For the quality of the information provided to the managers to be met, some appropriate solutions are needed to address the above restrictions; these solutions must be feasible to meet management requirements from the management system of Vinacomin and Vinacomin based enterprises.

3.1. From Vinacomin

As a parent company that dominates several activities of coal mining enterprises, Vietnam National Coal - Mineral Industries Holding Corporation Limited has always been monitoring, orienting and directing coal mining enterprises to fulfill the assigned duties and ensure that production and business activities are efficient, creating high income for employees. Vinacomin should consider some recommendations:

- It is necessary to have a clear specific strategy in developing and putting modern IT applications to be deployed in enterprises, providing a particular roadmap, and ensuring that enterprises are ready and take the initiative for this recommendation.

- It is necessary to develop general processes and standards on information technology development policy. Assisting enterprises in identifying information technology development processes ensures that enterprises comply with Vinacomin's policies and guidelines.

- Another activity is to support enterprises in finding modern IT application tools, software providers.

- Vinacomin should have support policies enterprises in financial difficulties to apply modern information technology application (e.g, integrated software).

- Vinacomin should regularly organize training courses on professional qualifications, disseminate new accounting policies to the staff of the enterprises (from statistics of the worksite, workshop to accountants).

3.2. From the coal mining enterprises

To improve the quality of the accounting information system, coal mining enterprises need to see the limitations of the system as well as the causes of those limitations. On that basis, the solutions must focus on addressing the above limitations, specifically as follows:

- Enterprises need to build a system of certain detailed documents to keep track of their specific characteristics. The system can ensure easier tracking of each subject.

- It is necessary to apply modern information technology into operation in the accounting information system. To ensure adequate support for the accounting information system, operating in an enterprise-compatible manner, it is needed to have an appropriate investment in equipment innovation.

- Applying an integrated system for the whole enterprise supportsmooth and consistent connection of the data system . Companies need to manage the changes, especially in the management structure to utilize the data and improve their management.

- Enterprises need to train and retrain staff to keep up with the changes in work when deploying modern information technology.

- Enterprises need to have specific financial plans for investing in modern information technology in the system. Identify long-term financial sources to ensure stability and safety for enterprises.

4. CONCLUSION

Thus, the research has partly solved the restrictions from coal mining enterprises - Vinacomin, to have quality information, it is necessary to have an appropriate information system from the collection, processing, and provision of information as well as have high-tech support tools to provide the information for managers on time for the business management.

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INVESTOR SENTIMENT AND CORPORATE INVESTMENT LEVEL: AN EMPIRICAL STUDY BASED ON VIETNAMESE LISTED COMPANIES

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Abstract: *The study examines the impact of investor sentiment on the investment level of Vietnamese listed companies. The study uses the sample data collected from 348 companies on Vietnam's Stock Exchange during the period from 2012 - 2019 with 2436 observations. The findings show that Investor sentiment has an opposite effect on the corporate investment level. The results suggest that the positive relationship between investor sentiment and corporate investment may be due to that corporate managers are also driven by investor sentiment. An optimistic investor sentiment would make the investment level of the company increase.*

Keywords: *Investor sentiment, corporate investment, investment level, Joint-stock company.*

1. INTRODUCTION

Investment is an essential strategic policy for companies. Justiano et al (2010) conclude corporate investment is important to understand business cycles. Investment is influenced by irrational factors, including "agency problem" and "asymmetric information", which means that individual interests can lead to ineffective investment activities. The economists have speculated that stock-market investor sentiment may be an important driver of corporate investment and business cycles. Investor sentiment is the existence of investor sentiment - a phenomenon that biases expectations of future corporate performance. Baker (2007) explored how firms vary their financing and investment decisions to investor sentiment and its possible effect on market prices. Investor sentiment shocks have a significant impact on business cycle fluctuations, particularly on expectations related to future investment decisions (Milani, 2017).

2. LITERATURE REVIEW ON THE RELATIONSHIP BETWEEN INVESTMENT AND CORPORATE INVESTMENT LEVEL

Researchers have conducted research on the relationship between investor sentiment and corporate investment level and made different perspectives, mainly divided into two groups:

Firstly, the research team has the viewpoint that investor sentiment is positively related to the enterprises' investment level: The studies on investment sentiment and investment level have been currently various but mainly through two viewpoint groups: "Catering theory of dividend" and "theory of optimism". The team researches the influence of investor sentiment on the investment level of enterprises through the "Catering theory of dividend": Baker et al (2004) gave the theory of meeting the demands of the investor as a basis for studies of scholars later when conducting research on the relationship between investor sentiment and investment level of enterprises. In the study, the authors pointed out that due to cognitive and psychological limitations, some investors lacked an in-depth understanding of published information or consultation with experts or only saw a short-term vision, not vigilant when considering distributed dividend information, resulting in their continuous changes in demands. For business managers, when formulating policies, they will consider the demands of investors. To meet the emotional demands of investors, the enterprises may decide to pay dividends; thereby, the stock prices have deviated from the actual value of the stock. Based on the research of Baker et al, the scholars continued to expand the research on the relationship between investors and the investment level of the company and the main research results include: Polk et al (2009) showed that when the enterprises were not financially constrained, they had enough money or could mobilize external loans, investor sentiment also affected the investment activities of the company. The research model of effects of investor sentiment on the investment level of enterprises was built with control variables such as free cash flow, investment opportunities, and data of enterprises collected from CRSP - Compustat database, from the period of 1963 to 2000 of enterprises, the authors conducted regression and the results showed that investor sentiment and investment level of the company showed a positive relationship. However, this study did not mention the factors that affect the investment level, such as debt ratio, number of years of business establishment, etc. The study of Robert et al (2008) researched the relationship between the deviation of shares and investment activities of the enterprises, collected data from 1971-2004 of 2116 US companies. In addition to the investment sentiment, the model considered the factors that affected the investment level of the enterprises, including debt ratio, cash flow and business size. The results of the study indicated that a misleading assessment of the stock prices reflected investor sentiment when the investor sentiment become increased (optimistic), the investment level of the company also increased and vice versa. Investor sentiment and the investment level of the company had a positive relationship. The study of Wei - Ju Chen (2013) considered whether data of companies participating in the stock market in Taiwan with 7745 observations of conducting research on corporate governance minimized the impacts of the investor sentiment on the enterprises' investment decisions. The research result showed that the more optimistic the investor sentiment becomes, the higher the company's investment level becomes, especially the more spending on new investments. The team studied the effects of investor sentiment on the investment level of the enterprises through the theory of “optimism”. For the viewpoint that this research was new, so it has not been applied much by scholars in research articles. According to the research of Hua GuiRu (2015), the study gave the “theory of optimism”. In the study, the author pointed out that the managers were not always rational, in them, there was always influenced by the sentimental factors, so they will be affected by the investor sentiment. In this way, when the investor's sentiment is optimistic, the sentiment is transmitted to the manager, the sentiment of the manager is also optimistic and confident, thereby affecting the company's investment activities. The author collected data from the period of 2002 to 2013 of enterprises participating in the Chinese stock market with 1679 observations. The study concluded that the influence of investor sentiment on investment activity was through the effect of “sentiment transmission”, the optimistic sentiment of investor resulted in the optimistic sentiment of the manager, thus making the investment level of the company increase, the investor sentiment and the investment level of the company showed a positive relationship. However, the research on optimism theory is a new viewpoint and has been still discussed by scholars in that the managers are “transmitted” in sentiment, rarely applied.

Secondly, the research team had a viewpoint that investor sentiment was positively related to the investment level of the enterprise. The investor sentiment had a negative relationship with the investment level of the enterprise: The researches showing the negative relationship between investor sentiment and investment level of the enterprise were very limited. Research by Liuhong Zhong et al (2004) used data from 356 companies in the Chinese manufacturing industry in 1998-2002, the research of testing the relationship between investor sentiment and investment level of the company was conducted and the result reflected that the investor sentiment and the investment level of the company reflected an opposite relationship. However, in the model of building factors affecting the corporate investment level, the authors did not mention the growth rate of the company.

3. HYPOTHESE

However, in the model of building factors affecting the corporate investment level, the authors did not mention the company's growth rate.

According to the traditional viewpoint in financial theory that the capital market is the perfect market, the managers and investors participating in the capital market were those who understand the market and make absolutely exact decisions. In a perfect market, stock prices reflect the company's real value; there is no difference in stock prices. However, in fact, in the capital market, there is a phenomenon that stock prices simultaneously increase or decrease, proving that the market is not a perfect market. This is also the viewpoint of modern financial theory. The managers participating in the capital market do not always make the right decisions; they will be affected by the psychology of investors in the market, the influence of “crowd psychology”, thereby affecting the stock prices and there is a difference in the stock prices in the market from the real value. To prove that investor sentiment has a great influence on stock market price fluctuations, direct or indirect influence on the investment behavior of the company, many scholars studied the issues related to the investor sentiment from different perspectives. Some scholars believed that stock prices could reflect investor sentiment because stock price fluctuations were affected by investor sentiment (Stein, 1996).

When stock prices went up or down, the company manager would issue more shares or repurchase stocks to maximize the company's value, thereby affecting the enterprise's investment decisions. At that time, it could be said that the investor sentiment affected the company's investment level through the “Catering theory of dividend” path. When investor sentiment became optimistic, stock prices were overestimated, the company's financial costs fell and managers seized the opportunity to issue new shares to get more capital. Upon the capital was raised, the manager could make decisions to invest the projects with a current net value of less than zero, so the company's investment level increased. On the contrary, when the investor sentiment became pessimistic, not interested in buying and selling stocks, the stock prices would be undervalued. This influenced the trend of increasing the company's financial costs; the company had difficulty raising capital, so projects whose current net value was greater than zero could be ignored. Besides, due to the information mismatch in the capital market, institutional investors had more advantages than individual investors in gathering information, managers and internal members of the company had more advantages than external investors in understanding the company's current financial situation. Therefore, when making decisions on buying and selling the company's shares, because of failing to understand the details of the company's price changes, the external investors could only rely on the observation of the projects, investment decisions of the enterprise. When investor sentiment becomes optimistic, the investors trust that a company project is profitable but the company abandons it. The investors may then sell the company's stock, thereby may affect the company's stock prices, which is not good for the company. Therefore, the company managers want to pursue the company's stock prices, meet the psychological needs of investors and increase the investment level. When the investor sentiment becomes pessimistic, the stock prices will decrease. In order to survive, the company reserves cash to repurchase stocks, influences the company's investment decisions, abandons a number of investment projects with a present net value greater than zero and reduces investment level. With the analysis and argument on the relationship between investor sentiment and corporate investment level, the research gives the following hypotheses:

H0: Investor sentiment and corporate investment level have a positive relationship.

4. METHODOLOGY

4.1 Model specification

Based on the content of theoretical and hypothetical analysis, along with previous studies on the relationship between investor sentiment and investment level of the enterprises, refer to Polk et al (2009), Wang Guo Ming (2017), the research article builds a research model (1):

$INV_{i,t} = \alpha_0 + \alpha_1$ Sentiment $_{i,t-1} + \alpha2\ Cash_{i,t-1} + \alpha_3\ Lev_{i,t-1} + \alpha_4\ SaleG_{ri,t-1} + \alpha_5 Time_{i,t-1} + \alpha_6 Size_{i,t-1} + \alpha_7 Number_{i,t-1} + \varepsilon_{i,t}$ (1)

In which Dependent variable: The corporate investment level (INV) is calculated by the difference of tangible, intangible and other long-term assets of the following year compared to the previous year. The higher the INV value is, the more the company's investment level is. The INV value reflects the fact that the company's investment activities increase or decrease.

Independent variable: Investor sentiment is measured by turnover rate. The higher the Turnover value is, the more optimistic the investor sentiment is. Based on the hypnosis, the research gave H0, the expected coefficient α1> 0.

Table 1. Research variables and their corresponding definitions

Symbol	Variable Name	Calculation method
1. Dependent variable		
INV	Investment level	Investment (I) on Net Total Assets (K)
2. Independent variable		
Sentiment	Investor Sentiment	The ratio of number of shares traded daily to the number of shares outstanding
3. Control variable		
Cash	Cash Flow	Net cash from operating activities / Total Assets
Lev	Debt Ratio	Total Liabilities / Total Assets
SaleGr	Sales growth	Gross sales at year t diveded by gross sales in the previous year (t-1)
Time	Time	Ln (the number of years of business establishment)
Size	Company Size	Ln (Total Assets)
Number	The number of manager	Manager members of the Board

In addition, based on the researches related to the investment level of the company such as Makina et al (2016), Basty

(2016), Panousi et al (2012)..., the researchers controlled the influence of other factors on the investment level of the company such as internal cash flow, debt ratio (Lev), the company's growth rate (SaleGr), company size (Size), the number of years of business establishment (Time).

4.2. Data

The article uses data of companies participating in Vietnam stock market from 2012 to 2019 with a total of 2436 observations, to ensure the scientificity of the research, it's needed to select data, remove data of companies with abnormal differences or incomplete data, data of insurance companies, financial companies, etc.

The study used three regression models for the table data as follows: Pooled least square regression model (OLS model), fixed effects model (FEM) and Random effects model (REM). Then conduct the Hausman test and Breusch - Pagan LM test to choose the suitable model for the study. This was followed by the multicollinearity test, autocorrelation and variable deviation variance, and cross-dependence for the model chosen to find the model's defects. Finally, the model's defects (if any) would be overcome to ensure the regression result's reliability. This study uses the generalized least squared estimation method (GLS).

5. EMPIRICAL RESULTS

5.1. Summary statistics

A summary of the descriptive statistics on the variables was presented in Table 2. Table 2 described the variables used in the study, including the average value INV of joint-stock companies was 0.2663, indicating that in 2012-2019, the company's investment level had a big difference. The cause of the difference was due to the fact that the research samples were selected from different companies, different business sectors; moreover, in the companies of the stock market at each period, investment activity models were different. For the independent variable, the investment sentiment showed that the turnover value was in the range of 0.00002 - 22.97. The average value is 5.124, showing that almost investors became optimistic from 2012 to 2019. For control variables such as the average of the internal cash flow was in the range of 0.00005 to 0.678, the average value was 0.108. Besides, according to the results in Table 2, the average debt ratio value was 0.243; The company's age ranged from 0.6931 to 4.158, the average value was 0.687.

Table 2. Summary statistics

Var	Obs	Mean	Std.Dev	Min	Max
INV	2.436	0.266365	0.347911	-0.8620839	3.877765
Sentiment	2.436	2.49393	5.124974	0.0000232	22.97229
Cash	2.436	0.095859	0.108781	0.000050	0.678423
Lev	2.436	0.545917	0.243353	0.001778	0.97004
SaleGr	2.436	1.612934	4.257185	0	76.86057
Time	2.436	2.937213	0.687140	0.693147	4.158883
Size	2.436	27.02629	1.455547	23.33036	31.92201
Number	2.436	5.497947	1.149411	3	11

(Source: Author’s calculation from the data Sample)

5.2. Correlation matrix between variables

Based on descriptive statistics, this study looked at the correlation coefficients between the variables and the specific results shown in Table 3. Table 3 showed the investment level and investor sentiment of the companies listed in Vietnam stock market, debt ratio, internal cash flow, and size of the company... all affected the company's investment level. The correlation coefficient between the investment level of companies listed in Vietnam's stock market and investor sentiment was positive, showing that the more optimistic investor sentiment was, the more the company's investment level was. The study continued to conduct the research model's regress to test this conclusion's accuracy and prove the hypothesis H0.

Table 3. Correlation matrix between variable

Var	INV	Sentiment	Cash	Lev	SaleGr	Time	Size	Number
INV	1							
Sentiment	0.1249***	1						
Cash	0.0589***	0.0659***	1					
Lev	0.0693***	-0.0628***	-0.2826***	1				
SaleGr	0.0354	0.0465**	0.0045	-0.0260	1			
Time	0.0193	-0.0117	0.0125	0.0355*	0.0146	1		
Size	-0.0918***	-0.3292***	-0.0871***	0.2585***	-0.1212***	0.0176	1	
Number	0.0669***	-0.0729***	0.0312	0.0042	-0.0384	0.0538***	-0.2655***	1

(Source: The analyzing result from the data Sample)

*Notes: *, ** , *** denote the significance level of 10%, 5% and 1%, respectively*

5.3 Regression results

The result of the regression of relationship between investor sentiment of the enterprise based on equation (1) under Table 4 showed that: For the whole investor sentiment psychology sample and the investment level had a positive relationship at 1%, consistent with hypothesis H0. The result showed that when making the company's investment decisions, the company's managers were affected by investor sentiment. The study adopted the value of the turnover indicator to express investor sentiment; the greater the turnover indicator's value, the more optimistic the investor sentiment was (Baker et al., 2004). An optimistic investor sentiment would make the company's investment level increase (Hua GuiRu, 2015); the pessimistic investor sentiment would make the company's investment level decrease. According to the characteristics of Vietnam stock market conditions for listed companies, the study divided the sample (Sample) into two groups: Listed companies participating in the Ho Chi Minh Stock Exchange (HOSE) that were large-scale companies and those participating in Hanoi Stock Exchange (HNX) that were small-scale companies. In the sample of large-scale companies, investor sentiment and the company's investment level were statistically significant at 10 % and the regression coefficient of investment sentiment was relatively small 0.00551. In companies participating in the Hanoi Stock Exchange, the small-scale companies, investor sentiment, and the company's investment level were statistically significant at 1 %. The regression coefficient value of investor sentiment was 0.00602. According to the research result in Table 3, in small-scale companies, the influence of investor sentiment on investment level was relatively small compared to large-scale companies. The reason was that the conditions for joining the Ho Chi Minh City Stock Exchange compared to the Hanoi Stock Exchange were relatively strict, in addition to the requirements on the number of years of business establishment, the regulations on capital size and business results were also required..., so participating in the Ho Chi Minh City stock exchange was usually large-scale companies with long establishment duration and much experience.

In addition, compared to small-sized companies, large-scale companies had more business managers, the size of the board of management was larger, so when developing investment strategies for the enterprises, members of the board of management would discuss investment plans, the influence of external factors was limited such as the influence of investor sentiment. In considering control variables in the model, most control variables such as internal cash flow, debt ratio, business size, concurrent positions and investment level of the company had the positive administration and were statistically significant at 1 %. The research result and conclusion in the research article of Lamont & Owen (1977) were similar.

Table 4. Regression results show the relationship between Investor sentiment and corporate investment level

Var	Sample	HOSE	HNX
$Sentiment_{t1}$	0.00666***	0.00551*	0.00602***
	(4.67)	(1.73)	(3.76)
$Cash_{t-1}$	0.239***	0.136	0.342***
	(3.61)	(1.52)	(3.57)
$Leverage_{t-1}$	0.178***	0.283***	0.168***
	(5.83)	(6.80)	(3.71)
$SaleGr_{t-1}$	0.00198	-0.00033	0.00178
	(1.21)	(-0.12)	(0.90)
Timet-1	0.00568	-0.0179	0.0252*
	(0.56)	(-1.19)	(1.89)
$Size_{t-1}$	-0.0261***	-0.0308***	-0.0674***
	(-4.83)	(-3.77)	(-7.24)
$Number_{t-1}$	0.0304***	0.0414***	0.000862
	(4.87)	(5.36)	(0.08)
	0.648***	0.782***	1.792***
_cons	(4.54)	(3.42)	(7.54)
N	2436	2436	2436

*Notes: *, ** , *** denote the significance level of 10%, 5% and 1%, respectively*

6. CONCLUSIONS

The research showed that the investor sentiment in Vietnam's stock market had a certain influence on the enterprises' investment level. When the investor sentiment became optimistic, the stock prices would increase, the managers would respond to the investors' sentiment, became optimistic with investment plans, ready to invest in projects even if NPV < 0, the company's investment level increased. In contrast, when the investor sentiment became pessimistic, the investment level of the enterprises would decrease. The article's conclusion enriches research on the relationship between investor sentiment and investment level of the company, helping readers understand the impact of investor sentiment on the company in a more profound comprehensive manner. Based on the conclusion of the article, the author can make some recommendations: Firstly, for the enterprises, it's needed to pay attention to the relationship between investors and businesses in the process of developing the business activities of the enterprises, enhancing the internal management of the enterprises, improving the public information system so that investors have an accurate assessment of the enterprises, avoiding the adverse effects of investor sentiment on the company. Secondly, for investors participating in the stock market, it is needed to supplement the financial market's knowledge to have a good understanding of the financial market and reduce securities speculation and limit herd investment behaviors. Thirdly, it's needed for management agencies to improve market supervision with the enterprises participating in the market, prevent market manipulation so that the stock market is growing more and more.

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DONG BAC CORPORATION

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Abstract: *In production and business activities, accounting of provisions plays an important role in providing information to help administrators limit risks and better handle possible losses. In provisions, payable provision is an integral part of the enterprise accounting system. However, currently, the payable provision still has many problems when enterprises implement in reality, including Dong Bac Corporation. By analyzing, synthesizing, evaluating, the author focuses on studying the theoretical basis of payable provision accounting, clarifying the reality of payable provision accounting at Dong Bac Corporation, from which making a number of recommendations to improve the payable provision accounting in the specific conditions of Dong Bac Corporation.*

Keywords: *provision, liabilities, payable provision, Dong Bac Corporation.*

1. INTRODUCTION

In the current trend of globalization of the economy, with fierce competition and increasingly complicated market fluctuations, businesses must always be on guard against possible risks. Therefore, the implementation of the policy of provisions accounting in the enterprise is crucial. The provisioning can help businesses take the initiative in dealing with risks and at the same time have a reasonable plan of production and business to be able to stand firm in a competitive environment now. In the provisions, the payable provision is a new problem; the recognition, valuation, initial information collection, processing and presentation of accounting information on provisions are still controversial issues.

Dong Bac Corporation is an economic and defense enterprise under the Ministry of Defense, whose main function is coal production and trading. Between 2017 and 2019, with 09 limited companies, with 07 accounting units dependent on the parent company and 03 affiliated joint-stock companies, the accounting of payable provision at Dong Bac Corporation is implemented according to a certain process. In the reporting framework, the author delves into the situation of payable provision accounting in Dong Bac Corporation from 2017 to 2019 and proposes to complete the proposal.

2. RATIONALE FOR PAYABLE PROVISION ACCOUNTING

2.1. The concept of payable provision

According to International Accounting Standard (IAS) No 37, "payable provision is a liability that is uncertain in value or time". According to the UK's Financial Reporting Standards (FRS) 12, "A payable provision is a liability that is uncertain in value or time, resolved by the transfer of economic benefits". According to Vietnamese Accounting Standard No. 18 "A provision is a liability that is uncertain in value or time".

Thus, payable provision is a debt that can be distinguished from other debts such as trade creditors, loan debts, etc. liabilities determined almost with certainty value and time, and payables provision is uncertain in value and time.

For example, with trade creditors, the amount of money and payment period usually are specified in the contract of sale. With the warranty payable to the customer, the exact amount and payable time must not be determined, even though the warranty liability is the business's current responsibility.

Basically, the contingency viewpoints agree that the payables provision must be considered an uncertain economic obligation of the enterprise. Consistent with the viewpoints of contingency presented above, the author said that "Payable provision is a liability of uncertain value or time".

2.2. Classification of payable provision

According to the Corporate Accounting Regime issued in Circular 200/2014/TT-BTC, the payable provisions usually include:

(1) Payable provision for product warranty is a provision for product and goods warranty with the number of products and goods which have been determined to be consumed in a period, including expenses of raw materials, wages, and depreciation of fixed assets, etc. incurred during the warranty of products and goods.

(2) Payable provision for construction works warranty is a provision for warranty of construction works, construction work items completed and handed in a period, including expenses of raw materials, wages, and depreciation of fixed assets, etc. incurred during the warranty of construction works.

(3) Payable provision for corporate restructuring is the provision for corporate restructuring, such as relocation costs, support costs for employees, etc.

(4) Other payable provisions: such as Payable provision for environmental reimbursement, cleanup, restoration and site return costs; Payable provision for severance allowances as prescribed by law; Payable provision for periodic repair and maintenance of fixed assets (according to technical requirements); Payable provision for high-risk contracts. A high-risk contract is a type of contract in which the cost of fulfilling the contractual obligation is higher than the expected benefits from that contract.

2.3. Characteristics of payable provision

A payable provision has got the following main characteristics:

Firstly, the payable provision is a liability, so it will almost certainly arise, but it is only uncertain about the value or timing. Payable provision has been recognized as a liability because it is a current liabilities and will undoubtedly impair the economic benefits to pay that liabilities. And due to the assumption of making a reliable estimate, the payable provisions need to be reviewed and revised at the end of each accounting period to prepare a Balance Sheet to fully and logically reflect the enterprise's debt obligations.

Secondly, the payable provision must be tied to the current obligation. This present obligation as a result of events that have arisen in the past. The current obligation may be a legal obligation or a committed obligation. Legal obligations arise when the enterprise engages in economic relations that are guaranteed by law, such as the obligation to pay salaries to employees, the obligation to pay debts to the seller, the obligation to repay loans, the obligation to pay taxes to the state, etc. These legal obligations are usually clear and meet the requirement to record a debt. Besides, the accountant considers acknowledging the committed obligations. In terms of the level of influence on the financial structure and solvency, legal obligations and committed obligations have resulted in the enterprise having to sacrifice economic resources to pay. Therefore, from the viewpoint of dynamic accounting, these obligations need to be recorded. However, the recognition and recognition of committed obligations such as: indemnified indefinite obligations, obligations to customers, obligations to the community, etc. often bring a lot of judgment in each situation associated with specific conditions of socio-economic development. These committed obligations are usually recognized as payable provisions in the financial statements.

Thirdly, the obligation associated with a provision must be reliably estimated because a provision is usually related to a legal obligation or committed obligation. Normally, the relevant quantitative factors are clearly grounded for legal provisions, and the determination is often quite simple. In contrast, determining a committed obligation is often more difficult, but can be reliably estimated. The estimation of these debts' value and duration is often made according to various estimation models such as statistical probability, cash discount model, regression model, etc. which are accepted based on the reliable database.

2.4. Accounting of payable provision

2.4.1 Conditions for recognition and methods of determining value of payable provision in the enterprise

* Conditions for recognition

According to VAS 18, the amount of money is recognized as a provision only when the following conditions are satisfied:

- The enterprise has a current obligation (a legal obligation or a committed obligation) as a result of an event that has occurred.

- A decline in economic benefits may occur resulting in payment of debt obligations;

- Give a reliable estimate of the value of that debt obligation.

Debt obligations arise from past events independent of the future operation of the enterprise are recognized as provisions. A number of obligations arise; however, the enterprise can avoid this expense by adjusting its operations in the future, so no provision is recognized. For example, expenses for dismantling an unused production line will be recorded as a back-up. On the contrary, under commercial pressure or legal requirements, businesses are forced to repair the production lines that no longer meet environmental standards. However, by changing the production process, the enterprise can avoid this expense when it is not allowed to record provision.

* Methods of determining the payable provision

The value used to recognize a payable provision will be determined by the most appropriate estimated value of the cost to pay current obligations at the end of the accounting period. It may be based on experience from similar activities or reports of independent experts, with reliable evidence available to determine the value of a payable provision.

According to author Ha Dang Thi Hong (2017), there are many evaluation methods to recognize the value of a payable provision, including:

(1) Direct comparison method: According to this method, in order to determine the value of accounting estimates, accountants must collect market information on assets or liabilities that are completely identical to the valuated objects. The accountant considers the observed market value to be the value of the valuated objects. This method can be applied to determine accounting estimates related to assets and liabilities, which are common in the market.

(2) Adjusted comparison method: According to this method, in order to determine the value of accounting estimates, accountants must collect market information on similar assets or liabilities with the valuated objects. The accountant adjusts

observed market prices to determine the value of the evaluated object.

(3) Income method: The income method, also known as the investment method, is built on adherence to the principles of forecasting future economic benefits. Accordingly, the value of a valuated object is the present value of the economic benefits gained or sacrificed in the future. The basic technique for applying the income method is to discount the cash flow that can be earned or paid in the future at an appropriate discount rate.

(4) Regression method: This method relies on the relationship between accounting estimates and related parameters to determine estimates based on forecasted values of known parameters. The regression method is applied to determine accounting estimates that are directly related to other elements of the financial statements or other economic parameters, such as estimation of product warranty by sale quantity and revenue.

(5) Probability method: Some accounting estimates related to the forecast of future economic-financial parameters. Usually, it is not possible to have a single prediction of probable events that will have different possibilities corresponding to different probabilities. Expected values are calculated on the basis of forecasts and probabilities that can be used as an estimate. The expected value is the average value of a quantity, given its probability of occurrence. The expected value is often used to make accounting estimates that depend on the likelihood of future events. For example, payable provisions determining include goods and product warranty, construction works warranty, provision for enterprise restructuring, etc.

(6) Allocated method: Many accounting estimates are the distribution of determining values for accounting periods according to an expected criterion. For example, depreciation must be made according to the estimated use time of fixed assets, prepaid expenses allocation, etc. The resulting allocation and residual value after allocation are accounting estimates when the allocated criterion is an estimate.

Depending on each contingency's characteristics, the appropriate method is the method of comparison, probability, income, etc. to estimate a payable provision. For example, for the provision of construction works warranty, the average warranty rate of works may be used as a basis for setting up. For a provision for a high-risk contract, the enterprise will use the adjusted comparison method. Accordingly, the accountant must collect market information on similar contracts and adjust the observed market value to estimate the payment provisions of the contract to be calculated.

When the provision is assessed in relation to many items, the liability will be calculated based on all possible results with probabilities (estimation method). Therefore, the provisions will depend on the estimated probability of incurred losses, for example, 50% or 80%. If the estimated results are equal and continuous within a certain limit and each point within that limit is equally likely, the midpoint in that limit will be chosen.

For example, a company sells goods with a 6-month warranty after purchasing. According to previous experience statistics, the average small repair cost per year is 200 million VND, the average large repair cost per year is 600 million VND.

Expected for next year's production shipment, the company estimated the good product ratio is 70%, minor damage is 22% and large damage is 8%.

So the estimated cost will be: 70 % * 0 + 22 % * 200 + 8 % * 600 = 92 (million VND)

In some cases, the most appropriate estimate is sometimes higher than the value when estimating the liability separately. For example, businesses are forced to repair a serious failure of a large device sold to customers, and the most likely result is that it will cost 100 million VND to repair it successfully for the first time, but if it is possible to repair next time, it must provide a provision worth more than 100 million VND.

2.4.2 Original information collecting

Depending on the payable provision, information collecting is various, as follows:

(1) Regarding provision for products and goods warranty, construction works warranty: Enterprises must estimate the level of damage of products, goods and construction works due to detected construction and installation errors during the time of warranty when handing over the work to the investor. For this provision, enterprises need to have documents such as economic contracts, decisions on setting up and a list of provisioning for warranties of products, goods and construction works.

(2) Regarding provision for enterprise restructuring: Enterprises must anticipate expenses incurred when restructuring enterprises such as relocation costs, support costs for employees, etc. Enterprises need to have documents such as the contract for hiring a business location, the enterprise's decision to make provisions, a table of expenses for supporting employees when restructuring the enterprise, and other documents showing that information about the cost of implementation when restructuring businesses.

(3) For a provision for a high-risk contract: The enterprise must classify the contracts with high risk as prescribed. The contract must have related compulsory expenses exceeding the expected economic benefits obtained from that contract. The mandatory costs under the terms of the contract reflect the lowest cost of the contract's waiver. That cost will be lower than the cost of contract performance, including compensation or compensation arising from the failure to perform the contract. As such, businesses need to gather the types of contracts with great risks as a basis for setting up provisions and accounting into corporate management costs. The documents include economic contracts, the enterprise's decision to make provisions and other relevant documents showing information about the cost of contract performance.

(4) For other provisions: For each other type of provision, the enterprise needs to collect documents to determine the value of the provision, that is, the payment obligations of an enterprise (for example, in order to have a basis for making annual environmental recovery provision, if the enterprise leases land, it is required to quote the price of the site return service from the service providers). The accountant also needs to collect the Decision of provisioning and the List of provisions (if there are many related subjects in this provision).

2.4.3 Accounting information processing

According to the Vietnamese accounting regimen issued by Circular 200/2014/TT-BTC, to reflect the payable provisions, the accountant uses the "Payable provision" account to monitor.

* For payable provisions:

+ When setting up payable provision, the accountant shall record:

Dr Account “Cost”

Cr Account “Payable provision”.

+ When incurred expenses related to the initially established payable provision, the accountant shall record:

Dr Account “Payable provision”.

Cr Related Account

* At the end of the accounting period, the enterprise calculates to determine the number of provisions to be set up at the end of the accounting year:

+ In cases, the number of provisions to be set up in this accounting period is larger than the number of provisions already set up in the previous accounting period but not yet used up. The difference amount accounted for expenses and the accountant shall record:

Dr Account "Cost"

Cr Account "Payable provision".

+ In case the number of provision to be set up in this accounting period is smaller than the number of provisions already set up in the previous accounting period but not used up yet, the difference between the reversal and reduction shall be recorded as expense reduction, the accountant shall record:

Dr Account "Payable provision".

Cr Account "Cost"

+ Upon the expiry of the warranty period for construction works, if payable provision for construction work warranty is larger than the actually arising expenses, the difference must be refunded and record:

Dr Account "Payable provision".

Cr Account "Other Income".

2.4.4 Presentation of information about the payable provision on corporate financial statements

According to VAS 18, enterprises must present each type of provision in the financial statements according to the following items:

+ The surplus at the beginning and end of the period;

+ The number of provision increases due to the additional provisions in the period, including the increase of existing provisions;

+ The amount of provision decreased due to the expenses related to that provision that was made in the beginning;

+ The unused provision is recorded decrease (reversal) in the period;

+ The amount of provision increased in the period due to the present value of the provision increased over time and due to the impact of changes in the discount rate of cash flow.

For each type of provision with the main value, enterprises must present the following information:

+ Summary of the nature of the debt obligation and the estimated repayment time;

+ Signs of uncertainty about the value or timing of payments.

3. CURRENT SITUATION OF PAYABLE PROVISION ACCOUNTING AT DONG BAC CORPORATION

3.1. Conditions for recognition and methods of determining the payable provision value at Dong Bac Corporation

3.1.1. Conditions for recognition of the payable provision

Dong Bac Corporation applies the principle of recording the payable provision according to VAS 18, which is clearly stated in Section IV- The main accounting policies in the Notes to the Corporation's financial statements.

- The enterprise has a current debt obligation (legal or committed liability) due to an event that has occurred.

- A decline in economic benefits may result in the payment of debt obligations;

- Give a reliable estimate of the value of that debt obligation.

3.1.2. Method of determining the value of payables at Dong Bac Corporation

From 2017 to 2019, Dong Bac Corporation has 20 member units and subsidiaries, including Mining Industry Construction Company whose main task is to build mining works, ten companies have the function of exploiting minerals, the rest are the units with business, assessment and transportation functions in the mineral industry. The data of payable provision for each member unit of Dong Bac Corporation in 2017-2019 is aggregated in Table 1, of which 12 units have to make payable provision.

Payable Provisions of Dong Bac Corporation include: Payable provisions for the warranty of construction works and environmental restoration and reverting expenses. The Mining Industry Construction Company makes payable provision for construction work warranty. The payable provision for restoration and environmental restoration expenses is made by 11 units with mineral exploitation activities. The provision for construction works warranty accounts for a very low proportion of the total payable provisions, usually less than 1%, while over 99% is the payable provision for environmental restoration and restoration costs. This is because construction works are not a major activity of the Corporation, but the Dong Bac Corporation's main activity is coal and mineral exploitation and trading. Therefore, the provision for restoration and environmental restoration costs is the main kind of payable provision for the Dong Bac Corporation.

Payable provisions at Dong Bac Corporation monitor the details of short-term payable provisions (payment period is within one year) and long-term payable provisions (payment period is over one year) (Table 2). In which at the beginning of 2017, short-term payable provisions accounted for a much lower proportion than the long-term payable provisions (14.57% compared to 85.43%), and in the following years, short-term payable provisions is not much lower than the long-term payable provisions (over 40% compared to over 50%). This is mainly due to the time of payment of the payable provision by the project has been implementing increasingly shorter, while the new mining project is also not much.

Table 1. Payable provision data of each member unit of Dong Bac Corporation in the period of 2017 - 2019

Unit: VND

No.	Unit	The beginning of 2017	The end of 2017	The end of 2018	The end of 2019
1	Office of Dong Bac Corporation				
2	Mining Transport Management Center				
3	Inspection center				
4	The Southward Dong Bac Coal Trading Company - Branch of Dong Bac Corporation				
5	Mining Industry Construction Company - Branch of Dong Bac Corporation	398,345,206	383,513,809	285,601,009	639,848,517
6	Port Company - Branch of Dong Bac Corporation				
7	Dong Bac 1 Mineral Company - Branch of Dong Bac Corporation				
8	Landmines Center - Branch of Dong Bac Corporation				
9	35 One Member Limited Liability	3,907,676,255	4,935,539,222	6,333,780,983	7,528,305,219

No.	Unit	The beginning of 2017	The end of 2017	The end of 2018	The end of 2019
	Company				
10	45 One Member Limited Liability Company	1,354,322,749	3,647,382,276	8,365,574,760	14,766,449,299
11	86 One Member Limited Liability Company	1,345,770,183	9,175,809,241	10,527,257,656	11,469,310,514
12	91 One Member Limited Liability Company	1,578,032,923	3,404,449,476	5,408,351,062	11,775,619,192
13	397 Joint Stock Company	58,646,497,728	5,126,454,835	4,918,206,656	6,671,315,945
14	618 One Member Limited Liability Company	3,649,809,940	8,855,041,289	14,728,587,687	
15	790 One Member Limited Liability Company	1,878,956,000	2,391,845,368	2,102,140,822	2,744,912,678
16	Khe Sim One Member Limited Liability Company			5,847,810,000	22,516,474,479
17	Mining Exploitation One Member Limited Liability Company	1,324,544,691	2,602,366,089	5,479,774,231	10,506,684,841
18	Thang Long One Member Limited Liability Company	3,107,327,053	666,937,280		2,125,510,458
19	Song Hong Coal Joint Stock Company	67,482,713			
20	Dong Bac Coal Transportation and Processing Joint Stock Company				
	Total	77,258,765,441	41,189,338,885	65,292,875,079	90,744,431,142

(Source: Dong Bac Corporation)

Table 2. Payable provision data follows economic content of Dong Bac Corporation in the period of 2017-2019

Criteria	Provision for environmental reimbursement costs		Provision for warranty costs		Total	
	Amount (VND)	Proportion (%)	Amount (VND)	Proportion (%)	Amount (VND)	Proportion (%)
1. At 1/1/2017	*76,860,420,235*	99.48	*398,345,206*	0.52	*77,258,765,441*	*100%*
- Short-term payaple provisions	10,858,247,657	96.46	398,345,206	3.54	11,256,592,863	14.57%
- Long-term payaple provisions	66,002,172,578	100	-	0.00	66,002,172,578	85.43%
2. At 1/1/2018	*40,805,825,076*	99.07	*383,513,809*	0.93	*41,189,338,885*	*100%*
- Short-term payaple provisions	18,158,625,649	97.93	383,513,809	2.07	18,542,139,458	45.02%
- Long-term payaple provisions	22,647,199,427	100	-	0.00	22,647,199,427	54.98%
3. At 1/1/2019	*65,007,274,070*	99.56	*285,601,009*	0.44	*65,292,875,079*	*100%*
- Short-term payaple provisions	28,941,972,447	99.02	285,601,009	0.98	29,227,573,456	44.76%
- Long-term payaple provisions	36,065,301,623	100	-	0.00	36,065,301,623	55.24%
4. At 31/12/2019	*90,104,582,625*	99.29	*639,848,517*	0.71	*90,744,431,142*	*100%*
- Short-term payaple provisions	37,282,923,778	98.31	639,848,517	1.69	37,922,772,295	*41.79%*
- Long-term payaple provisions	52,821,658,847	100	-	0.00	52,821,658,847	*58.21%*

(Source: Dong Bac Corporation)

**** Provision for construction works warranty costs***

Payable provision for construction works warranty = Total settlement value of construction works x 0.2% (1)

With payable provision for construction works warranty, there is only a member unit of the Dong Bac Corporation is the Mining Industry Construction Company. Other member units do not make this provision. Payable provision for construction works warranty is calculated at the rate of 0.2% with the settlement value of construction works, like the formula (1).

For example, in 2019, the payable provision for construction works warranty of the Dong Bac Corporation is calculated as:

Provision for construction works warranty in 2019 = 319,924,258,500 x 0.2%

= 639,848,517 VND

The calculation of payable provision for construction works warranty of the Dong Bac Corporation in the period of 2017 - 2019 is illustrated in Table 3.

Table 3. Table of payable provision for construction works warranty of Dong Bac Corporation in the period of 2017-2019

Criteria	Unit	2017	2018	2019
1. Total settlement value of construction works each year	VND	191,756,904,500	142,800,504,500	319,924,258,500
2. Proportion of provision	%	0.2	0.2	0.2
3. Payable provision for construction works warranty	VND	383,513,809	285,601,009	639,848,517

(Source: Mining Industry Construction Company - Dong Bac Coal Corporation Branch)

**** Payable provision for environmental restoration and reverting costs***

The legal documents used to determine the payable provision value of environmental restoration and reverting costs at Dong Bac Corporation include:

- Decree No. 19/2015/ND-CP on 14/02/2015 of the Vietnamese government detailing the implementation of several articles of the Law on Environmental Protection.

- Circular 38/2015/TT-BTNMT on 30/06/2015 of the Vietnamese Ministry of Natural Resources and Environment on environmental rehabilitation and restoration in mining activities.

- Decision No. 5456/ĐB-TCKT at 19/9/2016 of Dong Bac Corporation on the provisioning, allocating expenses for environmental rehabilitation and restoration for coal mining activities.

Based on each approved coal mining project's environmental rehabilitation and restoration scheme, the units make an environmental rehabilitation and restoration deposit. The coal production units make deductions for setting up, allocating expenses for environmental renovation and restoration for coal mining activities in the Dong Bac Corporation as follows:

- For projects that have completed exploitation, the units that are currently or are preparing to conduct environmental rehabilitation and restoration under the approved plan, the expenses for environmental rehabilitation and improvement are gathered and allocated within the time which no more than three years from the end of the environmental rehabilitation and restoration.

- For projects that have been put into operation, the unit shall determine the remaining coal output of the project on 01/01/2016 as a basis for setting up. For new projects, coal output under the project's approval decision is the basis for setting up.

Quarterly, the unit sets up the payable provision for environmental renovation and restoration expenses for coal mining activities according to formula (2).

$$\text{Payable provision for environmental restoration and reverting costs} = \frac{\text{Amount to carry out environmental rehabilitation and restoration according to the approved project}}{\text{Raw coal quantity of the project or the remaining coal quantity of the project}} \times \text{Output of raw coal exploited in the period} \quad (2)$$

For example, calculate the amount of payable provision for environmental renovation and restoration expenses in the first quarter of 2019 at Thang Long One Member Limited Liability Company as Table 4.

$$\text{Payable provision for environmental restoration and reverting costs in Mining license 2821} = \frac{2{,}078{,}573{,}000}{462{,}213} \times 42{,}935$$

$$= 193{,}079{,}071 \text{ (VND)}$$

$$\text{Payable provision for environmental restoration and reverting costs in Mining license 2923} = \frac{1{,}111{,}575{,}000}{1{,}344{,}370} \times 12{,}835$$

$$= 10{,}612{,}454 \text{ (VND)}$$

Other units in the Dong Bac Corporation also count the same.

The data of provisional deduction for the restoration of the environment in each quarter in the Dong Bac Corporation units will be recorded in the accounting book of account 352 - Payable Provisions of each quarter. For example, the data in Table 4, Thang Long One Member Limited Liability Company will record according to the entry:

Dr Account 642: 203,691,525 VND

Cr Account 352: 203,691,525 VND

Table 4. Provisional deduction sheet for restoration of environment in Thang Long One Member Limited Liability Company in the first quarter of 2019

No.	Content	The amount of rehabilitation is under the plan (VND)	The mining coal reserves (Ton)	The exploited coal output at 12/31/2015 (Ton)	The remaining coal output (Ton)	The average (VND/ Ton)	The accounting number		
							Quantity (ton)	Amount (VND)	Total (VND)
1	Mining license No. 2823/GP-BTNMT 31/12/2008	1,111,575,000	1,690,672	346,302	1,344,370	827	12,835	10,612,454	10,612,454
2	Mining license No. 2821/GP-BTNMT 31/12/2008	2,078,573,000	680,637	218,424	462,213	4,497	42,935	193,079,071	193,079,071
	Total	**3,190,148,000**	**2,371,309**	**564,726**	**1,806,583**		**55,770**	**203,691,525**	**203,691,525**

(Source: Thang Long One Member Limited Liability Company)

3.2. Receiving the initial information on payable provision in Dong Bac Corporation

3.2.1. For the payable provision of construction works warranty costs

Mining Industry Construction Company - Branch of Dong Bac Corporation has expected the building works to be damaged due to construction and installation errors detected during the warranty period of construction products, is calculated at the rate of 0.2% with the settlement value of construction works.

In order to determine the value of this provision, which is also used as a basis for accounting, the Company has collected documents such as economic contracts, decisions on setting up the provision for construction works warranty, the table of total quantities, settlement of works and List of the provision for construction work warranty.

3.2.2. For the payable provision of environmental reimbursement costs

The units will be based on each approved coal mining project's environmental rehabilitation and restoration scheme to determine the amount to perform environmental rehabilitation and restoration.

For projects that have been put into operation, the units determine the remaining coal output of the project at 01/01/2016 as a basis for making deductions. For new projects, coal output under the project's approval decision is the basis for setting up.

After that, the units determines the actual mining output in the period through the Acceptance Report. Table 5 shows the information on the actual 2019 catches of projects in each member unit of the Dong Bac Corporation.

Table 5. Information about the operation of mining licenses of Dong Bac Corporation in 2019

No.	The mining license	The mining unit	Name of project	The licensed reserves		The remaining reserves until 31/12/2019	The wattage	The actual mining production in 2019 (Ton)	The remaining years are exploited
				Geological (Ton)	Industry (Ton)				
1	No. 3197/GP-BTNMT 30/12/2014	35 Co.,Ltd	Tay Nam Khe Tam 35 project below -50	1,607,317	1,088,621	455,680	underground mining: 200,000 T/year	204,449	5 years
2	No. 792/GP-BTNMT (Extension of No. 2707/GP-BTNMT 29/12/2008)		Tay Bac Nga 2 35 project	1,407,746	1,126,197	574,472	underground mining: 300,000 T/year	304,973	4 years
3	No. 2800/GP-BTNMT 31/12/2008	86 Co.,Ltd	Nam Khe Tam 86 project	14,241,20	10,087,500	8,810,610	underground mining: 600,000 T/year	560,020	5 years
4	No. 3231/GP-BTNMT 30/12/2014	Minerals Exploiting Co.,Ltd	DongDa Mai - Khe Sim	11,914,779	11,252,317	8,937,109	open-cast mining: 1,500,000 T/year	966,745	4 years
5	No. 3239/GP-BTNMT 25/10/2018		Khe Hum, Bu Lu - Tan Lap Mining	2,413,000	2,290,422	1,650,613	open-cast mining: 500,000 T/year	438,838	6 years

No.	The mining license	The mining unit	Name of project	The licensed reserves		The remaining reserves until 31/12/2019	The wattage	The actual mining production in 2019 (Ton)	The remaining years are exploited
				Geological (Ton)	Industry (Ton)				
6	No. 3119/GP-BTNMT 30/12/2016	397 JSC	Nam Trang Bach Mining	2,149,068	1,954,708	1,279,908	open-cast mining: 500,00 T/year	565,168	3 years
7	No. 2948/GP-BTNMT 19/12/2014	91 Co.,Ltd	Khe Chuoi Mining - 91	8,387,761	5,313,647	6,124,698	underground mining: 500,00 T/year	518,566	10 years
8	No. 3196/GP-BTNMT 30/12/2014	618 Co.,Ltd	Adjustment of the Ho Thien project 618	3,772,000	2,735,000	2,561,801	underground mining: 300,00 T/year	203,303	Gia hạn
9	No. 2823/GP-BTNMT 31/12/2008	Thang Long Co.,Ltd	Dong Quang La- Thang Long Project	1,864,107	1,573,207	1,196,000	underground mining : 150,000 T/year	140,029	1 year
10	No. 2046/GP-BTNMT 05/10/2017 (Extension of No. 2821/GP-BTNMT 31/12/2008)		Tay Quang La-Thang Long Project	1,047,134	680,637	322,691	underground mining: 100,00 T/year	99,902	3 years
11	No. 2543/GP-BTNMT 12/11/2014	45 Co.,Ltd	Dong Ri underground mining Project	9,490,93	7,104,132	6,013,308	underground mining: 800,00 T/year	859,870	7 years
12	No. 2545/GP-BTNMT 12/11/2014; extension No. 2194/GP-BTNMT 29/8/2019		Dong Ri Open-cast project	501,694	501,694	396,608	open-cast mining: 200,00 T/year	149,948	3 years
13	No. 3041/GP-BTNMT 05/10/2018	Khe Sim Co.,Ltd	Tay Khe Sim project	3,496,000	3,461,501	2,576,225	open-cast mining: 500,00 T/year	567,899	9 years
14	No. 3411/GP-BTNMT 28/12/2017	790 Co.,Ltd	Mining underground mine extension at Bac Quang Loi mining Project	8,449,000	6,385,000	8,091,658	underground mining: 500,00 T/year	276,472	17 years
Total				**70,741,73**	**55,554,583**	**48,991,381**		**5,856,182**	

(Source: Dong Bac Corporation)

3.3. Handling payable provision accounting information at Dong Bac Corporation

3.3.1. Method of accounting

The payable provision is made at the date of the consolidated financial statements. The recording of the payable provisions, the use of payable provisions, the reversal of payable provision is made in the member units of Dong Bac Corporation.

+ In case the amount of payable provision to be set up in this accounting period is larger than the amount of payable provision already set up in the previous accounting period, which has not been used up, the difference shall be recorded into the production and business costs of this accounting period.

- An example of providing for construction works warranty expenses of at 31/12/2019; the accountant recorded the provision for construction works warranty costs at Mining Industry Construction Company - Branch of Dong Bac Corporation according to the following entry:

Dr Account 627: 354,247,508 VND

Cr Account 3522: 354,247,508 VND

- An example of setting up environmental reimbursement fee of Company 35 - Dong Bac Corporation, at 31/12/2019, the accountant recorded according to the entry:

Dr Account 627: 7,528,305,219 VND

Cr Account 3524: 7,528,305,219 VND

+ When incurred expenses related to the initially established payable provision, the unit shall use the payable provision to pay.

- An example of environmental reimbursement costs incurred in 2019 at Company 35 - Dong Bac Corporation, the accountants recorded according to the following entry:

Dr Account 3524: 3,736,583,458 VND

Cr Account 111, 112, 152, 214, 331, 334, 338,…: 3,736,583,458 VND

+ In case the amount of payable provision to be set up in this accounting period is smaller than the amount of payable provision already set up in the previous accounting period that not yet used up, the difference must be reversed and recorded as a decrease in production and business costs of this accounting period. If the warranty for construction works expires, if the works are not warranted, or the payable provision for construction work warranty is greater than the actual costs incurred, the difference must be reversed and recognized into other income.

- An example of a reversal of payable provision for construction works warranty in 2018 at Mining Industry Construction Company - Dong Bac Corporation Branch. Upon the warranty period's expiry, the amount of payable provision for construction works warranty was larger than the actual expenses incurred. The difference shall be refunded and the accountant recorded according to the following entry:

Dr Account 3522: 97,912,800 VND

Cr Account 711: 97,912,800 VND

3.3.2. Accounting process

In Dong Bac Corporation, the accounting department was built, including the accounting department at the office of the Corporation and accounting department at member units. The accounting makes the recording of the payable provisions, the use of payable provisions, the reversal of payable provision of member units based on accounting vouchers. At the member unit, the accountants record the entries about payable provision into the accounting book of account 352, including details of arising account 352 and a detailed book about a surplus of account 352 (Table 6). At the end of the accounting period, they transfer the accounting books of account 352 to the Corporation's office for accounting at the Corporation's Office into the Criteria of Payable Provision on the consolidated financial statements (column 6, Table 1). For example, in 2019, it was 90,744,431,142 VND (ending surplus on the Consolidated Balance Sheet in 2019).

Table 6. Some detailed reports of payable provision at member units of Dong Bac Corporation in 2019

Unit: VND

DONG BAC CORPORATION

35 LIMITED COMPANY

DETAILED PAYABLE PROVISION ACCOUNT - ACCOUNT 352 AT 31/12/2019

No.	Explain	Surplus	
		Debit	Credit
1	Establishing fund for environmental improvement of Tay Bac Nga 2 coal mine		2,205,803,812
2	Establishing fund for environmental improvement of Tay Nam Khe Tam coal mine		2,887,103,407
3	Establishing fund for environmental improvement of Tay Bac Khe Tam coal mine		2,435,398,000
	Total		**7,528,305,219**

DONG BAC CORPORATION

86 LIMITED COMPANY

DETAILED PAYABLE PROVISION ACCOUNT - ACCOUNT 352 AT 31/12/2019

No.	Explain	Surplus	
		Debit	Credit
1	Provision for expenses for rehabilitation and restoration of an underground environment		5,100,743,514
2	Provision for expenses for rehabilitation and restoration of an open-cast environment		6,368,567,000
	Total		**11,469,310,514**

DONG BAC CORPORATION

397 JOINT STOCK COMPANY

DETAILED PAYABLE PROVISION ACCOUNT - ACCOUNT 352 AT 31/12/2019

No.	Explain	Surplus	
		Debit	Credit
1	Reversal cost of 9a.9b project		1,167,156,356
2	Reversal cost of Nam Trang Bach project		5,504,159,589
	Total		**6,671,315,945**

(Source: The member units of Dong Bac Corporation)

3.4. Presentation of information about the payable provision on corporate financial statements

Dong Bac Corporation presents the Notes' payable provisions to the consolidated financial statements on each type of payable provision according to the following items:

+ The surplus at the beginning and end of the period;

+ The number of provision increases due to the additional provisions in the period, including the increase of existing provisions;

+ The amount of provision decreased due to the expenses related to that provision that was made in the beginning;

+ The unused provision is recorded decrease (reversal) in the period;

+ The amount of provision increased in the period due to the present value of the provision increased over time and due to the impact of changes in the discount rate of cash flow.

The author has summarized data on the payable provisions of Dong Bac Corporation in 2017 - 2019 in Table 7.

Table 7. The payable provisions were on the consolidated financial statements of Dong Bac Corporation in 2017 - 2019

Unit: VND

Criteria	Provision for environmental reimbursement costs	Provision for warranty costs	Total
1. At 1/1/2017	*76,860,420,235*	*398,345,206*	*77,258,765,441*
2. Increase in 2017	20,710,079,609		20,710,079,609
3. Use in 2017	-56,764,674,768		-56,764,674,768
4. Reversal of unused provisions in 2017		-14,831,397	-14,831,397
5. Adjusted due to cash flow discount in 2017			
6. At 1/1/2018	*40,805,825,076*	*383,513,809*	*41,189,338,885*
7. Increase in 2018	82,566,285,479		82,566,285,479
8. Use in 2018	-58,364,836,485		-58,364,836,485
9. Reversal of unused provisions in 2018		-97,912,800	-97,912,800
10. Adjusted due to cash flow discount in 2018			
11. At 1/1/2019	*65,007,274,070*	*285,601,009*	*65,292,875,079*
12. Increase in 2019	108,735,573,402	354,247,508	109,089,820,910
13. Use in 2019	-83,638,264,847		-83,638,264,847
14. Reversal of unused provisions in 2019			0
15. Adjusted due to cash flow discount in 2019			
16. At 31/12/2019	*90,104,582,625*	*639,848,517*	*90,744,431,142*

(Source: Dong Bac Corporation)

4. CONCLUSIONS AND RECOMMENDATIONS

Thus, in general, the accounting of payable provisions at the Dong Bac Corporation has complied with the Vietnamese Finance Ministry's regulations on the conditions for recording, determining the value of the provisions, initial information collecting, information process, and accounting information presenting.

However, Dong Bac Corporation needs to consider setting up some other provisions such as provision for the restructuring of enterprises, provision for large risk contracts. Because in the period of implementing the policy of equitization, divestment, restructuring State-owned enterprises, it is possible to incur expenses for restructuring enterprises in the member units of Dong Bac Corporation. In addition, in the context of a highly competitive and complicated market economy, the provisioning of large risk contracts should also be considered for implementation by Dong Bac Corporation.

In particular, expenses are provided for the restructuring of enterprises when they meet both conditions:

- Required for restructuring activities.

- Unrelated to the regular activities of the business.

Conditions for setting up high-risk contracts provision: The provision may only set up for contracts with high risks in cases where the obligatory expenses for fulfilling obligations related to the contracts are larger than the economic benefits that the contract brings and meet the following three conditions:

- The enterprise has a current debt obligation (legal or committed obligation) as a result of an event that has occurred;

- A decrease in economic benefits may occur, resulting in a payment of debt obligations;

- The value of that debt obligation is a reliable estimate.

At the time of preparing the Financial Statements, Dong Bac Corporation's companies made payable provision for high-risk contracts and payable provision for the restructuring of enterprises based on the payment of debt obligations. These expenses are recorded in general and administration expenses.

In addition, in order to the accounting of payable provisions contributes to a more accurate reflection of the reality of the business, the decision to set up provisions must be based on reliable evidence submitted by good managers, at the same time, determine the right object and the level of provision. Therefore, the in-depth studying and perfecting the accounting regime on the accounting of payable provision in enterprises is very necessary. In the legal documents system on the provision, there is a lack of guiding documents for implementation. Currently, the Vietnamese Financial Ministry has just issued Circular 48/2019/TT-BTC which only guides how to set up provisions for product and goods warranty expenses and provision for construction works warranty expenses, replacing Circular 228/2009/TT-BTC. The remaining types of payable provisions have no guidance for implementation. The methods of determining the value of each type of provision are also not specified. Therefore, the Vietnamese Financial Ministry needs to improve the legal documents system to enable businesses to implement payable provisions in practice easily and in accordance with regulations.

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APPLYING MARKET APPROACH FOR MEASURING THE VALUE OF TAY NAM DA MAI JOINT STOCK COMPANY

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Abstract: *According to the restructuring project for Vietnam National Coal - Mineral Industries Holding Corporation Limited (Vinacomin), six companies will carry out the consolidations in the period 2017-2020. The Prime Minister of Vietnam approved this project in 2017, however, the business consolidations have not been implemented so far. The consolidation process has encountered many obstacles, such as difficulties in arranging labor and measuring the value of the two consolidated enterprises. In 2020, Vinacomin intends to carry on arranging Tay Nam Da Mai Joint Stock Company (JSC) and Cao Son Joint Stock Company. This article aims to recommend the market approach with a wide range of suitable valuation enterprises method to promote the restructuring process in Vinacomin.*

Keywords: *Valuation, Vinacomin, income approach, market approach.*

1. INTRODUCTION

Business valuation is a much controversial topic in the world but in Vietnam there are not many studies on this topic. In general, we can define business valuation is the process of calculating the economic value of a whole company. The estimation to find out the fair value of a business is useful for a variety of purposes such as merging, funding and litigation purpose. Since 2000, mergers and acquisitions have overgrown, up to 790,000 transactions with a known value of over US$ 57 trillion according to The Institute for Mergers, Acquisitions and Alliances. Calculating the fair value of the company is necessary for these merger and acquisition transactions as the owners and buyers need to set a suitable price. It can also bring involved parties with the final values that might encourage them to invest or to reconsider. An independent valuation will help the company in raising capital from the lenders, prospective investors. For the aim of ensuring the creditworthiness of companies, an individual loans package usually requires an objective business appraisal file (Frykman et al., 2003). To purchase and sell securities in the stock market, it is necessary to shareholders to value the business to avoid the disputes over the value of the shares.

2. BUSINESS VALUATION APPROACHES

In theory, there are several methods of business valuation which can be divided into three approaches: asset approach, income approach and market approach (Palepu, 2013; Schmidlin, 2014; Fabozzi, 2011). The asset approach encompasses a variety of methods such as book value method, adjusted book value method and liquidation method. In this approach, the value of a company is based on the assessment of present assets and liabilities. Meanwhile the income approach for valuation mainly focuses on the discounting of the expected cash flow to present value. The two primary methods of the income approach to valuation are the Discounted Cash Flow Method and Discounted Economic Profit Method. Finally, the market approach relies on relative valuation, including the Comparative Analysis method and the Precedent Transaction method.

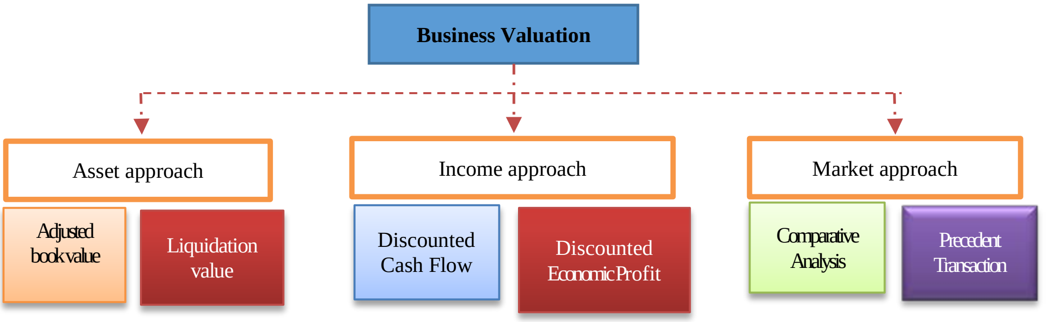

Fig 1. Valuation approaches and basic methods.

2.1. The asset approach in business valuation

An asset-based business valuation is a method of valuing the subjected company by totaling the value of all the assets minus liabilities. The assets and liabilities are recorded at fair market value. Two potential limitations on the application of this approach are: (1) the difficulties in measuring both assets and liabilities; (2) the disappearance on the balance sheet of the internally generated asset due to the relevant accounting standard. Although less widely used than the income approach or the market approach, this approach is a generally accepted business valuation.

Adjusted Book Value

All balance sheet items are adjusted to fair market value, hence, the differences between the adjusted assets of the company and its adjusted liabilities are the value of the company as below:

Net asset value = Adjusted assets - Adjusted Liabilities (1)

Liquidation Value

This method is generally applied for valuing the industrial companies. To calculating the liquidation value of the company, the following formula is used:

Liquidation Value = The liquidation of Assets of the company - The value of liabilities - Liquidation cost (2)

2.2. The income approach in business valuation

The fundamentals of the income approach are that a company or a stock has an intrinsic value that can be determined based on the expected economic benefits -generally cash flow. Williams (1938) developed a theory for determining the value of a stock based on the idea of discounting a constant stream of dividends -the future cash flows that shareholders would receive. With the same manner of converting the expected economic benefits to the present value using an appropriate discount rate or discounted factor, the value of the subjected company is calculated . The discount rate reflects the time value of money and the risks allocating to these cash flows. “This approach overcomes the limitation of assets -based on approach, which ignores the firm’s prospects of future earnings and ability to generate cash in business valuation” (Khan M.Y., 2014).

Discounted Cash Flow Method

Many researchers supposed the discounted cash flow method is the most accurate and flexible method for valuing a project, divisions and companies (Koller, Goedart and Wessels, 2005; Fernandez P, 2013). The discounted cash flow method is widely admitted by economists (Kaplan and Ruback, 1995) and for this reason, this method is a good standard to compare to the assets approach result. By applying this method, the target company value can be determined by using an appropriate rate of return to discount the future cash flow. Then the value of a company can be defined as in (3):

$$Value = \sum_{t=1}^{n} \frac{CFt}{(1+i)^t} \quad (3)$$

Where, CFt - Cash flow in the future period

i - the discount rate (the rate of return)

Many studies for the question of usable cash flow and discount rate have been published. According to Fernandez (2007), by using a discounting cash flow technique when valuing a company, we can divide the discounted cash flow method into ten common models. In general, for the differences in cash flow and discount rate, the discounted cash flow method has many models to value, as showing in Table 1.

Table 1. Summary of discounted cash flow method

Model	Measure	Discount Factor	Formula
Firm discounted free cash Flow	Free cash flow to firm (FCFF)	Weighted average cost of capital (WACC)	FCFF = EBIT * (1- tax rate) + Depreciation - Capital expenditures - Changes in Working capital (4) WACC = $\frac{D}{E+D} k_d (1-T) + \frac{E}{D+E} k_e$ (5) Where: D, E: market vulue of debt, equity; k_d: the cost of debt; k_e: rate of return on equity; T: tax rate
Equity cash flow	Cash flow to equity (ECF)	Required return on equity (levered cost of equity)	ECF = FCFF + ΔD - I.(1-T) (6) Where: ΔD is the increase in debt; I is the paid interest.
Adjusted present value	Free cash flow (FCF)	Unlevered cost of equity	$WACC_{BT} = \frac{D}{E+D} k_d \ \frac{E}{D+E} k_e$ (7)
Capital cash flow	Capital cash flow (CCF)	Unlevered cost of equity (WACC before tax)	CCF=ECF - ΔD + I = FCFF + I. T (8)

Discounted economic profit (economic value added)

According to Stern and Stewart (1995), this method can supply information to make better decisions in both long -term and short - term because it also gives a useful insight of company. The value of the company can be calculated as followings:

$$Value = \sum_{t=1}^{n} \frac{EAV}{(1+WACC)^t} + \frac{EAV_x}{(1+WACC)} \quad (9)$$

Where: EAV- economic value added and calculated by deducting the Net operating profit less adjusted tax (NOPLAT) with capital charge (Makelainen, 1998) as formula below:

EAV = NOPLAT - (D+E).WACC (10)

2.3. The market approach in business valuation

While the income approach estimates the intrinsic value of a company based on its ability to generate cash flow/economic profit in the future, the market approach measure by comparing the current value of a business to other businesses. For comparison, these companies must be in the same industry or have the same size or/and within the same region, thus, they have similar quantitative and qualitative characteristics.

Comparative Analysis Method

The Comparative Analysis method uses ordinary shares' prices of comparable firms to establish pricing multiples that may be applied to the subject (target) enterprise. It can be challenging to apply this method to companies that are diversified in operations or small businesses that they do not have a sufficient number of similar entities.

The pricing multiple is calculated by dividing the comparable enterprise value by an economic variable as formula (11):

$$M = \frac{EVc}{Ec} \qquad (11)$$

Where: M: multiple

EV_c: comparable enterprise value

E_c: comparable economic variable.

An economic variable can be chosen, such as Ebit (Earnings before interest, tax), Ebitda (Earnings before interest, tax, depreciation and amortization), Earnings, revenues, assets book value, cash flow. Hence the multiples can be divided into two groups: (1) Enterprise value (EV) multiples concern the company's performance from the view of all investors (equity investors and debt lenders) as well as the whole capital structure of a company (equity and debt). Common EV multiples include EV/Ebit, EV/Ebitda, EV/Sales, EV/FCF; (2) Equity value multiples base on the company's performance from the view of shareholder as well as the equity portion of the capital structure. Equity value multiples are P/E (Price to Earnings), P/B (Price to Book Value). Almost common economic variables are related to economic profit but according to Lie, E. and Lie, H. J (2002), Ebitda are among the most satisfactory variables.

Kim and Ritter (1999) concluded that "there is no clear-cut answer for which multiples should be used". Similarly, both Lie, E. and Lie, H. J (2002) stated that the estimated value varies differently depending on which multiple are chosen. Hence, selecting the multiple is also of great importance and a combination of multiples might perform better than individual multiples.

Precedent Transaction Method (Comparative Transaction Method)

According to this method, the value of the companies sold in previous merger and acquisition transactions are used to assess a target company today. Both precedent and target companies should possess the similarities, such as relevant sector, same size, growth and profitability. The weaknesses of this method derive from the lack of sufficient transactions and outdated information. Because of these disadvantages in applications, the Precedent Transaction method is not widely used.

3. THE REALITY OF DETERMINING THE VALUE OF COMPANIES FOR CONSOLIDATING BUSINESS IN VINACOMIN

According to the Restructuring Project for the period 2012-2015, which was approved by the Prime Minister under Decision No. 314/QĐ-TTg in 2013, Vinacomin merged Viet Bac Geological Co., Ltd. into Vinacomin Mining Geological Co., Ltd. Consequently, the consolidation continued to comply with the Prime Minister's approval of restructuring for the period 2017-2020 in Decision 2006/QĐ-TTg. As a result, Hon Gai Logistics Branch was merged into Hon Gai Coal Branch, Hong Thai Coal Branch was merged into Uong Bi Coal Company, consolidating the Pit Construction Branch No.1 and The Pit Construction Branch No.2 to establish the Mining Installation Construction Branch.

Table 2. The summarized result of mergers and consolidation in Vinacomin period 2013-2019

Merger/Consolidation	**Result**	**Approach of valuation**
Merging Companies: + Viet Bac Geological Co., Ltd. + Vinacomin Mining Geological Co., Ltd	Viet Bac Geological Co., Ltd stopped existing	Asset approach
Merging Branches: + Hon Gai Logistics Branch + Hon Gai Coal Branch	Hon Gai Logistics Branch stopped existing	Asset approach
Consolidating Branches: + The Pit Construction Branch No.1 + The Pit Construction Branch No.2	The Pit Construction Branch No.1, The Pit Construction Branch No.2 stopped existing New Branch: Mining Installation Construction Branch	Asset approach
Consolidating Companies: + Cao Son Coal JSC + TNDM Coal JSC	Not yet implemented; just signed consolidated terms	

(Source: Vinacomin, Report on the implementation of restructuring in 2014, 2015, 2016, 2017, 2018, 2019)

Decision 2006/QĐ-TTg also stated that the consolidation for 6 mining companies such as Cao Son Coal JSC and TNDM Coal JSC, Coc Sau Coal JSC and Deo Nai Coal JSC, Nui Beo Coal JSC and Ha Lam Coal JSC are required. However, the consolidation of these organizations, which Vinacomin holds more than 65% of charter capital has not been conducted. By the end of 2019, the consolidated terms between Cao Son Coal JSC and TNDM Coal JSC have been signed with details as follows:

(1) Cao Son Coal JSC vs TNDM Coal JSC will be consolidated into a completely new company named Hop Nhat company and they cease to exist. All of the assets and liabilities of the two companies will belong to the new one.

(2) The Hop Nhat company charter capital is 428,467.73 million VND (corresponding to 428.467.730 shares) by totalling the charter capital of Cao Son Coal JSC and TNDM Coal JSC.

(3) The estimation of the equity of Cao Son Coal JSC and TNDM Coal JSC will be mainly based on the assets approach. After that, the stock exchange ratio will be defined as the following:

$$SE_{CS} = \frac{E_{CS}}{E_{CS} + E_{TNDM}} x\ Total\ stocks\ of\ Hop\ Nhat\ company \qquad (12)$$

$$SE_{TNDM} = \frac{E_{TNDM}}{E_{CS} + E_{TNDM}} x\ Total\ stocks\ of\ Hop\ Nhat\ company \qquad (13)$$

Where: SE_{CS}: The number of stocks of Hop Nhat company issue to swap for stocks of Cao Son Coal JSC

SE_{TNDM}: The number of stocks of Hop Nhat company issue to swap for stocks of TNDM Coal JSC,

E_{CS}: The value of equity of Cao Son JSC based on the asset approach,

E_{TNDM}: The value of equity of TNDM JSC based on the asset approach,

$$\%\ The\ stock\ exchange\ ratio\ of\ Cao\ Son = \frac{SE_{CS}}{Total\ outstanding\ stocks\ of\ Cao\ Son\ Coal\ JSC} \quad (14)$$

$$\%\ The\ stock\ exchange\ ratio\ of\ TNDM = \frac{SE_{TNDM}}{Total\ outstanding\ stocks\ of\ TNDM\ Coal\ JSC} \quad (15)$$

From the business valuation in Vinacomin summarized in Table 2, some issues can be seen as following:

Firstly, according to Vietnam Valuation Standards, the equity of a company can be assessed by the assets approach and the income approach. The valuation in the process of these mergers and consolidations mainly used the assets approach owing to its conveniences (Table 2). This approach can cause the improper value of the target companies because the calculation process did not mention the mineral exploration license or intangible resources as goodwill and high-quality labor force.

Secondly, although the income approach has more advantages, the application of this one encounters many problems such as the difficulties in forecasting earnings and cash flows as well as calculating the discounted factor. Moreover, the mergers and consolidations in the period 2013-2019 are mainly among branches or limited liability companies. Therefore, the information was not sufficient to apply the income approach.

4. PROPOSAL FOR APPLICATION OF THE MARKET APPROACH IN VALUING COAL MINING COMPANIES - THE CASE STUDY OF TAY NAM DA MAI JOINT STOCK COMPANY

Theoretically, all three approaches can be applied in business valuation. Still, the assets approach has drawbacks such as difficulty in measuring intangible resources and disregarding the prospective earnings of the company. Meanwhile, the income approach provides the intrinsic value of the target company compared to the two approaches, it requires a lot of prediction. Therefore, it is necessary to use the market approach in estimating the value of companies in Vinacomin that are going to be consolidated. The application of the market approach, along with other approaches, will bring into wide range of value. Hence, the authorities could have enough information to make a suitable decision for consolidating with the aim of not losing the a stated-owner shares.

The market approach contains two methods: Comparative Analysis Method and Precedent Transaction Method (Comparative Transaction Method). The data in Table 2 stated that in the period 2015-2019, there was not any merger and acquisition transactions of coal mining companies that have similar characters to those in Vinacomin. For this reason, the Comparative Analysis Method is more appropriate and the authors analyzed for the case study of TNDM JSC. The process of applying the Comparative Analysis Method is illustrated with the following steps:

Steps 1: Selecting the companies that are comparable to TNDM JSC.

The first basic guideline for applying this method is that the selected companies must have similarities to the subject company in operational processes, supply, and demand factors. Besides, it is necessary to consider the comparability of other financial ratios among these companies and TNDM JSC. These financial ratios include, but not restricted to:

- Ratios reflex the scale of the companies such as: Sales and Charter Capital

- Ratios reflex the profitability of the companies such as: Gross Profit, Return on Equity (ROE) and Return on Assets (ROA)

The coal mining companies in Dong Bac Corporation do not have similar characters to TNDM JSC as they are limited liability companies. Hence, from viewpoint of the authors, the eight exploring joint-stock companies in Vinacomin are suitable for determining comparable companies.

Table 3. The comparison for financial ratios of comparable companies to TMDM JSC

Parameters	**TNĐM**	**Ha Lam**	**Cao Son**	**Coc Sau**	**Vang Danh**	**Mong Duong**	**Đeo Nai**	**Nui Beo**	**Ha Tu**
Sales (billion VND)	3,035.20	3,155.00	6,184.60	3,557.60	4,545.50	2,077.00	3,450.10	2,435.00	2,448.50
Charter Capital (billion VND)	160.00	254.15	268.47	324.96	449.63	214.18	294.39	369.99	245.69
Gross Profit (billion VND)	241.9	479.85	305.36	166.72	438.27	235.97	249.73	383.38	231.651
ROE (percent)	23.38	13.18	58.57	7.68	10.12	8.10	4.90	14.76	18.33
ROA (percent)	5.25	1.04	9.29	1.54	1.76	1.46	1.46	2.59	6.71
Conclusion		**Comparable**				**Comparable**		**Comparable**	**Comparable**

(Source: Authors' calculation from financial statements 2019 of nine mining companies in Vinacomin)

Table 3 illustrates the sales, charter capital, gross profit, ROA and ROE between TNDM JSC and eight other mining joint-stock companies in Vinacomin. From these results, Ha Lam JSC, Mong Duong JSC, Nui Beo JSC and Ha Tu JSC have identical features with TNDM JSC. These comparable enterprises can be selected for comparison when assessing the value for TNDM JSC.

Step 2: Calculating the multiples

The multiples used for the comparison list such as P/E (Price/Earnings), EV/Ebit (Enterprise value/Earnings before interest and tax), EV/Ebitda (Enterprise value/Earnings before interest, taxes, depreciation and amortization), EV/sales. The enterprise value of comparable companies can be calculated as the following formula:

$$EV = \text{Market capitalization} + \text{Preferred Shares} + \text{Market Value of Debt} + \text{Minority Interest} - \text{Cash and Equivalents} \quad (16)$$

Market capitalization is the value of the ordinary share of the company and calculated by multiplying the total outstanding shares by the current share price. The price of shares is consistently chosen the latest closing price on the Hanoi Stock Exchange (HNX). In this article, the authors use the closing price on December 31, 2019. All the comparable companies do not have the Preferred Shares and Minority Interest (Noncontrolling Interest). The market value of debt is unknown so the book value of debt on the audited balance sheet for the year ended December 31, 2019, can be used instead. Using the MS - Excel the authors determine the average (mean) pricing multiples as well as median pricing multiples of peer companies. The results are summarized in Table 4.

Step 3: Calculating the value of TNDM JSC based on market approach.

Table 4. Calculating the average and median pricing multiples of peer companies

Ratios	Ha Lam	Mong Duong	Nui Beo	Ha Tu	Average (Mean)	Median
Sales (billion VND)	3,155.00	2,077.00	2,435.00	2,448.50		
Ebit (billion VND)	355.95	105.65	218.30	99.49		
Ebitda (billion VND)	761.65	243.80	494.02	224.69		
Total outstanding shares	25,415,199	21,418,346	36,999,124	24,569,052		
Share Price at 31/12/2019 (VND)	6,700.00	7,100.00	6,600.00	7,000.00		
Market capitalization (billion VND)	170.28	152.07	244.19	171.98		
EV (billion VND)	3,122.89	1,094.24	3,385.21	1,219.11		
EPS (earnings per share) VND	800.00	1,177.00	921.00	2,654.00		
P/E (Price/Earning)	8.38	6.03	7.17	2.64	6.05	6.60
EV/Ebit	8.77	10.36	15.51	12.25	11.72	11.31
EV/Ebitda	4.10	4.49	6.85	5.43	5.22	4.96
EV/Sales	0.99	0.53	1.39	0.50	0.85	0.76

(Source: Authors' calculation)

Determining the value of TNDM JSC based on average P/E ratio of peer companies:

Market Capitalization of TNDM JSC = Forecasted Profit after tax of TNDM JSC x Average P/E ratio of peer companies (17)

The value of TNDM JSC = Market Capitalization of TNDM JSC + Market Value of Debt (18)

Determining the value of TNDM JSC based on average EV/Ebit ratio of peer companies:

The market value of TNDM JSC = Forecasted Ebit of TNDM JSC x Average EV/Ebit ratio of peer companies (19)

Determining the value of TNDM JSC based on average EV/Ebitda ratio of peer companies:

The market value of TNDM JSC = Forecasted Ebitda of TNDM JSC x Average EV/Ebitda ratio of peer companies + Cash and Equivalents (20)

Determining the value of TNDM JSC based on average EV/Sales ratio of peer companies:

The market value of TNDM JSC = Forecasted Sales of TNDM JSC x Average EV/Sales ratio of peer companies (21)

Hence, using the four average pricing multiples of peer companies in Table 4, the authors assess the value of TNDM JSC. All the results are summarized in Table 5.

Table 5. Estimating the value of TNDM company based on the market approach

I. Financial Data of TNDM JSC	
Forecasted Sales in last three years (billion VND) [1]	2,518.83

Forecasted Ebit in last three years (billion VND) (2)		171.14
Forecasted Ebitda in last three years (billion VND) (3)		370.54
Forecasted Profit after tax in last three years (billion VND) (4)		77.57
Market Value of Debt (billion VND) (5)		940.45
Cash and Equivalents at 31/12/2019 (billion VND)		0.64
II. Estimating the TNDM JSC Value derived from respective multiples	**Mean (Average)**	**Median**
The value of TNDM based on the average P/E ratio of peer companies (billion VND)	1,410.11	1,452.35
The value of TNDM based on the average EV/Ebit ratio of peer companies (billion VND)	2,006.26	1,934.83
The value of TNDM based on the average EV/Ebitda ratio of peer companies (billion VND)	1,932.98	1,836.78
The value of TNDM based on the average EV/Sales ratio of peer companies (billion VND)	2,144.02	1,910.10
III. Final Estimated Value of TNDM JSC (billion VND)	2,026.28	**1,939.40**

Notes: (1), (2), (3), (4) the Forecasted Sales, Ebit, Ebitda, Profit after tax of TNDM JSC is determined by using the moving average predictive method

(5) The authors use the book value of debt on the audited balance sheet of TNDM JSC for the year ended December 31, 2019.

(Source: Authors' calculation)

5. CONCLUSION

The consolidating process among mining companies in Vinacomin encounters obstacles because of different causes in which business valuation is one of the most debatable issues. The application of the assets approach has its limitations; meanwhile, the income approach requires a lot of estimation and prediction. Indeed, coming up with a process that can estimate future corporate value with 100% accuracy is impossible. For all these reasons, it is reasonable to apply the market approach for valuing corporate in Vincomin because it provides an excellent benchmark to compare with the assets approach result as well as the income approach result. However, to improve the efficiency of the market approach, Vinacomin should carefully consider these matters, such as the selection of comparable companies, the forecast of sales, profit after tax, Ebit, Ebitda of the target company. A fair business valuation helps to push the consolidation more rapidly, also helps Vinacomin to reach the goal of protecting the stated-owned equity in the consolidated companies from undervaluation.

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GREEN FINANCIAL POLICIES AND SOME RECOMMENDATIONS FOR THE COAL MINING INDUSTRY IN VIETNAM

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Abstract: *Green financial policy is a policy meant to provide financial support to promote growth in different industries without making negative impacts on the environment, such as decreasing the greenhouse effect and pollution while increasing sustainable production. In Vietnam's case, coal still plays a significant role in providing the main energy source for the whole nation, and other sources of power can't replace it. That is why the coal mining industry still needs to develop to meet the economy's growing demand. In the process of developing the coal industry, it is essential that we minimize environmental impacts. To do this, we need to have feasible policies and solutions to this problem, like the green financial policy for the Vietnam coal industry.*

Keywords: *Green financial policy; the coal industry; Vietnam National Coal - Mineral Industries Holding Corporation Limited.*

1. INTRODUCTION

Green/clean/low-carbon development has been seen as an important direction in many nations' development plan that seeks to grow sustainably. One possible solution to this problem is the green financial policy, which is a financial aid policy that encourages industries to reduce the greenhouse effect and the pollutants released into the environment and pursue a sustainable production process. As of now, Vietnam National Coal - Mineral Industries Holding Corporation Limited (VINACOMIN) and Dong Bac Corporation (DBC) are the two primary producers of coal (up to 95% of Vietnam's total coal quantity). Both of these corporations have applied many environmentally friendly strategies in coal mining. But due to many factors, these strategies do not work up to standards, especially while Quang Ninh province - the main coal-producing region, is carrying out the economic development strategy 'from brown to green'. This article will go through the content of the green financial policy, the experience of some other nations and the reality of Vietnam's coal mining industry, and these serve as the basis to propose the use of the green financial policy in Vietnam's coal industry.

2. THE GREEN FINANCIAL POLICY AND THE EXPERIENCES OF SOME COUNTRIES IN THE WORLD

Nowadays, there are several definitions for green finance, for example:

Green finance is related to diversifying the products and financial services provided by the main financial institutions aimed towards the lasting growth of the nation (UNEP, 2016).

Green finance is the financial supports aimed to have environmentally friendly growth by lessening the greenhouse effect and pollution (Chowdhury and partners, 2013).

Green finance promotes developments using new sources of energy, producing environmentally friendly products and organic produce by using preferential loans for firms, all the while limiting the number of new projects of firms that discharge pollutants into the environment by applying high-interest rates (Xu, 2013).

From the definitions above, we can conclude that green finance is the financial support that encourages the industries that produce a lot of pollution to minimize their impact on the environment and promote the growth of industries that are sustainable and environmentally friendly.

Nations that pursue the green finance policy can gain economic benefits by: (1) increase energy efficiency in the production process, save on the input materials, and create a competitive advantage for the product and the environmental service; (2) minimize the environmental impacts made by the manufacturing industries, especially the mining and mineral processing industry. Furthermore, the green financial policy also helps the economy develop the potentials for new industries like eco-tourism, organic agriculture, renewable energy, public transportation, green industry, environmental services, etc. This will broaden the job opportunity for labor.

Different places in the world have different approaches to developing green financial policy. The differences are due to the economic condition as well as the characteristics of the financial market, and these approaches provide useful lessons for the nations that follow, and that includes Vietnam. We will go through three examples: England - a developed country, China - a country that experienced outstanding growth in recent years, and the Philippines - a country quite similar too Vietnam.

+ *The experiences of England:*

The British Government plays a critical role in establishing green financial markets. Their commitment to developing the green financial system was included in the general economic development strategy; the Government also directly participates in the green capital's mobilization.

First of all, the Government builds a framework for a simple green financial policy system, which helps with the application process, as well as the revision and adjusting process. In order to attract investments from institutional investors and independent organizations, the British Government has come up with solutions to simplify the investing process, support in risk management and develop skills for environmental projects. The Government also regularly assesses the process of converting into the green economy model in order to make appropriate and timely adjustments. Thanks to that, the British Government has managed to build an accessible investment environment and attract investment from inside and outside of England.

Secondly, the British Government itself invests in the green economy area to promote actual implementations of the policy. In specific: (i) establish a direct investment system for the green investment projects; (ii) the Government guarantees for the green infrastructure projects and sponsor the environmental protection funds. By doing this, they build a stable funding stream into the green industries and help them develop sustainably. Even though the capital investment from the Government accounts for a small portion, it plays a very crucial role in encouraging the actions of independent firms. According to the assessment of UNESCAP, a Government's investment worth of 10 billion USD towards climate change can call for 50-150 billion USD worth of investments from independent firms.

Thirdly, the green investment bank is established to raise funds for the green infrastructure projects that the market can not afford. The main investment sectors of this type of bank are renewable energy, transportation, water and waste processing, etc. By establishing the Green investment bank, the Government can promote private investments into the green projects, and in turn, they speed up the process of converting into the green economy. The Green investment bank has attracted 18 billion USD worth of investment in the fiscal year of 2015-2016.

The Government's actions mentioned above lowers the risk and increases the chances of receiving the anticipated return rates for the projects' private investors. And thus, they created the chance for the green economy to grow and for the green projects to spread their influence.

+ *The experiences of China:*

According to the People's Bank of China (PBoC), China needs about 320 billion USD worth of investment each year to protect this country's environment. However, the state budget can only meet 15% of the requirements. That is why, in 2015, the Green financial market program was created in order to build a stable green economy. This program focuses on the following points: (i) create a financial mechanism that encourages green investments; (ii) build investment institution meant to carry out investment activities and green loans; (iii) provide green products and green sponsorships; (iv)ensuring the effective use of the public finance to encourage the stream of private finance; (v) establishing information infrastructure to aid the investors in assessing the environmental impact on the investments. The Government makes detailed implementation plans for each stage of the Green financial market program.

In order to promote the growth of green bonds, PBoC has allowed financial institutions to issue "green bonds" on the interbank market. By doing this, they will increase the amount of investment into green projects and promote the process of converting the economy into a green one. The conditions to issue green bonds are not difficult to fulfill, the procedures are easy to carry out and this helps encourage the growth in the scale of the market. The rules for the green bonds are quite flexible (you are able to repurchase bonds from another person, the interest rate can be agreed between the two parties, etc). There is a variety of 6 investment sectors (1) Energy-saving; (2) Control and prevent pollution; (3) Preserve and create recycle resources; (4) Clean transport; (5) Clean energy; (6) Protecting the ecosystem and adapt to climate change, and within that, there are 31 sub-sectors.

Thanks to the actions above, the amount of green bonds issued in China has dramatically increased from over 1 billion USD (2015) to 36 billion USD (2016). In June of 2017, China has issued another 11,52 billion USD of bonds, which amounts to more than 20% of the globe's total green bond. In 2019, China became the biggest green bond-issuing country globally, with a total of 93 billion USD worth of green bonds (which takes up 22% of the global market), and the financial banks issued 2/3 of that amount.

+ *The experiences of the Philippines:*

The Philippines develop their green finance by maximizing the support from an international financial institution like the International Finance Corporation (IFC), the World Bank (WB),... and form big banks that supply the products of green finance under the form of selling to other banks. And because of this, financial banks have considerably contributed to the growth of green finance in this nation. In specific: (i) DBP Bank collaborates with JICA to carry out the credit program that supports the environmental technology; they collaborate with KfW to carry out the solid waste processing program, and they collaborate with the WB to carry out the countryside electricity project approved in 2003 as part of the global environmental protection program. (ii) BPI Bank carries out the sustainable energy finance program with the help of IFC. The financial provision program for the investments into technological projects is meant to help increase the efficiency of production, distribution and energy use.

The enthusiastic participation of the financial banks comes partly from the benefits they gained from the green financial projects: (i) they can access a rare long-term capital; (ii) Deposit rates are lower than market rates, and the financial banks can supply their customers with attractive products and thus attract new customers; (iii) the reputation of the financial banks is heightened considerably when they work with international organizations, this is also a way to advertise at a low cost; (iv) the banks has a lower risk of bankruptcy, especially in the back credit guarantee business, or get back-to-back collaterals.

In general, every country's green financial policy all offer incentives on mechanism and policies for the green projects to lessen the impact on the environment.

3. THE STATE OF THE GREEN FINANCIAL DEVELOPMENT IN VIETNAM

The green financial policy in Vietnam was build right after the issuance of Decision No. 403 / QĐ-TTg dated March 20, 2014, of the Prime Minister on the National Action Plan on Green Growth for the period of 2014-2020. The Ministry of Finance has constructed a development direction for the green finance market according to Decision number 2183/QĐ-BTC about the Financial sector action plan for the National strategy for the green growth until 2020 from 10/2015 (Decision 2183). On this basis, the specific laws and regulations issued are the Circular number 155/2015/TT-BTC, Decree 95/2018/QĐ-BTC. Decision 2183/QĐ-BTC is a background document in developing the green capital market in Vietnam, and it also identifies the responsibility of the state financial management agencies: (i) The Ministry of Finance continue to increase the products of the green capital market like green bonds, government-issued and local government-issued bond that is aimed at supporting the green projects, green index, sustainability index, carbon index, Green investment certificates issued by investment funds; (ii) The State Securities Committee (UBCKNN), the Facility of Exchange researched to create a green financial framework for capital markets: issuing regulations and conditions when listing stocks (green listing), reporting (in sustainability reports) and in monitoring (according to green financial criteria). From that, the system of documents guiding the implementation has been built. It is possible to assess that the green financial market in Vietnam is still in its infancy. The market activities are mainly at the inception stage. The green bond market is in the stage of pilot implementation and advertising programs, introducing green bonds to the entities on the market. The green equity market was launched and strongly implemented by putting into operation the VNSI index simultaneously with regulations requiring listed enterprises to provide information about the environment, society and the community.

In particular, on August 7, 2018, the State Bank issued Decision No. 1604 on approving the Scheme on the development of green banks in Vietnam, in order to enhance the awareness and social responsibility of the banking system with the protect the environment, fight against climate change, step by step greening banking activities, directing credit capital into financing environmentally friendly projects, etc.

Thus, the framework for green finance in Vietnam is gradually being formed and the financial system has actively participated in the greening campaign of the economy, but now mainly applies "green credit". In the banking sector, in particular, 19 credit institutions (CIs) have developed a social environment risk management strategy, including 13 credit institutions that integrate social environment risk management content into the process. In "green credit" activities, ten credit institutions have built bank credit products for "green credit", 17 credit institutions have used a manual of social-environmental risk assessment for ten economic sectors.

As of 2019, the financial investment in the green finance sector of the banking sector has had 20 credit institutions providing green credit loans with outstanding loans of VND 242,000 billion, up 2% compared to 2018, including medium and long-term loans approximately VND 188,000 billion, a short-term loan is VND 54,000 billion. The main subjects of lending in rural agriculture are VND 131,000 billion, loans for sustainable urban management are VND 31,000 billion, sustainable forestry loans are VND 13,600 billion, and renewable energy loans just over VND 8,000 billion. Also, as of 2019, the credit balance assessed according to social-environmental risks will reach nearly VND 314,000 billion, of which short-term loans will be VND 138,000 billion.

4. POLICY OF GREEN FINANCIAL FOR DEVELOPMENT OF VIETNAM COAL MINING

4.1. Role and orientation of Vietnam coal mining

The adjusted planning for the development of Vietnam coal mining until 2020, the prospect to 2030 (approved by decree 403/2016/QĐ-TTg on 14/3/2016 by Prime Minister - acronym QH 403/2016) has determined the target for developing the Vietnam coal mining into a development industry with high competitive potential, advanced technologies for producing enough coal for national need, especially for producing electricity.

In this QH 403/2016, the need of coal for the national economy is increasing, specifically, until 2020: 86.4 million tons; to 2025 is 121.5 million tons; to 2030 is 156,6 million tons; in which coal demand for electricity in 2020 is 64.1 million tons, in 2025 is 96.5 million tons; in 2030 is million tons. The increased coal demand of the national economy in general and for producing electricity shows that the coal industry still has an important role in ensuring national energy security. With the limited ability of hydroelectricity, oil and gas resources strongly decline; the project of nuclear power has been stopped; the recycled energy, such as wind and solar energy has limited capacity due to the dependence on the weather (the average number of operating hours is about 2000 hours/year and unstable, only operating in the conditions of sunlight and wind). Therefore, coal cannot be replaced by other energy and continues to develop to meet the increased demand of the national economy. In the next development stage, the Vietnam coal industry should take care of the reduction of pollution and bad effects on the environment. To do that, the policy, suitable solutions, and the policy of green finance for Vietnam coal industry should be issued.

4.2. Environmental problems and protection activities in Vietnam coal mining

According to the strategic environmental report of coal mining planning 403/2016, the main environmental problems arises when implementing the coal mining planning include:

- Water pollution.
- Solid waste and land appropriation.
- Air pollution.

- Landscape change.

- Environmental incidents and natural disasters.

- Affecting ecosystems and reducing biodiversity.

One of the most serious environmental pollution in surface coal mining is the dumping of waste rock. The summary of waste rock volume in areas following coal mining planning QH 403/2016 presents in Table 1.

Besides, at the Quang Ninh coal area, the wastewater from coal mining is about 1.9 to 2.1 m^3/ton raw coal. Totally, there are about 100 million m^3 of wastewater discharged from the mines.

Be aware of the dangers from environmental pollution from coal mining, Vietnam national coal-mineral industries holding corporation limited (TKV) has been carrying out many solutions for protecting the environment, such as:

- Planning, rearranging the infrastructure for production works, paying tens of thousands of billions VND for dismantling, moving factories, plants, storages, harbors, railroads and production units, from the center of the urban, crowed area, land transferring to local governments for extending or developing new urban areas, from that, improving the environmental quality, landscape of areas near coal mining areas.

Table 1. Sumary of waste rock volume following coal mining planning QH 403/2016

Area	**Total, 1000 m^3**	**Waste rock volume, 1000 m^3**			
		2016÷2020	**2021÷2025**	**2026÷2030**	**After 2030**
Total	**4,011,565**	**1,336,029**	**1,069,856**	**562,890**	**1,042,790**
Uông Bí area	263,119	95,074	62,198	38,900	66,947
Hòn Gai area	679,071	402,545	276,526		
Cẩm Phả area	2,172,451	742,125	613,202	401,310	415,814
Nội Địa area	896,924	96,285	117,930	122,680	560,029

(Source: Coal mining planning QH 403/2016)

- Environmental renovation, growing of trees for greening more than 1000 ha of the waste dump, closing mining area; some mining areas which are near urban areas, residential area, TKV is fast greening in 2 to 3 years with a high density of trees. Mostly, the waste dumping is discharging with low bench ≤15m to reduce the risk of erosion, dust.

- Building dams at the toe of waste dumps for preventing landslide, ensuring the safety of residential areas and the environment. Renovating, dredging the drainage systems for preventing alluvial soil which causes the risk of flooding for residential and downstream areas. There were more than 400 households moved out of the risk areas of landslides or flooding in Quang Ninh province.

- Building and operating 50 mine wastewater treatment stations with a total capacity of more than 150 million m^3/year, this meets the requirement for treating the amount of wastewater arising from mining following environmental standards. The coal processing plants invest the automated filter press with the ability to use circulating water, mostly reduce almost wastewater released into the environment. The automatic wastewater monitoring systems were installed and transmitting the data to the departments of the environment and resources of local governments, etc.

Besides, the mining, transporting units of TKV must comply and seriously implement the environmental protection rules, building and operating the environmental-friendly business strategy, innovating technologies, improving mining equipment for increasing productivity and environmental protection. Each year, TKV spends trillions of VND financial resources for environmental protection works in mining. Specifically, in 2015, the money spent on this works was 1045.292 trillion VND; in 2016 was 1084.193 trillion VND; in 2017 was 1091.346 trillion VND, in 2018 was 949.053 trillion VND. Besides, the companies in TKV must pay the environmental fees according to the decree 164/2016/NĐ-CP on 24/12/2016 of 10.000 VND/ton of raw coal; for waste-rock is of 200 VND/m3; deposit of environmental rehabilitation and restoration, pay environmental tax: for anthracite coal: 30 thousand VND/ton; brown coal, coke and other types of coal are 15 thousand VND/ton.

By actively spending financial resources to implement environmental protection measures in recent year, TKV has been basically overcome the situation of environmental pollution during coal mining in the past, preventing the new source of environmental pollution; the environmental quality, landscape in mining areas has been strongly improved, creating the stable conditions for the development of coal mining and the local community.

1. Proposing some solutions for applying a green financial policy for Vietnam coal mining

Towards aim to become the green industry, harmonious development, environmental-friendly and people, building the “parks in mines, plants and mines in the parks” and perform circulating economy in accordance with the guidelines and policies of the state which considers the waste from production and business is a secondary resource, next time the green policy for the coal mining industry will be created to support the following activities:

+ Building the policies, long plans as the orientation for environmental protection work, climate change response. Integration of environmental financial resource in zoning, long-term investment projects for environmental protection solutions and constructions from the capital of environmental protection, climate change response for actively implementing.

+ Implementation of environmental protection projects: (1) land reclamation projects in closing mine areas to forest economy, renovation of finishing surface mines into artificial ponds; (2) recycling and reusing wastes, such as: (i) recycling waste rocks from mining into construction material (replace the natural sands which has been restricted by government), using for backfilling roadbed, leveling the construction foundation, (ii) recycling mining wastewater into clean water using for production and daily needs in Quang Ninh province; (iii) Recovery of methane gas in coal; (iv) Recycling toxic waste from mining, coal processing, and coal transportation; (3) Projects for developing of forest economy on areas of waste dumps and mining areas with the synchronous Implementation of environmental protection solutions such as: Increasing the clean production solutions with the prevention of pollution from source during mining, processing, and transporting; growing trees for land reclamation; new investment of conveyor belts, increasing dust and noise prevention solutions; industrial hygiene; improving landscape; preventing landslide, environmental disasters, especially in waste dumps, waste ponds, plants using chemical… Research on combining land reclamation with the development of other businesses which are environmental-friendly on after-mining areas (such as ecotourism, solar energy, industrial trees, forestry, etc.);

+ Implementation of green technology coal mining projects: (1) Continue to study the projects for innovation and modernization of coal mining technology for improving productivity, safety, resource recovery and reducing pollution and bad effects on the environment; (2) Projects for transporting of coal and waste rocks by conveyor belt to replace trucks; (3) Projects for processing clean coal.

+ Increasing the international collaboration, research on the application of environmental protection technology for improving efficiency, reducing the cost for environmental protection works.

+ The financial resource for green policy of coal mining industry includes: (1) environmental costs at holding company TKV and Dong Bac corporation is at least of 1.5 to 2.0% the production expense for interregional environmental protection works and the research on recycling of waste, developing forest economy and environmental industry (outside the fund for scientific research); (2) The scientific fund for developing the technologies in waste recycling, developing forest economy, environmental industry and application in innovation of mining technologies, processing into clean production; (3) The money from the fund of environmental protection of Vietnam to carrying out the projects of waste recycling, developing forest economy, environmental industry in coal mining and renovation of closing surface mines into artificial water ponds; (4) Preferential credit policy for carrying out the projects on waste recycling, development of forest economy, environmental industry in coal mining and innovation of closing surface mines into artificial waster pond; (5) Spend a part of environmental fee in local government for projects on waste recycling, waste water recycling; (6) Financial resource form organization, personal in economic sectors by facilitating for them to joint in waste water recycling, forest economy, environmental technology development.

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THE EFFECT OF CAPITAL STRUCTURE ON PROFITABILITY OF VIETNAM COAL MINING ENTERPRISES

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Abstract: *Based on the assumption that asset and capital structures of a coal mining enterprise affect its return on equity (ROE), the paper applies the ordinary least squares (OLS) regression method on data of asset structures, capital structures, ROE of 18 coal mining enterprises during the period of 2015 - 2018. The results show that asset and the capital structures of a coal mining enterprise positively impact its profitability. The paper also suggests that borrowing to invest in technology will help coal mining enterprises improve their profitability.*

Keywords: *profitability, mining companies, ROE, LEV, assets structure.*

1. INTRODUCTION

Coal mining enterprises under Vietnam National Coal-Mineral Industries Holding Corporation (VINACOMIN) in Quang Ninh province play an important role not only in the socio-economic development of Quang Ninh province but also in that of the Vietnamese economy. In the context of competition and lack of resources, VINACOMIN has to restructure these enterprises to improve profitability during 2012-2015 period. After VINACOMIN Restructure Project during 2012-2015 period, to increase profitability, Vietnamese coal mining enterprises have two options: (1) save costs; (2) borrow money to invest in new machinery and equipment to increase productivity. In fact, VINACOMIN - HaLam Coal Joint Stock Company, which was borrowing the most, has the highest ROE. Ha Lam borrowed capital to build into new pit mining technology between 2015 and 2018. The same thing happened to other coal companies, such as Tay Nam Da Mai, Cao Son, Nam Mau. On the other hand, some coal companies (such as Ha Tu, Deo Nai), which have a low debt ratio, have relatively high ROE. The paper employs the ordinary least squares (OLS) regression method to determine the effect of the property structure and the capital structure on return on equity (ROE) of 18 coal mining enterprises of VINACOMIN (Fig.1) for a period of 4 years from 2015 to 2018. The analysis results will help these enterprises find an effective solution to improve their profitability.

2. LITERATURE REVIEW

Profitability plays a large role in measuring the success of business firms. Many studies found the impact of capital structure on profitability. In the early 20th century, DuPont Model has shown a positive relationship between financial leverage and profitability. In 1963, Modigliani & Miller indicated that leveraged firms had value higher than firms without debt because of debt tax shields. Gill, Biger, and Mathur (2011) noted that short-term debt to total assets, long-term debt to total assets and total debt to total assets positively impacted profitability. Gill, Biger, and Mathur (2011) presented that the impact of short-term debt to total assets and total debt to assets on ROA was positive in both the service and manufacturing industries.

In contrast, Stiglitz (1969) showed that if the rate of debt went up, the firm's value would decrease because of the existence of the risk of bankruptcy. Umer (2014) confirmed that most empirical studies showed that capital structure had a negative correlation with profitability. Titman (1988) also found that debt levels had a negative influence on firms' financial performance. Rajan and Zingales (1995) addressed that profitability was negatively correlated with leverage. Omondi &Muturi (2013) showed that leverage had a significant adverse effect on financial performance

On the other hand, Pathirawasam (2013) showed that the relationship between a firm's capital structure and financial performance could be either negative or positive. Although many theories have already been developed to explain the firms' debt structure, there is still no consensus theory that managers can rely on to determine an optimal level of debt (Ben Ayed and Zouari, 2014). Likewise, by examining the impact of adjustment in capital structure, Bouraoui and Louri (2014) addressed that leverage changes have a negative impact on performance.

Besides, the asset structure also has a strong impact on profitability. Lazaridis and Tryfonidis (2012) used a sample of 131 companies listed in the Athens Stock Exchange (ASE) between 2001 and 2004 to examine the impact of factors on profitability. Their research showed that the ratio of fixed assets to total assets had a positive impact on profitability. In contrast, the study of Gill et al. (2010) proves that the ratio of fixed assets to total assets had a negative impact on profitability when researching 88 companies listed on New York Stock Exchange from 2005 to 2007.

3. RESEARCH METHOD

3.1. Model

Based on the assumption that a coal mining enterprises' capital structures have a positive effect on its return on equity (ROE), the paper identified factors affecting profitability according to the Dupont model. In its most simplistic form, the DuPont Model establishes a relationship between net income and equity. However, the DuPont Model also expands upon the general ROE calculation to include two of its parts. These parts include the company's ROA and Debt ratio (LEV). Accordingly, this expanded DuPont formula for ROE is as follows:

ROE=ROA*1/(1-Liabilities/Total asset)

In order to clarify the impact of investment in fixed assets on the profitability of enterprises, the study adds the Long-term assets ratio to study the impact of assets structure on the profitability of businesses.

- Dependent variable: Return on equity (ROE)

Return on equity (ROE) is a measure of financial performance calculated by dividing net profit by shareholders' equity. Because shareholders' equity is equal to an enterprise's assets minus its debt, ROE is the return on net assets. ROE is considered a measure of how effectively management is using a company's assets to create profits.

ROE =Net Profit /Average shareholders' equity

- Independent variables: Return on total assets (ROA); Leverage (LEV); Long-term assets ratio (LTA).

+ Return on total assets (ROA): Return on total assets is determined by the ratio of the profit after tax in a year to the firm's average assets. This index measures the ability of a firm to use its assets to make profits. Good asset utilization levels will lead to an increase in the firm's profitability.

ROA=Net Profit /Average total Assets

+ Leverage (LEV): The debt ratio is a financial ratio that measures the extent of a company's leverage. Borrowing money provides firms an additional capital source to operate and an opportunity to get more profit from the difference between the additional revenue and the cost of the capital, leading to an increase in ROE. Most firms are currently using debts as a financial leverage to generate profit and divert risks for their owners' investment. Debt ratio is determined by the ratio of the average liabilities to the firm's average total resources.

LEV= Average liabilities/ Average total assets

\+ Long-term assets ratio (LTA): The structure of firm assets is measured by the ratio of long-term assets to total assets. In theory, companies heavily investing in long-term assets are more efficient in doing business. This paper examines whether investment in long-term assets of enterprises makes coal mining enterprises more profitable or not.

LTA=Average long-term assets/ Average total assets

This study adopted return on equity (ROE) as dependent variables for measuring firms' profitability while three independent variables are the rate of return on assets (ROA), capital structure or debt ratio (LEV), assets structure (LTA).

The model will be estimated using OLS regression running on IBM SPSS Statistics 20 version is as follows:

$$ROE_i = \widehat{\beta_0} + \widehat{\beta_1}.ROE_i + \widehat{\beta_2}.LEV_i + \widehat{\beta_3}.LTA_i + e_i$$

Where:

$\widehat{\beta_0}$: intercept coefficient

$\widehat{\beta_1}$, $\widehat{\beta_2}$, $\widehat{\beta_3}$: the coefficients indicating the impact of ROA, LEV, LTA on ROE, respectively.

$e_{i:}$ error term.

After going through the literature review, the author expected a positive sign of profitability. The following null hypotheses were developed to test the relationship between a firm's profitability and the independent variables.

$H_0$1: ROA has a positive/negative impact on ROE.

$H_0$2: Debt ratio (LEV) has a positive/negative impact on ROE.

$H_0$3: Asset structure (LTA) has a positive/negative impact on ROE.

3.2. Data

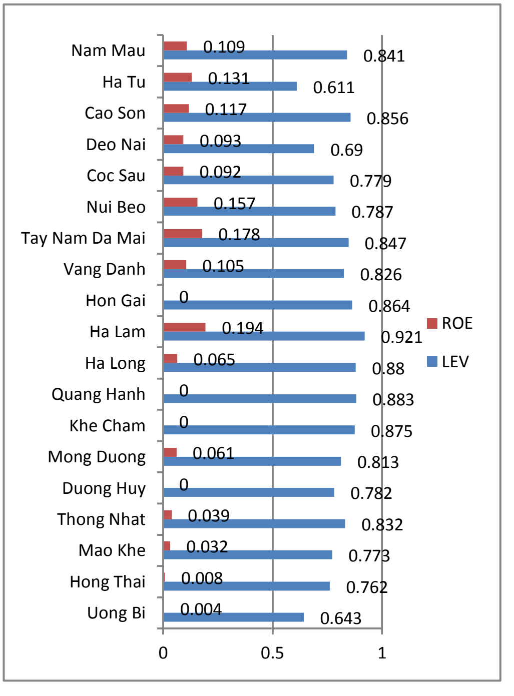

Fig 1. Average ROE and LEV for the period 2015-2018

(Note: (1) In 2018, VINACOMIN - Hong Thai Coal Company merged with Uong Bi Coal Company, so average ROE and LEV of VINACOMIN - Hong Thai Coal Company for the period 2015-2017; (2) Some companies lose, as in this case ROE is zero.

This research's empirical goal is to investigate the impact of capital structure on the profitability of coal mining companies of VINACOMIN. The secondary data for this research were collected from annual financial reports of 18 coal mining firms of VINACOMIN for the period from 2015 to 2018.

Coal mining enterprises belonging to VINACOMIN in Quang Ninh include 9 companies in which VINACOMIN holds 100% of charter capital and 9 joint-stock companies in which VINACOMIN holds over 50% of charter capital.

4. RESULTS AND DISCUSSION

Table 1. Descriptive Statistics

	N	Min	Max	Mean	Std. Deviation
ROE	75	-1	0	0.06	0.142
ROA	75	-0.1376	0.0935	0.013	0.028
LTA	75	0.4576	0.9361	0.7761	0.1095549
LEV	75	0.5273	0.9249	0.8010	0.0862442
Valid N (listwise)	75				

Descriptive statistics show that the ROE of 18 coal enterprises from 2015 to 2018 has the mean of 6b% with the standard error of 14.2 %. The mean of those enterprises' ROAs is relatively low, only 1.3 %, with the standard error of 2.8 %. The average assets structure of those enterprises is 77,61 % with the standard error of 11 %. Those enterprises' average debt ratio is 80.1 %, which is quite high, with the standard error of 8.6 %. The descriptive statistics suggest that those enterprises' efficiency is relatively low and they are heavily dependent on loans from external sources.

Table 2. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error	Durbin-Watson
1	0.939	0.882	0.877	0.050	1.826

Regression results show that the multiple R is 0.939, suggesting that ROA, LEV, and LTA are valid independent variables. The adjusted R-square is 87,7 %, which is quite close to the R-square, demonstrating that all the factors are important. The Durbin-Watson test result is 1.826 (1 <d <3), showing that there is no autocorrelation detected in the sample.

Table 3. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	1.319	3	0.440	177.060	0.000b
1	Residual	0.176	71	0.002		
	Total	1.495	74			

Significance F is approximately 0, implying that the linear regression equation cannot be rejected.

Table 4. Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
Constant	-0.321	0.059		-5.399	0.000		
ROA	4.979	0.218	.992	22.869	0.000	0.883	1.132
LTA	0.134	0.066	.103	2.011	0.048	0.632	1.581
LEV	0.270	0.084	.164	3.225	0.002	0.645	1.549

As the VIF of the variable selected in this model is less than 2, the model has no collinearity problem. The Sig value of the t-test of each independent variable is less than 0.05, meaning that these variables are statistically significant.

Therefore, the forecasted model can be rewritten as follows:

$ROEi=-0.321+4.979 *ROA_i + 0.134 * LTA_i + 0.270 * LEV_i$

The model reveals that all variables are positively related to ROE. In the case of other factors being fixed, when ROA increased by 1 unit, the ROE would increase to 4.979 unit; when LTA increased by 1 unit, the ROE would increase to 0.134 unit; and when LEV increased by 1 unit, the ROE would increase to 0.270 unit.

To understand the impact of LAT and LEV on ROE, we will consider each of the factors. The ratio of debt to equity has a positive effect on the profitability of the business. The result shows that leverage has been used successfully and increases ROE by Vietnamese Coal Enterprises. The asset structure has a positive effect on profitability. This is entirely consistent with the characteristics of Coal Enterprises in Quang Ninh. Mining conditions are challenging. So, Coal Enterprises have to invest in modern technology to increase productivity and reduce costs. Businesses with little investment will have lower productivity and, therefore, lower profitability.

5. CONCLUSIONS

The research results show that the debt ratio of coal mining enterprises is high and still plays an important role in improving businesses' profitability. Coal mining enterprises borrow capital to invest in machinery and equipment to improve business efficiency. The model shows that firms investing more in fixed assets are more profitable. Those enterprises should also think about increasing their investment in fixed assets to improve their profitability.

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TARGET COST SETTING MODEL FOR NEW PSC AMID LOW OIL PRICE

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***Abstract**: Low Oil Price is big trouble for oil and gas companies. New Profit Margin-Cost (PSC) model is a very important thing will support investors to adapt with the low oil price and other problems. The target cost setting (TCS) model is working in the existing fiscal arrangement for any particular field and subsurface definition. The TCS simulations are performed by using available tools for cost estimation and economic models. The driving idea behind this method is expediting the project framing and front end engineering process as well as maintaining continuous exploration and development within a limited budget by allowing some "low hanging fruit" projects while still obtaining the desired profit margin. The TCS model is depending on many assumptions for oil/gas price and the desired profit margin set by the PSC operator. Nevertheless, TCS is guided by fiscal arrangements in any particular field. The key to the target cost setting is reverse engineering, which pre-economic should be calculated based on the parametric cost model of subsurface definition that runs into any particular field on the respective fiscal term. By having the TCS model, frond end engineering will be faster.*

***Keywords:** TCS model, PSC, low oil price, reverse engineering*

1. INTRODUCTION

Target Cost Setting (TCS) objective is set up for the required capital and operating cost for the development of products at the desired profit margin (Cooper, 2001). Low oil prices recently, which are predicted longer (Bloomberg, 2016) will lead to a shortage of production by the year 2035 (Woodmac, 2016). The various concepts for oil and gas development have to be analyzed to sustain the growth of production while maintaining an economic threshold limit during this low oil price period. The preferred concept development shall be achievable by doing reverse engineering (top-down estimate) at the early stages of the oil and gas life cycle.

Oil companies are in the business to make money. When the market forces set oil and gas prices due to supply and demand conditions, or geopolitical factors, etc., Unit Development Cost (UDC) and Unit Production Cost (UPC) must be lower to make desired profit. Therein lies the underlying concept of target costing:

Price - Profit Margin = Cost

This concept contrasts dramatically with the historical practice of many firms and industries, where:

Cost + Profit Margin = Cost

The transformation of terms looks very simple. In reality, viewing costs as a derivative of prices and profit margin, rather than the other way around, it requires a significant shift in mindset. It should be pointed out that margins cannot be arbitrarily set, but are influenced by one's potential cost position. Not all companies can be the lowest-cost producer. Setting an unachievable margin could lead to an unreachable cost objective.

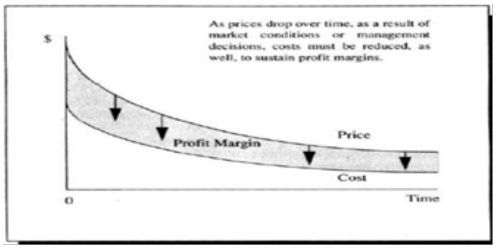


Fig 1. Profit Margin - Cost (AACE,2011).

Since target costing is usually applied to manufacturing product planning, which frequently requires investments in tooling, equipment, and other assets influencing costs, it can legitimately be said that price drives both costs and investments.

2. THE TARGET COST SETTING PROCESS

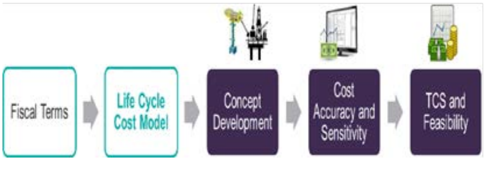


Fig2. TCS Process (developed by the authors).

The TCS model depends on many assumptions for oil/gas price and the desired profit margin set by the PSC operator. Nevertheless, TCS is guided by fiscal arrangements in any particular field. In general, the process is following these steps:

i) Establishing the budgetary terms applied for any specific areas.

ii) Setting desired profit margin

iii) Determining Life Cycle Cost (LCC) that must be achieved.

iv) Calculating the risk exposures with regards to cost accuracy and sensitivity.

v) Cost Iterations for Capital and Operating expenditures.

vi) Establishing the TCS and the amount that costs must be reduced.

Once the target cost has been calculated, companies should take the following steps to achieve it:

- Creating a cross-functional team, which is involved in the implementation process from exploration stages till development.

- Implementing tools such as value engineering during design stages and lean sigma during production stages.

2.1. Establishing the fiscal terms applied for any particular fields

The production Sharing Contract (PSC) type is commonly used as fiscal arrangement in Asian (appendix A).

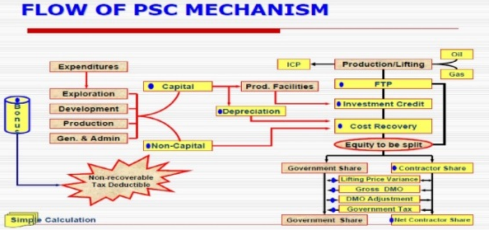


Fig 3. PSC Mechanism (Johnston, D, 1994).

The economic platform that used the determined TCS is referring to 100% of equity assumptions to avoid more complexity on the model. Some specific items might be applied in PSC terms such as signature bonuses, which generally differ from one contractor to another. The First Tranche Petroleum (FTP), government take and contractor after-tax equity split, Domestic Market Obligation (DMO) requirements, capital depreciation schemes, payment of cess fund for the abandonment cost, transportation tariffs, etc. One PSC to the others might have the uniqueness of fiscal arrangement. The application of economic tools is used to expedite the platform for generating the TCS model for any given budgetary term.

2.2. Set desired profit margin

Some economic indicators used as essential financial measurements such as Net Present Value (NPV), Internal Rate of Return (IRR), payback period, and Discounted Profitability Index (DPI).

Since the TCS model is related to the desired profit margin, DPI must be set at the beginning. DPI is defined as the ratio of cash generated to cash invested, using an appropriate discounted rate. Hence:

DPI = 1 + Net Present Value / PV Investment

A DPI value greater than 1.0 means that a project returned the investment plus some additional cash, on a discounted basis. This parameter will allow comparing the economic attractiveness of projects based on their efficiency instead of their size. DPI can help overcome the "bigger is better" bias. Each company has evolved its organizations and practices for business decisions.

2.3. Determining life cycle cost (LCC) that must be achieved

A full set of subsurface data, which include production profile, total recoverable reserves, Pressure volume temperature (PVT) data, number of wells, and target first hydrocarbon, are required in advance to determine the Life Cycle Cost. The cost incurred consists of capital, operation expenditure, and abandonment cost. The generating cost model is required at the exploration stage where the unknown technical parameters are bigger than general conditions.

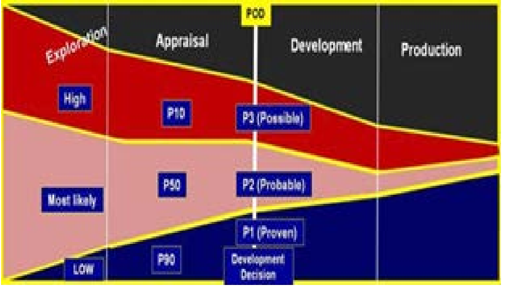


Fig 4. Life Cycle Oil and Gas[5].

Exploration and production activities were modeled as a typical new PSC into an exploration block. It considers first and second years exploration commitment till production stage and end up with 25 years PSC contract. Capital cost is determined by using a parametric cost model as influenced by:

- Locations (onshore or offshore)
- Design to capacity concerning subsurface definitions such as chemical properties, number of wells, production profile, etc.
- Total Depth for reservoir targets
- Tie in point or transportation/offloading scheme.

Operating expenditure per annum is calculated based on simple percentages from capital depending on the type of facilities, which are typically at the range of 4-8 % from total capital cost unless specified that FPSO/FSO or any other facilities lease is required. The abandonment cost is calculated as part of cost oil that is derived from the percentage of facilities and wells type.

All of the calculations can be handled by Excel formulas, but are quite tedious. Furthermore, modeling multiple projects within a PSC is not scalable in Excel. The sample of the parametric model is given here for a shallow-water development:

Table 1. Jacket Cost Models (developed by authors)

Type	Equation
Braced Monopod	$y = 9E\text{-}05x^2 + 0.0365x + 10.301$
Tripod	$y = 0.0016x^2 - 0.0054x + 18.018$
4 Legged	$y = 0.0009x^2 + 0.193x + 20.676$

Table 2. Topside Cost Models (developed by authors)

Type	Equation
Braced Monopod	$y = 0.29x + 11.643$
Tripod / 4 Legged	$y = 0.5843x + 14.624$

The cost model is generated to simplify preliminary capital investment at an early definition of projects before the exploration and drilling campaign. Referring to the American Association of Cost Engineers (AACE), when the engineering definition is premature; the cost generated is based on class 5 for accuracy of -50 % /+100 %.

2.4. Calculating the risk exposures with regards to cost accuracy and sensitivity

The risk factors vary from project to project. Generally, the risk for oil and gas development is exposed in the following items: technical, economic, commercial, organizational, and political. The key to mitigating many of the above common risks will be to simplify as much as possible through appropriate engineering and to apply proper cost contingency.

Cost contingency is added to the cost estimate model at the exploration stage of greenfield development would be on the high side, depending on the methodology that the company uses.

2.5. Cost iterations for capital and operating expenditures

The cost iterations are using inhouse PSC economic as per defined fiscal term. Upon the first economic run is finalized based on given input parameters, the iterations of life cycle cost is performed. The target is focused on capital cost to achieve the desired profit margin. Cost phasing is placed based on a rational project schedule to reach the first hydrocarbon date. Cost assumptions can be a real term or nominal, depending on the duration of the project. [9]

The reduction of capital cost will be followed by operation and abandonment cost since the assumption of production and abandonment cost is using a percentage of capital cost. A sample is given for DPI 1.25, which allow PSC operator to get recovered of investment and additional cash of $0.25 for every $1 that invested.

2.6. Establishing the tcs and the amount that cost must be reduced

Once TCS is established, a scenario for cost reduction is planned. To achieve a level of cost savings required following actions would be feasible, such as:

- Dropping commodity price due to deflation (low oil price scenario),
- Changing the contracting strategy,
- Local Content utilization,
- Value engineering or re-concept design and constructability,
- Efficiency improvement such as sharing installation and or mob-demobilization campaign,
- Applying best practices and project replication,
- Technology application and innovation.

3. TCS APPLICATION

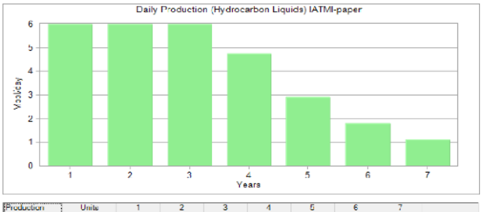
The simulation sample is using a fiscal term for PSC South East Sumatra (SES) Block, which expired in 2018

Table 3. PSC for Southeast Sumatra Block

Fiscal Terms	Main Features
FTP Rate	20%
Cost Recovery Ceiling	100%
Depreciation Rates	
- Tangibles, Liquids (Declining Balance, %)	25%
- Tangibles, Gas (Declining Balance, %)	25%
Investment Credit	
- Liquids	20%
- Gas	20%

Contractor Take (ETBS)		
First Contract	Liquid	34.09%
	Gas	79.55%
2^{nd} and 3^{rd} Contract	Liquid	28.85%
	Gas	57.69%
DOMESTIC MARKET OBLIGATION		
DMO Volume		25%

The SES is located in shallow water (20-50 m) in the Java Sea off the southern coast of Sumatera, which consists of 34 fields and covers approximately 8,000 sq km. The proposed illustrative concept development is to cater the Estimated Ultimate Recovery (EUR) of 10.43 million barrels as per below production profile for seven years and forecasted first oil in Q1 2020. The peak production rate is 6,000 barrels of oil per daywithin three years period before declining onwards [8]



Production	Units	1	2	3	4	5	6	7
Daily	Mbbl/day	6.000	6.000	6.000	4.751	2.921	1.795	1.104
Annual	MMbbl/yr	2.100	2.100	2.100	1.663	1.022	0.628	0.386
Cumulative	MMbbl	2.100	4.200	6.300	7.963	8.985	9.614	10.000

Fig 5. Production profile (developed by authors)

Based on the above assumption of subsurface technical data, the cost is defined by using preferred concept development which stochastic model is used. Schematic development concept is shown below.

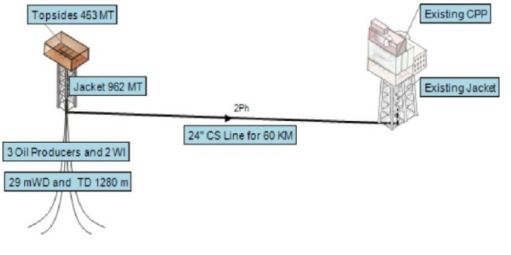


Fig 6. Concept Development (developed by authors).

As illustrated above, the drilling center is made based on lightweight jacket at 28.6-meter water depth. The total weight for topside is 453 metric tons, while the jacket is 962 metric tons. The Wellhead Platform is connected with 24" full well stream pipeline for 60 kms to the existing Central Processing Platforms (CPP), which had spare to cater additional flow from a new prospect. The associated gas production is flared (Sullivan, William G., Wicks, Elin M. & Koelling, C. Patrick., 2012).

Table 4. Cost Breakdown before TCS (developed by authors)

No.	Description	Cost ($ million)
1	Pre Development	4
2	Wellhead Platform	
	Topside (453 MT)	14
	Jacket (962 MT)	9
3	Pipeline 24" at 60 km	76
4	Host Tie in at CPP	10
5	Drilling (3 Producers and 2 Injectors)	46
6	Owner Cost	10
	TOTAL COST	**169**

Hence the model of life cycle cost shall include drilling cost (3 oil producers and two water injectors) and facility cost (wellhead platform, pipeline, and host tie into CPP). Based on the initial investment profile, the data will be feeding into an economic tool for further economic run and life cycle cost iterations.

The oil price assumption is made based on the graph below:

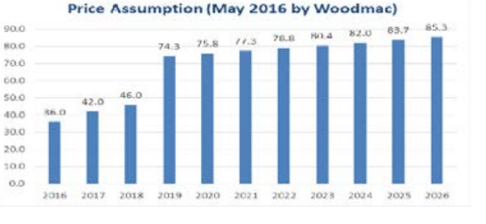


Fig 7. Oil Price Assumption (adopted from Woodmac, 2016).

After all the required input parameters are ready, then the first economic run is conducted. Some assumptions are made as per the following set up:

- The discount rate is 10 %,
- Real Term 2016,
- Economic is cut off,
- Stand-alone project,
- Escalation and inflation.

The first economic run is indicated that the DPI result is 1.07, which the NPV is positive.

However, to achieve DPI at 1.25, some cost reduction is required. The waterfall chart in Fig 8 is indicated efforts to be done to achieve cost reduction on individual cost items, which are assumed on the same concept of development. Some best practices and lessons learnt from previous projects might be used to improve fit for purpose design such as reducing weight, sharing barges for installation that reduced mob and demobilization campaign cost, contracting strategy, local content optimization, etc. that must be evaluated across engineering department.

Table 5. First Run Economic

NPV @10% (USD Million)	12.36
Company IRR (%) post-tax	13.63%
Discounted PI	**1.07**
Total Recoverable Reserve (mmboe)	10.43
Pay Out Time (years)	6.67
Breakeven Brent Price US$/bbl	57.43
Government Take (USD Million)	206.97
Capex ($/boe) discounted	16.41
Opex ($/boe) discounted	5.05

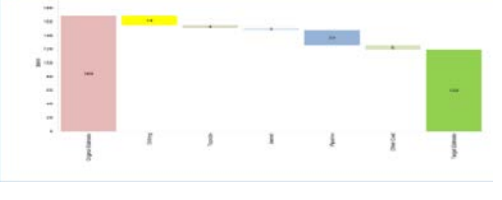


Fig 8. Analytical View from Current Estimate to Target Estimate (Putrohari, Rovicky Dwi, et al, 2007)

The cost reduction is not representing the do-ability of projects. Some engineering assessments need to be done whether the target cost is feasible through the application of value engineering. Hence, the capital cost required to achieve DPI 1.25 is broke down into cost items as per the below table:

Table 6. Cost Breakdown for Target Costing (developed by authors)

No.	Description	Cost ($ million)
1	Pre Development	4
2	Wellhead Platform	
	Topside	9.8
	Jacket	6.3
3	Pipeline	53.2
4	Host Tie in at CPP	7
5	Drilling (3 Producers and 2 Injectors)	32.2
6	Owner Cost	7
	Total cost	**119.5**

The current concept that run for TCS purpose is the most preferred concept practiced by many oil companies. There might be some opportunities to select other concepts such as:

- Subsea Tie In to existing platform
- Stand-alone development by using Early Production System (Vessel lease).

Do-ability of the concepts are measured against the historical data and benchmarking to assure that target cost setting is achievable before proceeding with the next stage of basic and detailed engineering for the project final investment decision (John K. Hollmann, 2006).

4. CONCLUSIONS

4.1. New findings

The key to target cost setting is reverse engineering, in which pre-economic should be calculated based on the parametric cost model of subsurface definition that runs into any particular field on the respective fiscal term.

4.2. Good compared to conventional models

By having a TCS model, frond end engineering will be faster due to the following reasons:

- The number of concepts generated is reduced by setting the target cost to be achieved. A full economic run is only performed for the most feasible one.

- For any fiscal term, the attractiveness of investment is known early due to the readiness of the cost model.

- Giving the indications of projects portfolio ranking based on the limited budget available due to the low oil price.

4.3. Benefits for investor, oil and gas company to run project

Table 7. TCS Economic Result

NPV @10% (USD Million)	28.34
Company IRR (%) post tax	20.52%
Discounted PI	**1.25**
Total Recoverable Reserve (mmboe)	10.43
Pay Out Time (years)	6.17
Breakeven Brent Price US$/bbl	40
Government Take (USD Million)	264.49
Capex ($/boe) discounted	10.87
Opex ($/boe) discounted	3.53

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STATIC TRAFFIC PLANNING: THE BASIS TO ATTRACT INVESTMENT IN STATIC TRAFFIC INFRASTRUCTURE IN HANOI

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Abstract: *This paper analyzes the needs of investment in the development of static traffic to the planning of static urban traffic in Hanoi to 2030, with an outlook to 2050. Based on that, solutions to attract investment capital, especially socialized capital in the form of Private Public Partnership (PPP) is proposed to develop static traffic in Hanoi.*

Keywords: *Static traffic; traffic infrastructure investment*

1. INTRODUCTION

Static traffic in Ha Noi is an integral part of urban traffic organization and an indispensable service type. Land use planning is the basis for deciding the size of stations and parking lots in a city. Space organization planning, land use planning, and traffic planning are supportive to determine the location and rational size of bus stations and parking lots.

Cities like Ha Noi, static traffic infrastructure is one of the most challenging areas to call for investment. Because the input capital is too big, the revenue is dripping, the time for capital recovery and turnover is too slow, not attractive to organizations and individuals. Therefore, Ha Noi needs a comprehensive, appropriate, and long-term strategic plan for static traffic infrastructure. Planning is not only a guideline for the whole process of static traffic infrastructure development but also is a sure guarantee and legal stability for investors.

2. DEMAND FOR INVESTMENT AND DEVELOPMENT OF STATIC TRAFFIC SYSTEM IN HANOI

Ha Noi lacks many public parking lots and parking spots. The ratio of land for static traffic is small, while the sudden increase in transport vehicles, incredibly individual cars, is on the rise. Lack of parking lots and parking spots for oversized vehicles such as trucks, passenger cars, and current lot parks is only suitable for small vehicles and small trucks. The inter-provincial bus stations are usually small in scale, connected to the primary market system and there is no large-scale node truck station. There is a lack of stops to support traffic activities in the gateway and traffic hub areas, so the vehicles have to park on the roadway and the roadside, causing a more severe traffic jam. The network of parking spots is not rational in terms of density, location, and distance. Many new urban areas have not been calculated correctly and sufficiently parking lots, but only arranged separately for high-rise buildings. Many hotels and commercial centers do not have parking spaces; the phenomenon of occupying the street as a parking place is quite common. The construction process is always on demand, even in determining the location and size of the land fund. The technical infrastructure of parking lots and parking spots is low. The form of parking lots is monotonous, mainly on the ground, equipment and facilities are not sufficient and synchronous. Many organizations and individuals involved in the business and operation of the parking lot lead to uncontrollable and unmanageable conditions, causing confusion, insecurity, disrupting planning, and even making the state lose revenue. Organization and management are still fragmented and limited. Although the City People's Committee has approved the plan for parking lots, the implementation of the project is still behind schedule due to insufficient and inadequate policies and the shortage of capital.

According to the statistics of the Ha Noi Department of Transport in 2019, 706,468 cars, 5,627,637 motorbikes, nearly 143,000 electric motorbikes, and other vehicles are now operating in the city. Meanwhile, 10 % of actual needs. The unbalanced development of individual transport vehicles and traffic infrastructure, including static traffic infrastructure, leads to complicated traffic congestion.

In 2013, the Ha Noi City People's Committee developed a Planning for a network of public parking lots and parking spots, which was approved in Decision No. 165/QĐ-UB (Plan 165). Accordingly, by 2020, Ha Noi will reserve a total land fund for static traffic of 796.82 ha. But, by the end of 2018, only 91.16 hectares were allocated, accounting for 0.21 % of urban construction land. The monitoring results of the Ha Noi City People's Council in 2017 showed that Plan 165 was no longer suitable for the current situation. One of the biggest problems is that many locations for static traffic in Plan 165 have been changing and adjusting according to some other plans and orientations. That uncertainty is a huge obstacle that makes the attraction of socialized capital for investing in static traffic infrastructure not so effective as expected.

Ha Noi aims to build a system of bus stations, parking lots, logistics centers, and roadside stations that meet the following criteria: Sustainability - synchronization - modernity; clearly define the scale, location, nature, and form of construction of each planned object; invest in each stage in line with the socio-economic development planning, meeting the travel and parking needs of the people, thereby reducing traffic accidents, ensuring traffic safety, contributing to sustainable and synchronous urban development with transport infrastructure.

The goal of planning a public parking network is to meet about 66 % of the required total parking in Ha Noi. The remaining parking needs are allocated to construction works (public, service, mixed works, headquarters, training schools, and high-rise buildings, etc.) in the direction of the increasing basement and increasing parking areas, supplying for the internal demand, and partly needs of the surrounding area. Static traffic need is a form of arising need, as shown in (Fig 1).

According to the Plan, there will be 1,480 concentrated public parking locations with a total area of 1,197.8 ha. Among them, there are 74 locations for underground parking lots (accounting for 5 % - mainly in the historical inner-city area); 450 high-rise parking lots (accounting for 30.4 %). The rest is ground parking lots. Planning 13 Park and Ride transshipment parking locations (17.7 ha) along belt roads, the centripetal axes are located near traffic hubs and mass passenger transport. One hundred thirty-three locations of bus parking lots and 88 truck parking lots in the central urban area are planned with a total area of 590.2 ha. The Ha Noi City People's Committee also introduced specific investment phases, including 2018 - 2025, and 2025 - 2030, with a total raised capital of 268,000 billion VND.

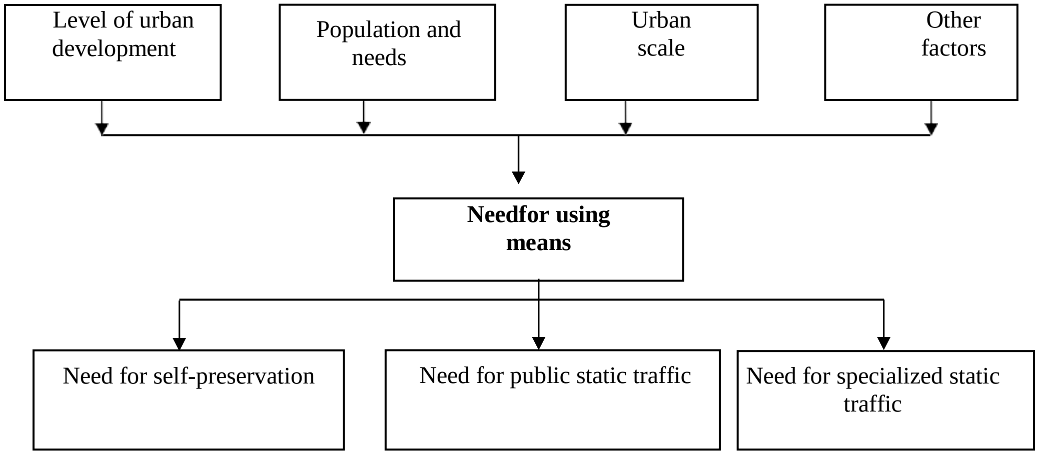

Fig 1. Mechanism for forming static traffic need

3. DEVELOPMENT PLANNING OF STATIC TRAFFIC SYSTEM IN HANOI

According to the trend of urban transport development, static traffic significantly affects transport development planning with the following major roles:

Firstly, static traffic ensures the systematic, synchronous, and compatible features among the parts of the urban transport system. Static traffic is a crucial element of the transport system. The transport system can only operate effectively when the elements in the synchronous system are compatible. It is necessary to put static traffic on a par with its importance. This should be considered right from the stage of planning and implementation in the process of operation. The main criteria considered here are land fund for static traffic compared to the total urban land area (6-8 %), the proportion of static traffic land fund compared to those for urban traffic (25-30 %), and investment capital for static traffic in the structure of investment capital.

Table 1. Indicators for calculation of static traffic land funds

No.	Applicable area		The proportion of urban construction land (%)	Indicator by polulation (m2/person)
A	***Indicators of cities in the world***			
	Reasonable level	Very high level	6.0-7.0	7.0-8.0
		High level	5.0-6.0	4.0
		Medium level	3.0-4.0	3.5
		Low level	2.0-3.0	2.5
B	***Reference indicators applicable to cities in Vietnam***			
	Special city, 1st-class city	Medium level	3.0-4.0	3.5
	2nd, 3rd, 4th, 5th-class city	High level	5.0-6.0	4.0

Source: Summary of the author

Secondly, static traffic is a tool to regulate the means of transport and regulate the traffic flow in the city. Using static traffic as a tool to control the need to use means of transportation and to regulate traffic flow in urban areas, through the planning of static traffic works (number and location of static traffic works) and pricing policy in static traffic (vehicle parking and keeping fees). The above is one of the essential solutions to allow cities to strictly control the increase of individual means of transport, as well as create advantages for the development of public passenger transport. This solution has been successfully applied by many countries in the world, such as the USA, UK, France, Germany, Japan, Singapore.

Thirdly, static traffic is a big problem in the current cities of Vietnam, especially in big cities like Ha Noi and Ho Chi Minh City. Effective handling of static traffic to meet the current and future development requirements of this service system is to contribute to improving the quality of operation of the urban transport system in particular and the quality of life of urban residents in general.

Fourthly, static traffic in Ha Noi is an integral part of the urban transport organization, an indispensable service type of each city. Land use planning is the basis for deciding the size of each bus station and parking lot in a city. Space organization planning, land use planning and traffic planning is a basis to determine the location and rational size of bus stations and parking lots. Transport planning to achieve high efficiency must not only solve the structure, choose the type of vehicle, transport distribution, etc. but also must reasonably and comprehensively solve the layout of a convenient and safe traffic system.

To solve the overload of urban traffic demand, Hanoi has been researching the construction of plans for static bus stations and parking lots. The development of underground transportation systems and the underground parking system in Ha Noi is an inevitable trend. Hence, it is necessary to have a master plan with specific calculations to develop its sustainably (*Decision No. 355/QĐ-TTg, 2013*). These works will affect the long-term development of the city. Hanoi is developing and urbanizing very rapidly, with specific projects such as zoning planning and detailed planning for precise determination. Thereby, we need to identify each specific location to build underground transport works accordingly. There must be synchronized underground transport planning to develop urban underground.

General and specific solutions for each urban area are organizing the implementation of the approved planning of parking lot and parking spot system, making detailed plan of parking stations and lots for each district, especially new districts to determine the specific land fund and scale; streamlining current parking spots in Hanoi's inner city; giving policies for developing urban vehicles and controlling vehicle structure, including growth and vehicle composition; prioritizing the development of public transport; prioritizing the investment in the definitive construction of a number of large parking lots as planned such as Xuan Phuong, Vinh Quynh, Mai Lam, Linh Nam, Bac Yen Vien, etc.; developing and issuing tax and fee policies including land use tax, tax for service activities, parking fees by time and parking location - area (central area is higher and lower in adjacent areas as well as suburbs; increasing investment in modern equipment and facilities for stable bus stations and parking lots; and unifying the management of parking lots, stations and spots in the city (*Decision No. 1259/QĐ-TTg, 2011*).

Specific solutions for the old town area are arranging concentrated parking areas in the belt area; taking advantage of the layout of alternant parking spots in the park area and underground parking spots under the new construction works; and using some neighborhood streets for parking at night. The land fund in areas with limited development and expansion should not be converted to other usage purposes but to parking lots and retain the existing parking lots in appropriate positions. It is possible to build an underground garage underpark gardens and even lakes. Factories and enterprises which must be relocated to the suburbs can create part of or the whole land for parking lots. Public offices and public service trade centers must handle parking demands by themselves and encourage the provision of available services; use some streets and administrative offices with large campuses in the area for parking, especially at night; arrange parking spots in the vicinity, especially in new urban areas, specialized in service of restricted development areas; and provide convenient parking location, combined with low fares and synchronized vehicle engineering services. Due to the restrictions of traffic networks, when investing in the construction of new routes, parking spots, and lot systems must be additionally designed and connected to streets.

+ For newly built areas, these are favorable areas, so they must be calculated enough to meet 100 % of the demand for the site itself, and on the other hand, support for the surrounding area. Parking spots combined with the function of automotive engineering services of the city should be arranged in this area. Independent parking lots and parking lots must be calculated for an additional 20 % of the land fund for greenery to ensure the critical coverage of parking lots reaches over 60% of the total land area.

+ For high-rise apartment buildings, it is imperative for apartment buildings to have adequate parking spaces. High-rise garages should utilize the land fund. For example, buildings that are higher than ten floors have to arrange independent high-rise garages; those are under ten floors occupy underground garages in combination with other construction works. It is possible to organize high-rise garages for some alternative complexes of low-rise apartments.

+ For sports and entertainment areas, if possible, parking lots should be arranged right on campus. Public transportation is the primary form of transportation to reduce the land fund for parking, and the service of public parking for the parking places with low use time and the parking places that are often not fully used up their capacity is put into operation. Attention should be paid to the arrangement of trees to ensure landscape and thermal stability to protect vehicles.

+ At traffic hubs along national highways and belt roads, it is necessary to organize thoroughly and scientifically to separate lanes when entering and leaving convenient parking lots. Along the national highways as well as the belt roads, it is necessary to arrange the parking spots along the route with a medium scale, the type of parking spots for rescue, provision of fuel, and technical services with an average distance between places of 2 km; combine these parking spots with focal parking spots, parking spots in industrial parks, external parking spots and take advantage of the operation of maintenance stations, technical services and services for drivers.

4. SOLUTIONS TO ATTRACT INVESTMENT CAPITAL FOR DEVELOPING STATIC TRAFFIC IN HANOI

In Hanoi, the construction of these convenient space areas has not changed much. The reason for the slow progress of the parking construction projects is that in addition to site clearance and land acquisition, which face many difficulties and obstacles, the initial investment capital for parking lots is quite large. The payback period is long; even when the government allows the opening of additional trade and service areas, it takes a lot of time for investors to maintain their interests of investment. Besides, the financial capacity of some investors is limited but still proposed to research the project to keep the land but not implemented, so many projects have come to a dead end.

Table 2. Demand for investment capital for urban traffic infrastructure development in the period of 2020 - 2030

Unit: billion dong

No.	Name of project	Reality 2015 - 2020	Demand 2020 - 2030	Total
1	Urban main trunk	38,539	8,175	**46,714**
2	Urban trunk	4,771	1,806	**6,577**
3	Overhead road	2,460	37,836	**40,296**
4	Static traffic	12,082	27,473	**39,555**
5	Intersection	19,940	21,810	**41,750**
6	Urban railway	170,735	153,412	**324,147**
	Total	**248,527**	**250,512**	**499,039**

Source: *Decision No. 1259/QĐ-TTg (2011), Approving the "General Plan of Construction of Hanoi Capital to 2030 and vision to 2050" by the Prime Minister*

International and national experiences in recent years show that the investment capital for building parking lots and parking spots is enormous. Meanwhile, the payback period can last 10 or 20 years, even up to 30 years. Uncertainty and risks also cannot avoid, especially for parking lots and parking spots that are far from the inner city.

Some proposal to invest in the construction of parking lots and parking spots in Ha Noi can be from the following sources (*Decision No. 4403/QĐ - BGTVT*).

(1) Source of capital through the State budget and the City budget: Including ODA loans, non-refundable aids, which are allocated to state enterprises to invest in construction and business operation of public parking lots and parking spots.

(2) Credit loan: The government provides long-term preferential loans with low-interest rates, creating conditions for investors sufficient time for capital to return; the government guarantees concessional loans of international organizations through projects approved by competent authorities.

(3) Money from Ha Noi Development Investment Fund: As parking lots and parking spots belong to urban infrastructure, the municipal authorities should create favorable conditions for enterprises and investors to borrow capital from this fund with preferential interest rates.

(4) With the policy of socializing parking lots and parking spots: The city can attract private capital through equitizing parking lots and parking spots, mobilize domestic enterprises and individuals to invest in the form of PPP. The city issues bonds to mobilize idle money in society, following these suggestions (Nguyen Hong Thai, 2012):

- Reviewing several routes, pavements, parking, and keeping areas to develop a plan for the city to allow regular hourly parking; Advising the city in implementing the socialization of investment, management, and operation of parking lots and parking spots by the approved planning, filling ditches and rivers to using as parking lots.

- For public parking lots and parking spots, investors will be supported from the city budget to perform tasks such as site clearance, construction of technical infrastructure systems (traffic routes, power supplies, water drainage outside the works, etc.), and a part of the propaganda. For parking lots and parking spots for business activities, the city will lease land for construction investment. Investors can choose ODA capital or mobilize investment in the form of domestic BOT to implement projects.

- Regarding the financial mechanism, in addition to enjoying investment preferences under the provisions of the Law on Domestic Investment Promotion, investors may borrow and enjoy loan rates of Hanoi Development Investment Fund specified in Decision No. 6693/QĐ-UB of Hanoi City People's Committee.

- Publicizing the planning (socio-economic development plan, transportation planning, and urban planning) and based on the approved planning, making a list of projects on the development of traffic infrastructure in general and static traffic infrastructure in particular. Depending on the size and features of each project, it is necessary to classify types of investments to select the appropriate list of tasks. The proposed projects must be fully and thoroughly studied and prepared to have a genuinely feasible project, especially in terms of technical and financial plans to ensure the mobilization of capital from credit institutions, especially the capital of socialization and significant return.

- It is necessary to calculate carefully, ensure the right value of the land to ensure investors gain profits but also do not waste the public resources by exchanging land for infrastructures. On that basis, making a list of projects and call for investment publicly and transparently. The project bidding process must also be based on appropriate criteria.

- Developing criteria and methods are necessary for determining the value of land in the technique of exchanging land for infrastructure and selecting investors with sufficient financial and technological potential to carry out investment without being too dependent on the volatility of external markets. Foreign investors with vital capital resources can do alone or combine two or three private investors to join PPP. Particularly for domestic private investors, it is advisable to combine many companies in the form of shares to overcome the limitations in size, financial capacity, and minimize investment risks.

- The contract between the competent state agency and the investor must be negotiated in detail and wholly, anticipating arising situations and method of settlement, and having clear sanctions if a dispute arises. The parties must be highly responsible for managing and executing the contract and are responsible when they have committed to perform other jobs and projects to exploit and synchronize with the implemented PPP projects.

- Propagating for the community to participate in managing and supervising the bidding and project implementation to improve the quality and efficiency of transport works.

(5) Attracting foreign investment capital and international organizations: based on foreign investment law.

(6) Another form of capital mobilization is exchanging land for infrastructures. The essence of the exchange is that investors will

bear all costs from site clearance compensation to construction. After the project is completed, infrastructures will be transferred to city for management. In return, the investors will be entitled to exploit some land lots designated by the municipal authorities.

5. CONCLUSION

Development of urban static traffic infrastructure is required indispensably to meet the travel needs of the people, to build a sustainable urban space, it is necessary to mobilize resources to socialize and invest in the development of urban static traffic infrastructure. Therefore, the Hanoi government needs to have mechanisms and policies to encourage and break down barriers and attract the participation of investors. Accordingly, it is necessary to have a clean land fund to hand over to investors and have a mechanism of annual land rent exemption and reduction. The city also needs a preferential counterpart fund from the traffic development fund to share the capital burden for investors because currently, parking investment projects are not included in the list of priority projects. In contrast, investors who borrow commercial capital will be hard to afford. In particular, it is necessary to have a policy of changing the current fee collection mechanism for vehicle parking services to be able to attract domestic and foreign investors. The authorities also need to study and promulgate specific regulations and standards for parking lot and parking spot projects for investors to implement.

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LESSONS LEARNT FROM OTHER COUNTRIES IN RISK MANAGEMENT OF PUBLIC-PRIVATE PARTNERSHIP (PPP) PROJECTS IN INFRASTRUCTURE DEVELOPMENT

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Abstract: *Like other forms of investment, investment in the form of public-private partnership (PPP) also carries certain risks. The problem is to identify and assess such risks and find solutions to handle and overcome them. This paper focuses on introducing the international experience of these issues: classification, distribution, causes and explanations, from which several lessons can be drawn for Vietnam.*

Keywords: *Risk; Private Public Partnership (PPP); infrastructure*

1. LITERATURE REVIEW OF RISKS IN INVESTMENT IN INFRASTRUCTURE DEVELOPMENT UNDER PPP FORM

There is not yet a unified concept of risk. While some researchers describe risk as events with negative consequences, other researchers describe it as the inclusion of negative and positive outcomes. At the same time, there is no clear combination of risk and uncertainty (Padiyar, 2004). Al-Bahar (1989) combined the nature of both risks and uncertainties and described risks in infrastructure development PPP projects as “The exposure to the chance of occurrences of events adversely or favorably affecting project objectives as a consequence of uncertainty”. Akintoye and Macleod (1997) conducted a survey of contractors on the project management practices in the British construction industry, which showed that the common perception of risks in PPP projects was “the likelihood of unforeseen factors occurring, which could adversely affect the successful completion of the project in terms of cost, time and quality”. Sharing the same view, Michel Barnier (2003), OECD (2008), ESCAP (2011) identified this issue, saying “Risks are inherent in all PPP projects as in any other infrastructure projects. They arise due to uncertain future outcomes which may have direct effect on the provision of services by the project, and/or the commercial viability of the project.”

A salient feature of PPP is its high level of risk, mainly due to the long concession period and the diversity of parties involved. Extensive research on risks related to PPP projects and risk allocation strategy have been carried out by many researchers. Although these studies may focus on different forms, different infrastructure sectors and/or different areas, they all play an important role in providing a comprehensive view of PPP related risks (Table 1).

Table 1: Summary of key studies on PPP risks

No.	Authors	Forms of PPP	Scope of study	Key findings
1	Charoenpornpattana and Minato (1999)	PPP	Thailand	Propose risk allocation strategies for five categories of risks: political, economic, legal, transactional, and operational risks.
2	Grimsey and Lewis (2002)	PPP	Scotland	• Present a framework for investigating and performing risk analysis. • Systematic review of project risks from the perspective of the procurers, project sponsors and senior lenders.
3	Li et al. (2005)	PFI	United Kingdom	• Identify three risk levels: macro, meso and micro level of risk. • Priority discovery in risk allocation: macro and micro level risks should primarily be retained by the public sector or shared with the private sector; while most of the meso level risks should be retained by the private sector. • There are some risks in which unilateral allocation is not always clear.
4	Nisar (2007)	PFI	United Kingdom	• Discuss two strategies of transferring risks, explicit and implicit risk transfer, about design, construction and development, performance, operating costs, change and end of revenue, and other project risks
5	Thomas et al. (2003)	BOT	India	• Identify eight types of risks: traffic revenue risks, delay in land acquisition, demand risks, settlement delays, completion risks, cost overrun risk, debt servicing risks and direct political risks. • Discuss the risk perception of project stakeholders and the factors affecting risk acceptance.
6	Wang et al. (2000), Xenidisand Angelides (2005)	BOT	Various countries	Discuss risk factors in political, foreign exchange and revenue, financial and legal risk categories.

Source: Summary from the author

✓ Identify and classify risks

Identifying risks is the first step in properly managing them (Berkeley, 1991). Therefore, the researchers identified potential risks associated with the PPP project and proposed a few classification methods to structure these diverse risks. Merna and Smith (1996) have classified PPP project risks into two main categories: global risk and elementary risks. The risk factors in the first group are generally those that are outside the control of project participants, including political, legal, commercial, and environmental factors. The latter group contains most of the project-level risks, such as construction, design, operating, financial and revenue risks. Li et al. (2005) proposed a three-level classification approach to PPP project risk classification. This approach classifies PPP risks into three levels: macro, meso and micro. Macro-level risks are external risks to the project itself; meso risks are risks associated with the project; while micro risks are risks related to each project participant. A widely used approach is to classify risks according to the specific areas of the project to which they are related, such as political risks, construction, operational and maintenance, legal, market and finance.

Summary of qualitative research results experts agreed with 08 types of risk and 46 risk factors from previous studies (Table 2).

Table 2: Summary and additional recommendations of the research team on risk factors list in infrastructure development investment in the form of PPP

Code	**Risk factors in PPP**	Wang et al. (2000)	Partner-ships Victoria (2001)	Michel Barnier (2003)	Pa-diyar (2004)	Li et al. (2005b)	Sachs et al. (2007)	Esta-che (2007)	Cristina and Jonathan (2007)	Zou et al. (2008)	OECD (2008)	Philippe Burger (2009)	Ke and Wang (2010a)	ESCAP (2011)	Moham-med et al. (2012)	No. of results
References		[16]	[12]	[8]	[11]	[7]	[14]	[4]	[2]	[17]	[10]	[13]	[6]	[3]	[9]	
A. Political risks																
RR.A.1	Nationalization and expropriation	X			x	X	x	x			x		x	x	x	9
RR.A.2	Government reliability risk	X		x		X	x	x		x			x		x	8
RR.A.3	Poor public decision-making process					X	x		x				x		x	5
RR.A.4	Political opposition			x		X	x			x			x		x	6
RR.A.5	Government intervention			x			x						x	x		4
RR.A 6	Corruption of government officials	X					x			x			x			4
B. Legal risks																
RR.B.7	Law and legislation changes risks	X			x	x	x	x	x		x	x	x	x	x	11
RR.B.8	Tax regulation change	X		x	x	x	x	x	x		x	x	x	x	x	12
RR.B.9	Sufficient, clear,						x					x	x			3

Code	**Risk factors in PPP**	Wang et al. (2000)	Partnerships Victoria (2001)	Michel Barnier (2003)	Padiyar (2004)	Li et al. (2005b)	Sachs et al. (2007)	Estache (2007)	Cristina and Jonathan (2007)	Zou et al. (2008)	OECD (2008)	Philippe Burger (2009)	Ke and Wang (2010a)	ESCAP (2011)	Mohammed et al. (2012)	No. of results
	and appropriate national law on PPP															
C. Economic and financial risks																
RR.C.10	Inflation risk	X	X	x	x	x		x	x	x	x		x		x	11
RR.C.11	Interest rate risk	X	X	x	x	x		x	x	x	x	x	x	x	X	14
RR.C.12	Foreign exchange and currency convertibility risk	X		x	x	x	x	x	x	x	x	x	x	x	X	13
RR.C.13	Reduced ability to provide capital		X			x			x			x	x	x	x	7
RR.C.14	Economic volatility			x	x	x					x			x	x	6
RR.C.15	Lack of appropriate financial instruments					x							x		x	3
D. Objective risks																
RR.D.16	Force majeure		X		x	x	x	x	x		x		x	x	x	10
E. Risks in project developments																
RR.E.17	Project approval and permit risk	X					x	x			x		x		x	6
RR.E.18	Inappropriate project selection							x	x							2

Code	**Risk factors in PPP**	Wang et al. (2000)	Partner-ships Victoria (2001)	Michel Barnier (2003)	Pa-diyar (2004)	Li et al. (2005b)	Sachs et al. (2007)	Esta-che (2007)	Cristina and Jonathan (2007)	Zou et al. (2008)	OECD (2008)	Philippe Burger (2009)	Ke and Wang (2010a)	ESCAP (2011)	Moham-med et al. (2012)	No. of results
RR.E.19	Financial attraction of project to investors				x	x		x				x			x	5
RR.E.20	Capability of the project company/ investor			x	x			x	x				x			5
RR.E.21	Inappropriate risk allocation for public-private partner in the contract	X				x		x	x	x		x	x	x	x	9
RR.E.22	Uncompetitive biding	X	x						x				x			4
RR.E.23	Failure or delay in land acquisition		x		x	x		x	x		x		x		x	8
RR.E.24	Design and estimation risk	X	x			x		x	x		x		x	x	x	9
								F. Project completion risks								
RR.F.25	Quality risk	X				x			x						x	4
RR.F.26	Overrun construction cost	X	x	x	x	x		x	x		x		x	x	x	11
RR.F.27	Delay construction time	X	x	x	x	x		x	x		x		x	x	x	11
RR.F.28	Inputs price	X			x	x		x					x		x	6

Code	**Risk factors in PPP**	Wang et al. (2000)	Partner-ships Victoria (2001)	Michel Barnier (2003)	Pa-diyar (2004)	Li et al. (2005b)	Sachs et al. (2007)	Esta-che (2007)	Cristina and Jonathan (2007)	Zou et al. (2008)	OECD (2008)	Philippe Burger (2009)	Ke and Wang (2010a)	ESCAP (2011)	Moham-med et al. (2012)	No. of results
RR.F.29	Engineering and technical risk	X	x	x		x		x	x		x		x	x	x	10
RR.F.30	Change in private investors, supply contractors	X				x			x				x		x	5
RR.F.31	Delay in the supply of supplies, machineries, and equipment	X		x	x	x		x	x				x	x	x	9
RR.F.32	Labor risk	X	x		x	x							x		x	6
G. Operation risks																
RR.G.33	Demand risk	X	x	x	x	x		x	x	x	x	x	x	x	x	13
RR.G.34	Fee risk	X	x	x	x	x		x	x	x	x	x	x	x	x	13
RR.G.35	Payment risk	X				x		x	x	x	x	x	x	x	x	9
RR.G.36	Competition (Monopoly)	X	x			x			x	x			x		x	7
RR.G.37	Operation cost overrun	X				x		x	x				x	x	x	7
RR.G.38	Higher-than-expected maintenance cost		x			x								x	x	4
RR.G.39	High frequency of maintenance		x			x					x			x	x	5

Code	**Risk factors in PPP**	Wang et al. (2000)	Partner-ships Victoria (2001)	Michel Barnier (2003)	Pa-diyar (2004)	Li et al. (2005b)	Sachs et al. (2007)	Esta-che (2007)	Cristina and Jonathan (2007)	Zou et al. (2008)	OECD (2008)	Philippe Burger (2009)	Ke and Wang (2010a)	ESCAP (2011)	Moham-med et al. (2012)	No. of results
H. Coordination risks																
RR.H.40	Excessive contract variation		x			x					x				x	4
RR.H.41	Weak contract management and dispute		x		x				x		x	x		x		6
RR.H.42	Lack of experiences in PPP			x	x	x	x	x				x	x		x	8
RR.H.43	Lack of commitment from public/private party				x	x			x		x	x			x	6
RR.H.44	Risk in organization and coordination		x			x			x			x	x		x	6
RR.H.45	Residual value risk		x			x		x			x		x	x	x	7
RR.H.46	Third part reliability					x			x					x	x	4

✓ Allocation of risks

Ward et al. (1991), Edwards (1995), Flanagan and Norman (1993) pointed out that stakeholders must first identify and understand all potential project-related risks to ensure risks are properly allocated. Risks should be allocated to one party with the best financial and technical ability to manage them, and that party must be willing to accept the risks. Based on these principles, researchers have studied risk allocation strategies in PPP projects. Charoenyhpattana and Minato (1999) identified risks associated with PPP transport projects in Thailand and proposed risk allocation strategies. Most of political risk, financial risk and legal regulations should be covered by the government. Most operational-related risks should be retained for the private sector (for example, technical and managerial risks) or shared between both parties (for example, supply and demand risks).

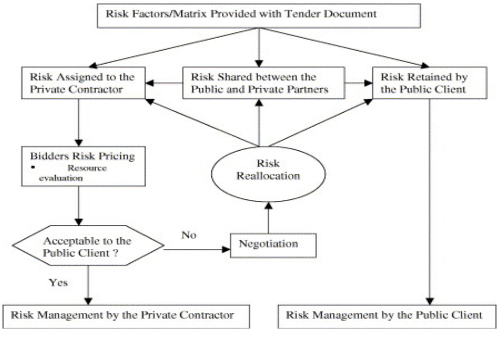

Fig 1. Risk allocation (transfer) process.

Source: Li, Bi et al. (2005b)

Many studies related to risk identification and allocation in PPP projects can also be found in Arndt and Maguire (1999), and Abednego and Ogunlana (2006). Although the actual risk allocation strategies may vary from project to project and from country to country, generally speaking, the environmental-related risks to which the project is implemented should be retained by the government, while the risks directly related to the project should be mainly allocated to the private sector. Some risks that are beyond the control of both the public and private sectors should be shared by both parties. However, the implementation of these principles in practice is very difficult. Froud (2003), A. Ng and M. Loosemore (2007) provided significant evidence that risks have not been managed and/or risk allocation strategies have not been properly implemented.

Risk allocation and management analysis all involve these following activities: (i) Identify all possible risks and assess their capabilities; (ii) Test the impact of quantitative and qualitative risks; (iii) Consider the possible mitigation strategies available; and (iv) Allocate of risks to parties.

2. IMPLICATION AND PROPOSED SOLUTIONS TO MINIMIZE RISKS FOR INFRASTRUCTURE DEVELOPMENT IN VIETNAM

2.1. Implication

In general, all studies agreed on the risk management process including 3 main steps: Identify risks; cope with risks; and control the risks.

Regarding the identification of risk factors through research, the author finds that there are some common risks between developed and developing countries. However, some risk factors only appear in developing countries where there is a lack of national laws on PPP, existence of corruption, risks in project approval and permission, etc. In addition, some risks mainly appear in developing countries such as risk of nationalization and expropriation, delay in the supply of supplies, machinery, and equipment, etc. Since each country has a different political, legal, economic, and social conditions, there are quite a number of different risk factors.

Studies on the distribution (transfer) of risks in infrastructure projects in the form of PPPs by countries have been carried out (for the public sector; for the private sector; or for sharing between both public and private sector) on the principle that risks are allocated to the party that is best at controlling the risk of occurrence and controlling the impact of the risk on the project result. The method used: Method ≥ 50%; half-adjustment method. The results show that there is some consensus on some risk factors allocated to the involved parties; however, the results are different in the allocation of some other risk factors. This is because PPP is highly dependent on the investment environment, especially the political, legal, economic, and social system.

2.2. Proposed solutions to minimize risks for infrastructure development in the form of PPP in Vietnam

* Risk allocation (transfer) principles:

- Principle 1: Risks must be understood by all participants to share responsibilities, risks and all parties should accept risks to actively manage and control (WB, 2009).

- Principle 2: A list of key risks for public-private partnership projects should be established (PPIAF, 2012; Shen et al., 2006).

- Principle 3: Risk should be allocated to the party who is best able to manage the risk and the impact of risk on the project outcome (Irwin, 2007; Estache et al., 2007) ; OECD, 2008; Padiyar et al., 2004).

- Principle 4: The core principle of a public-private partnership project is the risk should be allocated to the party who is able to manage it in the most cost-effective manner. (Irwin, 2007; Michel Barnier, 2003; Hayford, O., 2006; Padiyar et al., 2004).

* Proposal to allocate risks to Vietnam's infrastructure investment project:

The risk allocation between public and private partners is crucial in enhancing the effectiveness of private sector participation. It is also an important factor to promote the value of a PPP project. Here are some main risk factors of a PPP infrastructure project in Vietnam and the party that those risks should be allocated to (Table 2).

Table 3. Table of allocation and mitigation of PPP risks

Risk	Risk mitigation strategy	Allocation
Delay in land acquisition	The evaluation of the project site during the project proposal period needs to be done thoroughly and potential risks need to be identified. Based on the analysis, the most feasible project site should be selected. Land acquisition should be one of the prerequisites to minimize financial loss, if any.	Government agency
Approach project site	All external links necessary for the project need to be identified as one of the prerequisites for minimizing financial loss, if any.	Government agency
Financial risk	The draft PPP contract needs to be discussed with the lenders so that it can identify and resolve the project's ability to borrow money. Completing the financial arrangement is also one of the prerequisites to minimize financial loss, if any.	Project company
Design risk	The contract should include clear output specifications, design warranties, liability for errors, and an independent	Project company

	expert should be included in the dispute resolution process.	
Approval risk	The public agency needs to support the project company in obtaining approval decisions. The PPP contract should include a list of required approvals.	Project company
Construction risk - overrun time and cost	(i) The bidding process should include strict requirements on experience and competence; (ii) Private companies will often enter construction contracts with fixed unit price and term to transfer risks to an experienced construction unit with competent construction resources.	Project company
Operational and maintenance risk	The Government should conduct a special review on the main subcontractors of the project on the reliability and financial capacity, concurrently, engage a consultant to review on the legality of the subcontractors including warranty and other guarantees that private partners enjoy. In case a mistake or problem occurs, the private partner or the Government may replace the contractor.	Project company
Traffic flow risk	For projects in which the revenue of the project company is from user fee collection, the private partner needs to conduct a thorough and careful assessment of traffic flow.	Project company
Handover risk	The project contract should contain a provision for handover or a contingency fund for handover. If the project business violates the delivery commitment, the Government may use this security or contingency fund to pay for repairs/adjustments.	Project company
Change in law	The government should aim to prevent any serious adverse changes in the law. In unavoidable circumstances, the Government or the user will be subject to the financial implications as the consequences of the change of law.	Government agency
Risk of force majeure	Insurance for force majeure events should be required in the project contract. The financial impacts caused by these events need to be shared between the Government and the project enterprise.	Shared

Source: Summary and proposed research

*. Solutions to minimize risks

Firstly, it is the responsibility of the government's to create a stable and effective investment environment, and fulfill a strong commitment to promote public-private partnership through a complete, clear and effective legal system. Government needs to provide accurate and stable road strategy and planning. At the same time, to improve the feasibility of infrastructure projects in the form of public-private partnership, it is necessary to carry out.

Secondly, bidding needs to be fair, transparent, and competitive.

The government should publish information about the investment portfolio. The government should also support and create favorable conditions to encourage private investors to propose projects that are socioeconomically effective. The process of selecting investors to prepare a feasibility study report should be transparent to select investors with the best financial and professional competence (design, construction, operation, maintenance) for the PPP road traffic project. Along with information disclosure, the government needs to promote investment, especially at major financial centers around the world such as in London (UK), Hong Kong (China), Singapore, etc. to attract investors with strong managerial and financial capacity.

At the same time, the government needs to publicize the bidding process: receive, manage, evaluate, and select bidding documents. The criteria and evaluation method in terms of technical, financial, commercial should be transparent. The bidding experts must be well-trained and knowledgeable about investment law. They must have professional qualifications, foreign language skills and experience suitable to the requirements of PPP infrastructure projects.

The government should try to strictly control funding and financial risks by ensuring that only reputable and competent parties are the selected bidding group. By doing so, the government can ensure that not only the lowest cost bid can be selected, but that that bid is also financially strong and can meet the project's expected returns. Simultaneously, the government can achieve economic and social efficiency.

Thirdly, the capability of investors, allocation risks and land acquisition risk.

The risk factors Capability of the project company/investor, Failure and delay in land acquisition, Inappropriate risk allocation for public-private partner in the contract are ranked at the fourth, fifth and fourteen place respectively in the degree of effect of the project outcome. To successfully control this risk factor, the risk allocation results show that in the future, there should be a strong commitment to the factor Failure and delay in land acquisition by the government. In addition, the private sector should take responsibility for the risk factors Capability of the project company/investor, and Inappropriate risk allocation for public-private partner in the contract.

Therefore, it is necessary to improve the capability of private investors to improve their ability to take in risks in PPP transportation projects Foreign investors with strong capital sources can implement individually or in cooperation with two or three private investors. Particularly, domestic private investors should cooperate with companies under the form of equitization to overcome limitations on size, financial capacity and to minimize investment risks. By doing so, the private partners can improve the financial capability, managerial capability and experience when implementing PPP infrastructure project in Vietnam.

Next, the government should establish mechanisms, policies and regulations that are consistent with international practices and the current Vietnamese economy. At the same time, the government also needs to improve the managerial capability of state agencies, who are authorized to manage public-private partnerships. State agencies help the government to effectively undertake the risk factors in land acquisition.

(i) Effectively implement grassroots democracy in land acquisition procedures to ensure publicity, transparency, and fairness.

(ii) Focus on renovating and improving the quality of land use planning and management. Publicize the planning of projects, landmarks, and work protection corridors for grassroots administrations to manage. Let people supervise, fulfill their obligations, and protect their lawful interests.

(iii) Continue to develop and improve mechanisms and policies on compensation, support, and resettlement to accord with legal requirements and actual situations. Perform review on mechanisms and issued policies to make suitable supplement and amendment. Compensate properly for the land users, whose land and lawful assets were damaged due to land acquisition by the state, based on uniform implementation of land policies. Policies on compensation for losses incurred due to land acquisition by the state must meet the market standard and comply with current legislation.

(iv) Continue to promote administrative reform in the compensation, support, and resettlement procedure when the government acquires the land: Adjust and supplement promptly the procedure of compensation and site clearance. The process of compensation and site clearance must be accompanied with the project announcement, planning, land acquisition and investment registration procedures. During the process, it is necessary to clearly define the stages, implementation time, implementation responsibilities, and proactively forecast the probabilities to have specific resolutions.

(v) Enhance inspection and supervision: Enhance inspection and supervision in the implementation of site clearance compensation in order to promptly detect, supplement and adjust the policies and mechanisms that are inadequate and inappropriate with reality. Implement strict punishment to organizations and individuals that show negative signs and are lack of responsibility in the compensation and site clearance process. Increasing involvement of judicial agencies right from the announcement of land acquisition until the handover of land to investors.

3. CONCLUSION

The paper systematized the experiences of countries related to risk management (concepts, identification of factors and risk distribution in infrastructure development projects in the form of PPP). Accordingly, it is shown that the PPP project may be affected by several factors, such as the type and size of the project, the country where the project is implemented and the form of PPP project. Therefore, different PPP projects may have different list of risk factors. In addition, the importance of a particular risk factor may vary between projects and/or from one country to another.

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INCENTIVES AND FINANCIAL SUPPORT OF THE GOVERNMENT IN INFRASTRUCTURE INVESTMENT PROJECT UNDER PUBLIC-PRIVATE PARTNERSHIP IN VIETNAM

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Abstract: *The financial feasibility of public-private partnership (PPP) projects is the government's top concern. If the project is not feasible, private sectors will not be interested in participating in the project. For that reason, the article analyzes policies of the Vietnamese government in offering incentives or financial support with different options depending on the project's financial risk. By providing insights into the current situation of this topic, the authors expect to contribute to improving the financial income ratio of this type of projects to attract more investment of private sector in infrastructure development.*

Keywords: *Public-private partnership (PPP), infrastructure, financial support.*

1. INTRODUCTION

Regarding infrastructure development, many countries, especially underdeveloped and developing countries like Vietnam, face the challenge of huge investment needs, while state resources are limited and unable to accommodate. To resolve this issue, the role of the state has a decisive influence on mobilizing resources of private investors for. Facts indicate that some PPP projects of technical infrastructure development in Vietnam in recent years have been remarkably efficiency, contributing significantly to fulfil the demand of social-economic development. One of the biggest difficulties facing PPP projects is to find financial sources. Since the preparation of a proposal for an infrastructure project requires a great deal of costs and resources, the absence of clear regulations on funding sources to make up the financing gap will cause the authorities in charge to hesitate to prepare the proposal. It is expected that PPP Law concerns and addresses issues related to project assurance as well as principles for the preparation and disbursement of capital to support project financing.

2. LITERATURE REVIEW

2.1. Financial factors affecting the success of investment projects under PPP model

A sound financial plan is vital to the success of a PPP project. This importance is reflected in the higher weights assigned to financial criteria in evaluating PPP proposals for infrastructure projects. For example, the Hong Kong government applies three sets of criteria (financial, technical, and operational plans) to evaluate bidding for its infrastructure projects. The weights allocated to these three sets of criteria are about 65%, 20% and 15% respectively Zhang (2001). Zhang (2005) found that the financial capability of a franchise partner can be measured in four aspects: strong financial technique; favorable financial resources and low service costs; reasonable capital structure and low requirement for return on investment; and strong capability of risk management. Findings of key studies on financing for PPP projects are summarized in Table 1.

Table 1. Summary of key financial studies for PPP project

No.	Authors	Forms of PPP	Scope of study	Key findings
1	Merna and Dubey (1998)	PPP	Unknown	• Discuss the concept of fiancing technique and how it can be used to structure financial packages for infrastructure projects.
2	Levy (1996)	BOT	International	• Provide a thorough examination of the technical, construction and financial skills which are necessary to carry out a BOT project.
3	Schaufelberger and Wipadapisutand (2003)	BOT	International	• Propose alternative financing strategies that consider project risk, project conditions and financial capacity.
4	Ye and Tiong (2000)	BOT	China	• Discuss the supporting role of the government in BOT projects.
5	Zhang (2005)	PPP	Unknown	• Develop methods of optimizing capital structure and analyzing financial capacity.
6	Devapriya (2006)	PPP	International	• Consider the nature, form and unique management of debt and equity arrangements in regulated PPPs.

Source: Summary of the author

As can be seen in table 1, some PPP projects referred in listed studies are classified as BOT standing for BUILD - OPERATE - TRANSFER. This is a financing model, normally for large infrastructure project (Hayes, 2019). To be more precise, this type of PPP projects is concessed to a private firm by government to buil and operate within a certain time period. After agreed duration, for example, 20 -30 years, the government takes over the infrastructure.

2.2. Techniques, financial tools, and strategies

Infrastructure projects which are funded in the form of PPP are often complex, large-scale and require innovative financial techniques. Project finance is one such technique. In project finance, a project is considered as a separate legal entity, and debt and equity financing the project is returned from the project-generated cash flow (Merna and

Dubey, 1998). PPP projects are generally financed by both equity (e.g. ordinary shares) and debt (e.g. loans). A commonly followed philosophy is to use much debt as the project cash flow to generate attractive returns for shareholders. The capital structure in most PPP projects is highly leveraged, with equity accounting for 10-30% of the total project cost and debt financing accounting for the remaining 70-90% (Levy, 1996). Although a higher debt may allow a higher return on investment, an excessive debt ratio may pose a greater risk to the project. Therefore, an appropriate structure between capital and debt is necessary when financing PPP projects (Zhang, 2005).

International experience shows that many countries have applied the mechanism of State capital participating in supporting PPP projects called **Viability Gap Funding** - referred as **VGF**, summarized in Table 2.

Table 2. State funds support to increase the feasibility of PPP projects

Country	State support fund
Korea	VGF is applied but there is no VGF fund. Depending on the field, it can account for up to 30 % (road, port), 50 % (railway) of the total investment. The government of Korea assigns the specialized ministries to guide the ceiling of the State capital contribution in the construction and clearance phase. The initial period, the State capital is allocated to support construction capital and payment to investors in the operational phase. This is called BLT contract, referring Build - Lease - Transfer, introduced by Korean government at the end of 2004. BLT is a variation of BOT in which government also concesses an entity (i.e. a company) to invest in building the infrastructure. The entity then leases the infrastructure to the government who is directly in charge of operating. After a set time period, ownership is transferred to the government. Return on investment for the concessionaire is in the form of lease fee (Japan Fair Trade Commission, 2014). However, regulations on payments to investors are very strict to reduce the potential debt for the government. The total payment to the investor must be submitted to the National Assembly for approval.
Philippines	There are VGF and VGF funds.
Canada	There is a fund (PPP Canadian fund) managed by the Ministry of Finance, with a ceiling of 25 % of construction costs.
Japan	PFIs (Private Finance Initiatives). Applying this model means that private finance is utilized in constructing public infrastructures. Afterwards, management and maintenance are also under control of private entities within a given time set (the PFI in Japan), e.g. 25 to 30 years (PFI, investopedia).
China	There is a VGF mechanism including: Financial support; equity; preferential loans; preferential policies when the project does not compensate reasonably for investors' expenses and profits.
India	VGF is applied but there is no VGF fund, with a ceiling of 40 % of total investment (excluding 10 % of site clearance and resettlement cost). To be more specific, national budget contributes maximum 20 % of total investment. The rest proportion is covered by local budget and ministries. VGF is not for projects invested by state-owned enterprises.
Brazil	VGF is applied but there is no VGF fund. The fund is from 3 % of federal and state budget. There is no limit for VGF.

Option 1: Form a "PPP Project Development Fund"

Based on the experience of some countries, this fund has a function of allocating state capital and providing assurance. This fund can mobilize capital from various sources such as a state budget, government bonds, ODA, money returned by investors upon successful signing of contracts, fees collected from selling or authorizing an entity to operate an infrastructure, and revenue of selling state assets after rearrangement. Having the advantages of being flexible and independent in managing and allocating the capital, option 1 shows the willingness of government commitment, which attracts more investors. However, it is necessary to consider the fund mechanism regulated under Vietnamese law on state budget.

Option 2: Form a separate budget segment for medium-term public investment plans

It is possible to learn from the experience of some countries such as Canada and Mexico in establishing an Agency/Fund specialized in managing and investing in infrastructure projects (including transport infrastructure projects). It is also possible to follow the model of a financial company, mobilizing capital and investing directly or indirectly through the commercial banking system, guaranteeing risks of investment, and managing projects while investing.

In addition, project risks, project conditions and financial resources should be considered when selecting the appropriate financial strategy for an infrastructure investment project in the form of PPP. Schaufelberger and Wipadapisut (2003) recommended financial strategies for PPP infrastructure projects under four risk conditions (Table 3).

Table 3. Financial strategy for PPP project in different risk conditions

No.	The risk conditions	Financial strategy
1	Low risk	Using high debt-to-equity ratio for maximum leverage and maximum return on equity.
		Establishing minimum contingent credit facilities to minimize financial expenses.
		Using capital markets to buy debt to reduce interest expenses.
		Buying long-term financing early to reduce financial costs.
2	High political risks	Attracting international companies or organizations to create leverage with local authorities.
		Seeking help from influential individuals or organizations with relationships with local authorities.
		Seeking support and guarantees from local governments.
		Buying insurance from government organizations like the Foreign Investment Corporation.
		Establishing backup credit facilities to cover unforeseen expenses.
3	High financial risks	Obtaining loans from international lenders.
		Using debt financing with a fixed or standard interest rate.
		Applying face value in local currency.
		Structuring to finance debt in currencies which are similar to expected revenue.
		Structuring revenue in both local and foreign currencies.
		Seeking government support and guarantees.
		Including terms of revenue escalation in contracts.
		Establishing a backup credit facility to cover unforeseen expenses.
4	High market risk	Financing initial phase with equity and short-term loan & re-financing in operational phase with long-term debt at lower costs.
		Structuring debt repayment at low in the beginning, rising gradually in the beginning years of operation.
		Negotiating the terms of the contract that allows user fee increases.
		Establishing a backup credit facility to cover unforeseen revenue gaps.
		Re-structuring debt, if necessary, in order to resolve cash flow issues during

concession period	

Source: Schaufelberger và Wipadapisut, 2003.

3. MEASURES FOR INCENTIVES AND FINANCIAL SUPPORT FROM THE GOVERNMENT

In the period of 2020-2025, the demand for investment in infrastructure in Vietnam accounts for about 8-10 % of GDP, of which the state budget only meets about 50 %. According to the Asian Development Bank (ADB) and HSBC (the Hongkong and Shanghai Banking Corporation Limited), the average annual infrastructure investment demand of Vietnam is about 16-17 billion USD per year (about 370-400 trillion VND). Accordingly, the demand for PPP capital in the period of 2020-2025 can reach 4-5 % of GDP (i.e. about 10-12 billion USD per year), of which transport infrastructure accounts for about 50-60 %. PPP capital (i.e. about 5-6 billion USD per year). Apparently, this is a major challenge for the process of mobilizing resources for PPP projects.

3.1. State trade support

Other government supports include ensuring exchange rates and early project completion bonuses. The appropriate level of government support can improve the financial capacity and attractiveness of PPP investment projects. However, too much government support may raise concerns that the private sector will make too much profit at the same cost of public investment. To avoid such concerns, the government should adjust the level of support and select the appropriate types of assistance according to the profitability of infrastructure investment projects in the form of PPP.

Table 4. State trade support to PPP

Possible measures	**Apply**
Direct support from the government	
Subsidy	Yes up to 40 % of investment value, look up by fixed/absolute amount
Revenue share of existing facilities	Currently limit range but should be available
Government confiscates land	Yes
Operational fixing/subsidy payments	Yes (for DBFM and O&M contracts)
Blurry charge	No
Construction of related works	Yes
Government support equity	No
Secondary loan	Yes
Tax incentives	Yes
Additional development rights	No Bidding competes independently
Certified mail	Have
Potential government support	
Guaranteed minimum revenue	Only in cases where the revenue sharing limit is exceeded
Government guarantee for loans	No, secured by contract termination payments

Possible measures	Apply
Exchange rate risk	Yes
The Government acquires force majeure cases	Yes
Unexpected termination and payment	Yes
Transitional period	Yes
Flexible contract term	Yes
Extend the contract term	No
Partial risk guarantee	Yes
Partial credit guarantee	Yes

Source: Summary of the author

In general, the government can offer different types of incentives and with different tools to reduce the risks and possible uncertainties of a PPP infrastructure project. Incentives are given in a way that can significantly improve the financial feasibility of projects and reduce project risk to make them more attractive to the private sector.

3.2. Minimum guaranteed revenue

Minimal guaranteed revenue from the government is a way for the private sector to minimize market demand risk. To ensure that the project business has a certain revenue, the Government will provide a subsidy for operations. Such subsidies are often provided to ensure that the project meets the minimum solvency.

3.3. Flexibility in tariff structure

The tariff structure and adjustment have a significant impact on the project's cash flow. Therefore, some flexibility in tariff structure may be required to enhance the financial viability of the infrastructure project in the form of PPP. According to the VGF Survey Report for PPP projects in Vietnam, September 2017. For example, the case of Shajiao B - a power plant in Shenzen China - invested and constructed by a HongKong and industrial compan. For the guaranteed minimum electricity amount, the flat tax rate is 0.111 RMB/kWh (RMB: Yuan). In the meanwhile, for quantities exceeding the minimum quantity, the tax rate is 0.0748 RMB/kWh. In some cases, the mechanism for tariff adjustment will be determined in advance, whereby the franchisor will be allowed to increase taxes in some cases**.**

3.4. Financial support

Different types of financial support, both direct and indirect, can be used to increase the financial income of the project, thereby enhancing the attractiveness of the PPP project. Direct financial assistance may include capital investment (e.g. grants or loans), free use of construction sites and project facilities, and tax incentives. The case of Laibin B project could be considered as a well-illustrative example. This was the very first official BOT project of China. In late 20th century, Chinese economy grew significantly, demaning supporting infrastrcture such as transport links or utility supplies. For that reason, Chinese government offered various favorable concession to private entities in assisting investment and construction. In Laibin B project, for the second phase, not only BOT model was applied, but also government offered the right to freely use the appointed site (Alfen, Ogunlana, Kalidindi, & Wang, 2009)). Indirect financial assistance usually involves providing private sector support in the financial process. One way is to provide a loan guarantee to the project franchisor, guaranteeing the lender that the debt will be repaid or partially repaid by the government if the project fails.

Supporting capital for investment preparation: According to Article 6 of Decree No. 63/2018/ND-CP issued on May 4th 2018 about Invesment under PPP as follows: Ministries, branches and provincial-level People's Committees take the initiative in mobilizing lawful capital sources to support investment preparation of PPP projects in accordance with the provisions of Vietnamese Law on State Budget, the law on public debt management and other relevant law provisions. Expenses of investment preparation of PPP projects implemented by ministries, branches and provincial-level People's Committees must be specified in the bidding dossiers.

After the PPP contract is signed between the competent state agency and the winning investor (or the winning investor and the project enterprise), the winning investor shall refund the source of standard expenses. Investment of PPP projects for ministries, branches and provincial People's Committees has complied with bidding documents.

Ministries, branches, and provincial-level People's Committees shall prioritize the arrangement of sources of revenue returned by investors for investment preparation expenses to create sources of investment preparation for other potential PPP projects. The management and use of investment preparation support capital sources must comply with the provisions of the state budget law, the law on public debt management and other relevant laws.

For mobilized capital other than the state budget and the capital supplier with regulations on management and use of investment preparation support capital sources different from the provisions of law on state budget, the Ministry of Finance, branches and provincial People's Committees are solely responsible for mobilizing, managing and using this capital. In the case of the necessity to promulgate separate regulations, ministries, branches, and provincial-level People's Committees propose and coordinate with the Ministry of Finance for promulgation.

Payment by capacity or payment by implementation stage: For projects with high market risks, the Government may pay the private sector partner an annual payment in return for construction and infrastructure operation. For example, many of toll road projects in Australia are paid by phase. The investor receives a fixed amount of revenue from the Government in exchange for the construction, operation, and maintenance of the highway in accordance with standards and specifications.

Payments by phase covered by government can also be made in the form of an underwriting or a guaranteed supply. The government will either guarantee payment for goods and services provided by the project business by the Government (underwriting), or will secure the supply of goods for the project (supply guarantee).

Investment funding in the construction process: This is a fairly common form of government subsidy in which project enterprises are provided with a fixed amount of financial assistance during the construction process.

3.5. Protection of force majeure

Force majeure events can have significant negative effects on project performance, such as causing delays in project completion or termination. Extending the time of concession or compensation for certain force majeure events are two government supports that can protect the franchisee from damage caused by such events. For example, in the Shajiao B power project in China, the government agreed to extend the construction and operation time if the delay was due to force majeure events.

4. CONCLUSION

A sound financial plan for an PPP-invested infrastructure project must have a combination of equity and debt, and a financial strategy based on project risk considerations, project conditions and financial resources. Some government support such as guaranteed minimum revenue, flexibility in tariff structure, financial support and guarantees for force majeure events may be required to implement a projectfeasibly in terms of finance.

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PRODUCTION AND HUMAN RESOURCES MANAGEMENT IN MININGPRODUCTION AND HUMAN RESOURCES MANAGEMENT IN MINING

COMPLETING PRODUCTION PROCESS AND LABOR ALLOCATION FOR MECHANIZED LONGWALL 11 IN HA LAM COAL JOINT STOCK COMPANY - VINACOMIN

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Abstract: *Ha Lam Coal Joint Stock Company - Vinacomin is one of the companies that has successfully applied synchronized mechanization for longwall coal mining. However, the production process still has inadequacy maintaining productivity in the long run. If producing with the longwall 11 three consecutive shifts in the day and night according to the chart built by the company, after a while, the old equipment will be damaged intermittently. The content of the article focuses on analyzing the actual situation, completing the production organization, and labor allocation for longwall 11 by selecting a reasonable working mode, thereby increasing labor productivity, reducing product cost price, and improving business efficiency for the company.*

Keywords: *Production organization; labor allocation; longwall 11, working mode*

1. INTRODUCTION

The longwall 11 is the first longwall that Ha Lam Coal Joint Stock Company - Vinacomin synchronously applies mechanization in mining, with a designed capacity of 600,000 tons per year. For nearly five years of application, new technology has brought outstanding achievements to the company, marking a critical breakthrough and confirms the right way for the company and Vinacomin. However, for five years of operation, with the successes of the company, the research team reviewed and discovered the inadequacies that affect the sustainability of coal production and business efficiency. Ha Lam is operating the equipment with three consecutive work shifts daily, which can increase mining productivity, even exceeding the designed capacity. But over time, when the machinery becomes outdated, they cannot maintain this operational mode.

The article analyzes the actual situation and recommends a plan of improving the production organization and labor allocation in longwall 11 to increase labor productivity, lower production cost

price, and contribute to ensuring efficiency sustainability of the new technology in Ha Lam Coal Joint Stock Company.

2. THE ACTUAL SITUATION OF PRODUCTION ORGANIZATION AT LONGWALL 11

2.1. Overview of mining conditions and technology of longwall 11 in Ha Lam Coal Joint Stock Company

Longwall 11 is the abbreviation of Synchronous mechanized (CGH) longwall 11-1.16 seam 11, located in the West of the mining area of seam 11. Based on the seam structure, the length of the longwall in the cross pitch is 548m on average, the size of the longwall (under the pitch) is 118.5m.

According to the geological report, the mining area of seam 11 is 1.74 km^2, the sean thickness is 0.38 ~ 17.48 m, the average thickness is 5.46 m, and the sloping angle of the seam is 4° ~ 53°.

The synchronous longwall CGH 11-1.16

seam 11 applies the system of synchronous CGH mining for coal recovery. This design is based on the result of the exploration drilling of 24 boreholes within the scope of CGH mining synchronized with coal recovery. The seam thickness is 1.89 ~ 9.83 m, 6.8 m on average, the sloping angle is 12°, seal thickness of synchronous CGH longwall 11-1.16 seam 11 is 9.75 m ~ 15.15 m, 14 m on average, the sloping angle of the seam is 8° ~ 15°.

Geological - mining documents show that the condition of seam 11 of Ha Lam Coal Company is relatively convenient for the application of synchronous mechanized mining technology. The investment and selection of synchronous mechanized mining technology line of top coal recovery are entirely reasonable. During the process of mining and operation of these two technological lines, according to the comprehensive evaluation, the choice of the longwall mining system of top coal caving is entirely reasonable. However, the recovery height of both technology lines is very high, but the coal recovery rate is relatively high. Consequently, it can reduce the loss during the recovery process.

2.2. Actual situation of organizing production in longwall 11

Currently, Ha Lam has built a production organization model for longwall 11 with a design capacity of 600,000 tons/ year. The components in the production organization model in CGH longwalls include the chart of the mining cycle organization, the chart of labor allocation, and technical instructions for longwall coal mining. From the perspective of production organization, the article only considers two types of chart: production organization chart and labor allocation chart in the production organization model at CGH longwalls in the company today.

* Production organization chart: Under Fig 1.

* Labor organization work

The labor allocation chart is shown in Fig 2.

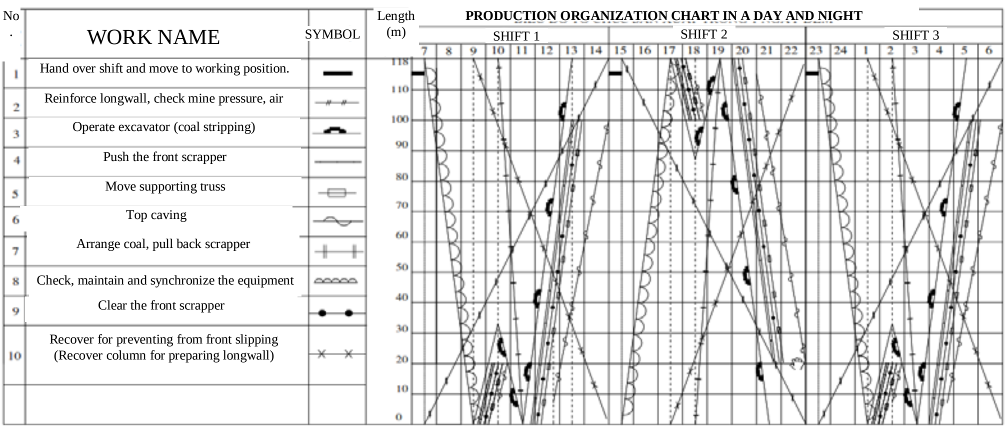

Fig 1. Production organization chart of longwall coal mining in seam 11 with a working mode of 3 work shifts per day

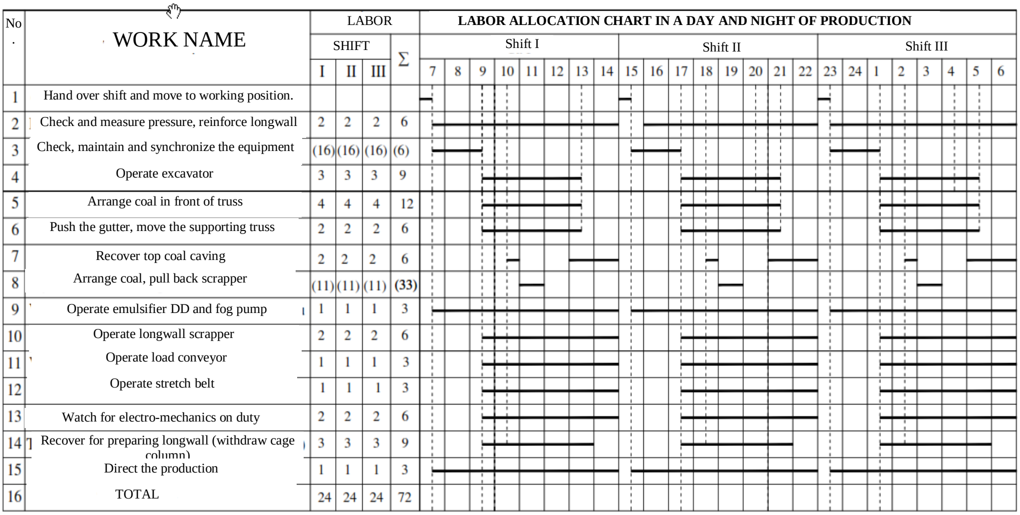

Fig 2. Labor allocation chart for seam 11 under the normal production conditions with the working mode of 3 work shifts per day.

To analyze, the research team has conducted the statistics of data on the number of employees and labor productivity from October 2016 to September 2018. The result is shown in Table 1.

The above analysis showed that the number of direct labors varied from 62 to 117 people, often higher than the calculation of the company (69 people), except November and December 2017. One of the reasons for the increase in the number of direct laborers was machinery malfunction, which interrupted production, and the company had to allocate more laborers to handle in this field. Due to the application of three consecutive work shifts, even the machines work overloaded for some times. These disadvantages affected the labor productivity and capacity of mechanized longwall in general.

Table 1. Analysis of labor use situation and labor productivity in longwall 11

No.	No.	Output (ton)	Direct labor (force)	Direct labor (person)	Direct labor productivity (ton/ labor)	Continuous increase in speed, %
1	10/2016	42.012	2.565	117	16.38	
2	11/2016	74.560	2.052	89	36.33	2.22
3	12/2016	76.506	2.093	91	36.55	1.01
4	01/2017	65.491	1.809	90	36.20	0.99
5	02/2017	83.946	2.021	88	41.54	1.15
6	03/2017	94.638	2.628	101	36.02	0.87
7	04/2017	85.447	2.407	105	35.50	0.99
8	05/2017	78.714	2.404	96	32.75	0.92
9	06/2017	85.906	2.561	99	33.54	1.02
10	07/2017	81.804	2.644	102	30.94	0.92

No.	No.	Output (ton)	Direct labor (force)	Direct labor (person)	Direct labor productivity (ton/ labor)	Continuous increase in speed, %
11	08/2017	15.841	2,434	97	6.51	0.21
12	09/2017	3.096	2,552	106	1.21	0.19
13	10/2017	11.284	2,632	101	4.29	3.53
14	11/2017	27.044	1,373	53	19.70	4.59
15	12/2017	13.692	1,415	62	9.68	0.49
16	01/2018	36.875	2,079	90	17.74	1.83
17	02/2018	41.612	1,374	86	30.29	1.71
18	03/2018	87.775	2,465	91	35.61	1.18
19	04/2018	84.842	2,214	96	38.32	1.08
20	05/2018	97.026	2,488	96	39.00	1.02
21	06/2018	100.942	2,573	99	39.23	1.01
22	07/2018	103.345	2,192	84	47.15	1.20
23	08/2018	71.326	2,235	86	1.91	0.68
24	09/2018	7.859	258	10	30.46	0.95

3. PROPOSAL TO COMPLETE THE PRODUCTION ORGANIZATION MODEL AT MECHANIZED LONGWALL IN SEAM 11

3.1. Identification of the economic and technical indicators in the longwall

To build a new production organization model and ensure the requirements of mining output and capacity of the longwall require determination of the economic and technical indicators of the longwall.

The calculation criteria include:

3.1.1. Output of single coal gallery

$$Qk = L \times mk \times k \times r .x\ \gamma, (T) \qquad (1)$$

In which:

L - The average length of longwall, L = 118.5 (m);

r - Progress of 1 strip, r = 0.6 (m);

mk - Strip height, mk = 2.6 (m);

γ - Volumetric weight of coal, γ = 1.66 (T/m^3);

k - Coefficient of coal mining, k = 0.95;

Upon replacing numbers, we get: Q_k = 292 (T).

3.1.2. Top coal caving output in one flow

$$Q_{th} = Lth \times h \times r \times \gamma \times k_{th}, (T). \qquad (2)$$

In which:

Lth = L-(1.5 x Xqđ +1.5x Xtg) = 118.5-(1.5x6 + 1.5x2) = 106.5 m

(Xqđ: number of nonrecovering excessive trusses)

(Xtg: number of nonrecovering intermediate trusses).

h - Thickness of top coal caving layer, h = 11.4 (m);

k_{th} - Coefficient of coal recovery, k_{th} = 0.82.

Upon replacing numbers, we get: Q_{th} = 992 (T)

3.1.3. Coal output mined in one flow

$$Q_l = Q_k + Q_{th} = 292 + 992 = 1,284 \text{ (T)}.$$

3.1.4. Coal output mined in one cycle

$$Q_{ck} = n_l \times Q_l \times k_c \text{ ; (T)} \quad (3)$$

In which:

n_l - Number of strip flow in a cycle, n_{ck} = 1 (flow);

k_c - cycle completion factor, k = 0.85.

Upon replacing numbers, we get: Q_{ck} = 1 x 1,284x 0.85 = 1,091 (T).

3.1.5. Longwall output of a day and night

$$Q_{day.night} = Q_{ck} \times n_{ck}\text{; (T/day.night).} \quad (4)$$

In which:

n_{ck}- Number of cycles per day and night, n_{ck} = 3 (Cycles/day.night).

Upon replacing numbers, we get: $Q_{day.ninght}$ = 1,091 x 3 = 3,273 (T).

3.1.6. Longwall output in a month

$$Q_{month} = Q_{day.ninght} \times n_t \text{ (T).} \quad (5)$$

In which:

n_t - Number of working days in month, n_t = 26 (days).

Upon replacing numbers, we get: Q_{month} = 3,273 x 26 = 85,098 (T).

3.1.7. Longwall capacity

$$Q_{year} = Q_{day.ningt} \times (\text{ n-t}), \text{ (T/year).} \quad (6)$$

In which:

n: Number of working days in year, n = 290 (days/year)

t: Change time. t = 45 days

Q_{year} = 3,273 x (290-45) = 801,885 (T/year), Take Q_{year} = 800,000(T/year).

3.2. Selecting working mode

With those mentioned above economic and technical criteria, the selected working mode must ensure the output and capacity of the longwall, and have time to maintain the equipment, avoid the malfunctions, interrupting the production.

Currently, with the active mode of 3 work shifts per day, the company is performing the stripping of 3 flows, and equipment maintenance is performed at the beginning of each shift. However, the analysis result indicates that: The current working mode meets the output and capacity of the longwall but does not guarantee the care and maintenance of machinery and equipment, causing the interruption, increasing the number of laborers, and reducing productivity.

For the above reasons, the research team proposes that the operational mode is one day and night, divided into 4 teams, of which three teams for stripping three flows and one shift for equipment maintenance. Organize the stripping of 3 flows in 3 sections, 4th shift for equipment maintenance. Thus, compared to the working regime of production in 3 consecutive teams, each shift for stripping one flow and maintenance at the beginning of each shift, the option selected here still ensures the stripping progress while being able to focus well for equipment maintenance.

3.3. Production organization chart

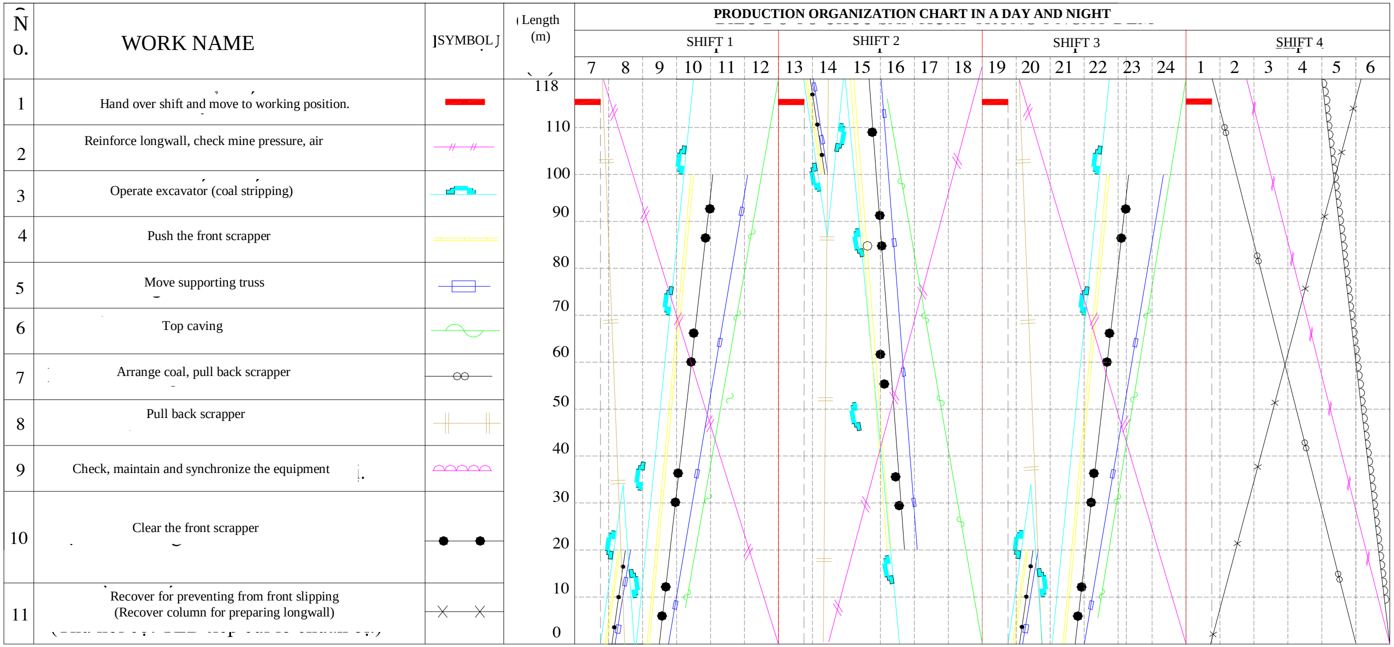

Fig. 3. An organizational chart of 3-stage stage production in 3 crews, four crews of equipment for maintenance of seam 11

3.4. Staffing

Each crew employs 22 workers, while the team of 4 employs 19 people for maintenance, the personnel arrangement is made according to Fig 4.

After completing, the longwall parameters are shown in Table 2 with a comparison with the actual situation of Ha Lam Coal Joint Stock Company.

No.	WORK NAME	LABOR SHIFT I	II	III	IV	Σ
1	Hand over shift and move to working position.					
2	Check and measure pressure, reinforce longwall	2	2	2	2	8
3	Check, maintain and synchronize the equipment				(16)	(16)
4	Operate excavator	2	2	2		6
5	Arrange coal in front of truss	4	4	4		12
6	Push the gutter, move the supporting truss	2	2	2		6
7	Recover top coal caving	2	2	2		6
8	Arrange coal, pull back scrapper				6	6
9	Pull back scrapper	2	2	2		6
10	Operate emulsifier DD and fog pump	2	2	2	2	8
11	Operate longwall scrapper	2	2	2	2	8
12	Operate load conveyor	1	1	1	1	4
13	Operate stretch belt	1	1	1	1	4
14	Watch for electro-mechanics on duty	1	1	1	1	4
15	Recover for preparing longwall (withdraw cage column)				3	3
16	Direct the production	1	1	1	1	4
	TOTAL	22	22	22	19	85

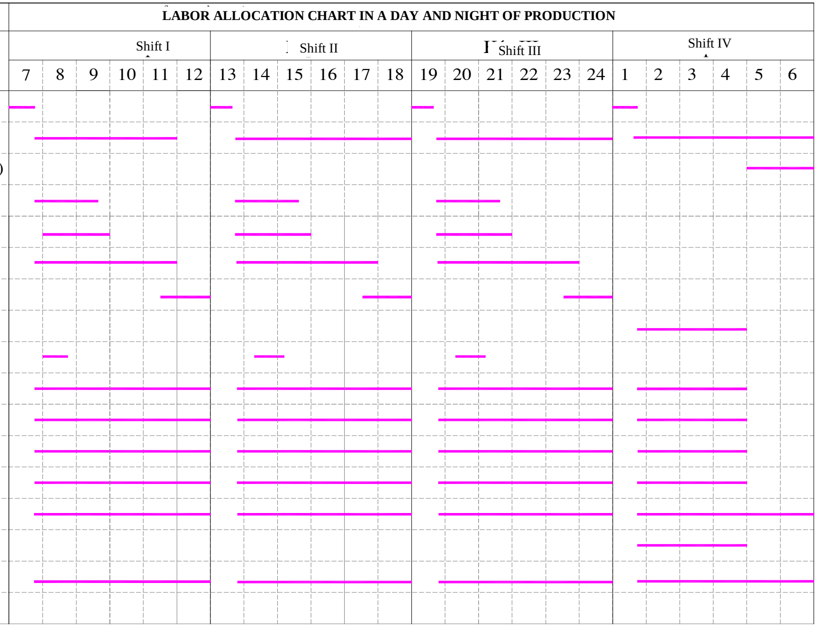

Fig 4. Chart of labor allocation team for longwall 11 stripping three flows (Working mode of 4 teams/day and night)

Table 2. Economic and technical criteria of longwall 11

No.	Criteria name	Unit	Plan for finalization	The reality of the mine (Take average from October 2016 to September 2018)	Comparison
1	Average seam thickness	m	14	14	-
2	Average seam sloping angle	degree	5-:- 12	5-:- 12	-
3	Length along the direction of the region to the stripping limit	m	548	548	-
4	Stripping height	m	2.6	2.6	-
5	The thickness of the top coal caving layer	m	11.4	11.4	-
6	Length of longwall	m	118	118.0	-
7	The volumetric weight of coal	T/m^3	1.66	1.66	-
8	Mining coefficient	-	0.95	0.95	-
9	Coefficient of top coal caving recovery	-	0.75	0.75	-
10	Number of mining flows per cycle	flow	1	1	-
11	Coal output per stripping flow	T	1,284	846	438
12	Coal output per cycle	T	1,091	719	372
13	Number of mining shifts per cycle	shift	1	1	-
14	Number of work shifts per day	shift	3	3	-
15	Cycle completion factor		0.85	0.85	-
16	Coal output minutes per day and night	T	3,273	2,537	736
17	Coal output mined in a month	T	85,098	61,316	23,782
18	Mining capacity	T/year	800,000	621,565	23,782
19	Number of direct labors per day and night	Person	77	88	(11)
20	Direct labor productivity	T/labor	42.5	29	13.5
21	The cost price of mined coal	VND/T	267,249	270,565	3,316

4. CONCLUSION

With relatively favorable mining conditions at longwall 11, the choice of Ha Lam in applying synchronous mechanized mining technology is very suitable and brings high efficiency. However, in the process of coal stripping at longwall 11 because the mining workers have just applied the technology, at the same time, with the output pressure, the company has chosen the production mode with three consecutive work shifts. When new machinery and equipment will ensure the output and capacity of the longwall even when operating overloaded. However, when the devices become old, it is necessary to plan a suitable maintenance schedule. Therefore, the article recommends a completing plan by organizing a working mode of 3 shifts and four teams per day and night, with three sections for stripping and one group for maintenance. Under the calculation, the effectiveness of the completing plan are ensuring output, reducing labor costs, increasing labor productivity, and reducing coal mining cost price.

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KEY FACTORS EFFECT TO PLANIFICATION OF COAL MINING COMPANIES IN VIETNAM NATIONAL COAL AND MINERAL INDUSTRIES HOLDING CORPORATION LIMITED

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Abstract: *Planification is the first function in the enterprise management process. This function is significantly important because it orients other operations or activities of companies. Therefore, it is necessary to implement this function effectively. And it is essential for companies to identify key factors that affect their planification to do this function. In this paper, the authors use several methods such as theoretical method, interviewing the specialists and practical survey, etc. to discover the key factors that affect to planification of coal mining companies in Vietnam National Coal and Mineral Industries Holding Corporations Limited (Vinacomin). The verification of the impacts of those factors is also mentioned.*

Keywords: *Planification, key factors, coal mining companies, Vinacomin*

1. INTRODUCTION

Planification is the decision - making process to establish desired images about the future state of companies and the process of making that decision (Bui Duc Tuan et al., 2005). However, there is a misunderstanding of plan and planification. Plans filled with intention about results and solutions to do them. A plan is the product of planning (Ngo Thang Loi et al., 2009). Planification aims to achieve specific goals with concrete solutions and operations. Therefore, planification is not only planning, but includes planning, doing, assessing, and adjusting plans.

There are some studies about factors effect on planning, such as:

- The study of Maureen Berry showed significant correlations between the perceived importance of business strategy formulation, accompanying planning formality, and company scale (as measured by the company turnover and the number of employees) (Berry, M.,1998).

- The study of Clay Dibrell et al. found that firms' formal strategic planning processes and planning flexibility are positively associated

(Dibrell, C., et al., 2013). According to this study, the process of planning is essential to have a flexible and effective strategic plan.

- The study of Brinckmann, J. et al. used meta-analysis to aggregate data on 8.095 observations leading small and medium-sized enterprises (SMEs) from 31 independent datasets. This study also used the theory of planned behavior as the based theory. Its results showed that education and broad work experience could effect to business planning process (Brinckmann, J., et al., 2017).

The abovementioned studies are in the context of SMEs to identify several factors that affect the planning of companies. But there is no research in the context of Vietnamese companies, especially the context of coal mining companies in Vinacomin. No study shows all factors which impact on planification of companies. The abovementioned studies mostly researched about planning - a step of planification.

Coal mining companies in Vinacomin are large-sized enterprises. They operate in the parent-subsidiary model of Vinacomin.

Therefore, planification is vital for those companies, as it could help to coordinate other companies in Vinacomin, and also coordinate other activities in coal mining companies. It is essential to find factors that affect to planification of those companies. It could help to do this work more effectively.

From this research gap and also the necessity, the authors researched factors effect to planification of coal mining companies in Vinacomin.

2. THEORETICAL BASIS AND RESEARCH METHODOLOGY

2.1. Theoretical basis

Because of no theory that relates directly to planification, therefore, the authors are based on institutional theory and the theory of planned behavior for researching.

a) Institutional theory (under social view)

Under the social view, institution includes constraints and actions belong to perception, normative, and regulation to create stabilization and sense of social behavior (Scott, W.R., 1995). The theory showed that when each individual or company abides well constraints of the institution, the society will recognize them (Nguyen Van Thang et al., 2015). According to this theory, there are three parts of the institutional approach that includes regulation, formation, and cognition.

The priority of the authors in this paper is about the regulative view. Most of the researchers agree with the regulative statement of regulation, limited regulation, and regulative behavior (Nguyen Van Thang et al., 2015). Regulation is implemented with some tools such as laws, policies, or punishment. The opinion of the authors from this reasoning is that rules, policies, or discipline could affect human behavior. Planification of companies is also a kind of behavior of managers. Therefore laws, policies, or punishment could affect this work.

b) The theory of planned behavior

The theory showed that some factors such as attitude toward the behavior, subjective norms, and perceived behavioral control could effect behavioral intentions through that effect to action (Ajzen, I, 1991).

Planification of companies is also a kind of behavior. This behavior is an individual one but tends to solve companies' issues together. This behavior is controlled by regulation, authority relationship, and constraint about the objectives and tasks of companies, etc. From this reasoning, the authors gave the opinion that the attitude of top managers and staff who do planification could affect their behavior about the activities of companies, especially planification.

2.2. Research methodology

In the study, the authors used mixed method research (qualitative research to explore factors and quantitative analysis to define the sufficient level of those factors). The process of mixed-method research is shown in Fig 1.

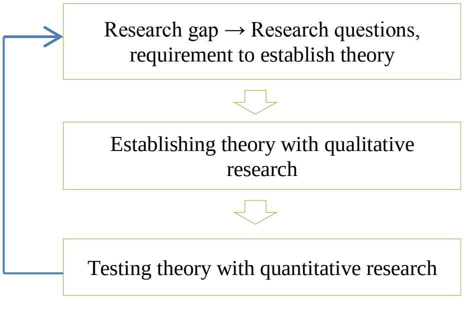

Fig 1. Process of mixed-method research

(*Source: Nguyen Dinh Tho, 2013*)

a) Qualitative research with in-depth interview method

Because of no modeling about factors that influence planification of coal mining companies, therefore, the authors use qualitative research with an in-depth interview method to explore factors that affect this work of coal mining companies in Vinacomin.

The process of qualitative research with an in-depth interview is implemented with these following steps:

Step 1: Establishing the guideline for the in-depth interview

A procedure was established for the in-depth interview, includings questions of:

1. In the planification of your company, which tasks do you have to do?

2. In your opinion, which factors could affect to planification of coal mining companies?

3. Ask about the definition of each element and the composed items.

During the interview, more questions or suggestions for further information can be conducted.

Step 2: In-depth interviewing experts

The experts were contacted in advance. The following process is the interview procedure:

- Interviewing technical experts who implement planification at coal mining companies (group 1);

- Interviewing lecturers who teach and research about the technology of mining at universities (group 2);

- Interviewing department managers or staff who are responsible for planification in coal mining companies (group 3);

- Interviewing lecturers who teach and research industrial economics and economics management at universities (group 4).

The interviews were implemented directly or indirectly by phone. Feedback from the experts was written down or recorded to provide data for analyzing.

The result of the in-depth interviews:

- Two experts participated in the interview of group 1 (P1.1 and P1.2). Three factors and some items can be the explanation to these factors were explored. When the second expert was interviewed (P1.2), no more element was found; therefore, the interview of this group was completed.

- One lecturer participated in the interview of group 2 (P2.1). No more factor was explored, but some more items can be the explanation of the elements found in the interview in group 1. Therefore, the talk of this group closed.

- Four experts participated in the interview of group 3 (P3.1, P.3.2, P3.3, and P3.4). Five new factors and some items can be the explanation of the elements were explored. When the fourth expert (P3.4) was interviewed, no more factor was found. Therefore, the interview with this group stopped.

- Three lecturers participated in the interview of group 4 (P4.1, P4.2, and P4.3). Two new factors and some items can be an explanation for the aspects that were explored. When the third expert (P4.3) was interviewed, no more element was found. Therefore, the interview with this group ended.

Although fourteen experts agreed to participate in the interviews, after interviewing ten experts, no more factor was found. So the in-depth interviews ended. The result of the talks is shown in Fig.2.

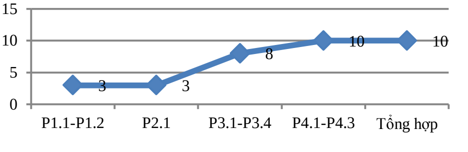

Fig 1. The process of exploring factors that influence to the planification of coal mining companies in Vinacomin

(*Source: The result of the in-depth interviews*)

The result was continued to discuss by some experts. The discussion showed the duplication of the factors and their contains. Therefore, the elements were rearranged to be nine new ones. From these factors, a research model of factors that affect the planification of coal mining companies in Vinacomin was established in Fig.3.

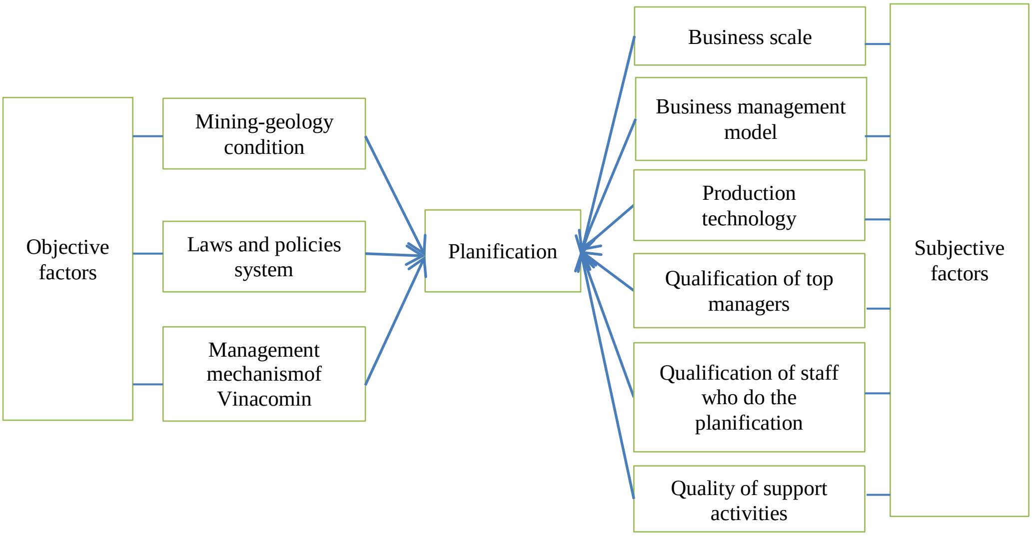

Fig 2. The research model of factors that affect to planification of coal mining companies in Vinacomin

(*Source: Established by the authors*)

The result also has some similarities to the abovementioned studies.

- Factor "business scale" is also similar to the study of Maureen Berry (Berry, M.,1998);

- Factor "Qualification of top managers" and "Qualification of staff who do planification" are also similar to the study of Brinckmann, J. et al (2017).

b) Quantitative research

**) Respondents*

The respondents are managers and staff who do planification directly or other works that relate to planification.

**) Sample size*

In this study, the experts were interviewed to have their opinions about planification, but not human behavior. Therefore, it is not crucial about the representation of the overall. The sample size was defined to do Exploratory Factor Analysis (EFA). According to Hair et al (1998), the minimum sample size is five times as many as the number of items in EFA. The study used 37 items to measure nine independent variables. Therefore, the minimum sample size is 185 observations.

**) Sampling method*

The study uses both stratified sampling method and convenience sampling method:

- According to the stratified sampling method, coal mining companies in Vinacomin are divided into branches and holding subsidiaries of Vinacomin (joint-stock companies).

- According to the convenience sampling method, respondents are managers and staff who were connected by relationships.

**) Scale development*

The paper used the scale that was developed in qualitative research in the study. The survey form was established with a 5-point Likert Scale.

**) Implementing the survey*

- Survey method: Combining direct survey method and online survey method;

- The result of the study after handling: After collecting the completed survey forms, the forms were taken. The development of the survey after handling was shown in table 1.

Table 1. The result of surveying after handling

Item No.	**Method of surveying**	**Number of issued survey forms**	**Number of collected survey forms**	**Number of rejected survey forms**	**Number of satisfied survey forms**
1	Direct survey	400	314	60	254
2	Online survey	60	41	9	32
	Total	460	355	69	286

(*Source: Synthesized analyzing of the authors*)

There were 286 satisfied survey forms (more than 185 observations - the minimum sample size). Therefore, the sample size was reliable for quantitative analysis.

3. RESULT AND DISCUSSION

3.1. Descriptive statistics analysis

Some descriptive statistics analysis about the degree, primary, and experience of respondents were shown in Table 2.

Table 2. Some descriptive statistics analysis

Degree

Intermediate Degree		College Degree		Bachelor/Engineer		Master		Total
Amount	Ratio,%	Amount	Ratio,%	Amount	Ratio,%	Amount	Ratio,%	
0	0	6	2,10	250	87,41	30	10,49	286

Major

Economics		Technology		Other		Total
Amount	Ratio,%	Amount	Ratio,%	Amount	Ratio,%	
101	35,31	172	60,14	13	4,55	286

Experience

< 5 years		5-10 years		10-15 years		> 15 years		Total
Amount	Ratio,%	Amount	Ratio,%	Amount	Ratio,%	Amount	Ratio,%	
47	16,43	115	40,21	81	28,32	43	15,03	286

(*Source: Synthesized analyzing of the authors*)

According to the results, most of the respondents are bachelors/engineers and masters. They also have more than five years of experience. Because of their competence, the impact of the survey was reliable. Most of the respondents are engineers. It is also reasonable for coal mining companies because they are manufacturing enterprises, especially they exploit coal mining.

3.2. Quality testing of scale

This step used Cronbach's Alpha to test the quality of the scale. The scale is credible when Cronbach's Alpha is more than 0.6, and Corrected Item-Total Correlation is more than 0.3 (Nunnally, J. and I. Bernstein, 1994).

Table 3. Result of quality testing of scale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Cronbach's Alpha MG: .658				
MG1	12.049	4.320	.382	.626
MG2	12.500	3.479	.551	.507
MG3	12.923	3.615	.454	.580
MG4	12.259	4.115	.374	.632
Cronbach's Alpha LP: .869				
LP1	11.514	7.984	.741	.825
LP2	11.573	8.140	.777	.811
LP3	11.720	8.483	.699	.842
LP4	11.483	8.251	.673	.853
Cronbach's Alpha MV: .864				
MV1	11.580	6.939	.758	.807
MV2	11.745	7.370	.750	.812
MV3	11.864	7.318	.724	.822
MV4	11.699	7.692	.623	.862
Cronbach's Alpha BS: .828				
BS1	11.755	6.789	.701	.761
BS2	11.846	6.839	.708	.758
BS3	11.713	8.100	.559	.823
BS4	11.972	7.319	.655	.783
Cronbach's Alpha BM: .845				
BM1	14.857	11.492	.529	.845
BM2	14.930	11.160	.592	.830
BM3	14.035	10.223	.683	.806
BM4	14.524	9.977	.759	.784
BM5	14.409	10.137	.705	.799
Cronbach's Alpha PT: .826				
PT1	12.748	4.301	.628	.794
PT2	12.962	4.311	.683	.767
PT3	12.776	4.399	.688	.765
PT4	12.755	4.621	.613	.798
Cronbach's Alpha QM: .878				
QM1	12.815	5.548	.760	.835
QM2	12.913	5.498	.765	.833

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
QM3	12.990	4.846	.786	.824
QM4	12.839	5.581	.649	.877
Cronbach's Alpha QS: .884				
QS1	12.514	6.173	.735	.857
QS2	12.650	6.074	.752	.851
QS3	12.497	5.535	.766	.844
QS4	12.626	5.421	.752	.852
Cronbach's Alpha SA: .805				
AS1	12.315	5.578	.511	.804
AS 2	12.713	4.816	.663	.734
AS 3	12.773	5.074	.609	.760
AS 4	12.696	4.662	.699	.715

(*Source: Synthesized analyzing of the authors*)

According to the result, Cronbach's Alpha of all the independent variables is more than 0.6, and the Corrected Item-Total Correlation of all items is more than 0.3. Therefore the scale is credible to measure independent variables.

3.3. Identification of affecting the level of the factors to the planification of coal mining companies in Vinacomin

The main goal of this study was exploring research; therefore, independent variables were only counted the mean to define the effecting level of the factors to the planification of coal mining companies in Vinacomin. The result was shown in Table 4.

Table 4. The result of affecting the level of the factors to the planification of coal mining companies in Vinacomin

Item No.	Code	Name of independent variables	Mean	Rank
1	MG	Mining-geology condition	4.144	5
2	LP	Laws and policies system	3.858	8
3	MV	Management mechanism of Vinacomin	3.907	7
4	BS	Business scale	3.941	6
5	BM	Business management model	3.638	9
6	PT	Production technology	4.270	2
7	QM	Qualification of top managers	4.296	1
8	QS	Qualification of staff who do the planification	4.191	4
9	SA	Quality of support activities	4.208	3

(*Source: Synthesized analyzing of the authors*)

The result showed that mean of all independent variables and items is more than 3. Therefore, all independent variables in the research model affect more than the mean level to the planification of these companies.

Effecting level ranking of the factors are in order:

1. Qualification of top managers;
2. Production technology;

3. Quality of support activities;

4. Qualification of staff who do the planification;

5. Mining-geology condition;

6. Business scale;

7. Management mechanism of Vinacomin;

8. Laws and policies system;

9. Business management model.

The result showed that:

- The objective factors had low effecting level ranking (the objective factors are less influenced to the planification of these companies). It is quite reasonable because of some reasons:

+ Mining-geology condition effect on all works of coal mining companies. But in the short term, mining-geology conditions can not change much. Therefore, it seems that these conditions do not affect the planification of coal mining companies in Vinacomin much.

+ Planification is the work inside companies; therefore, laws and policies do not affect much to this work. In the parent-subsidiary model, before making plans, companies must sign a business cooperation contract. But most of the plans were established by coal mining companies. Vinacomin only gives some guides for these companies. Therefore, laws and policies system do not influence much on the planification of these companies.

+ In the current period, there is not much change in the management mechanism of Vinacomin. Therefore, in the opinion of planners, this factor does not influence much on the planification of these companies.

- For the same scale and business management model and doing the planification similarly, the company scale and business management model also do not influence much on the planification of coal mining companies in Vinacomin.

- Four remaining factors (qualification of top managers; production technology; quality of support activities; and qualification of staff who do the planification) effect much to planification of these companies. It is entirely reasonable because of some reasons:

+ Top managers are people who supervise the staff of companies, which directly do the planification; Staff is people who do this work directly. Therefore, the qualification of top managers and staff effect much on this work. It is suitable for the content of the theory of planned behavior.

+ Coal mining companies must use complex technology to exploit coal excavation. Therefore, production technology affects much the production of these companies and also the planification of them.

+ Planification has the link with other activities such as exploration work, statistical work and norm work, etc. (support activities). If companies want to do the planification effectively, they must do support activities well. Therefore, the quality of support activities impacts much on the planification of these companies.

3.4. Managerial implications

From the results of the study, some managerial implications were given to improve the quality of the planification of coal mining companies in Vinacomin:

- The companies must continue to improve the cognition of top managers about the necessity and the role of the planification.

- The companies must develop training to improve the knowledge and skills of staff. It could help them to improve the planification.

- The companies must improve the quality of support works step by step and apply information technology into the planification;

- The companies must improve and innovate production technology gradually to increase the convenience and effects of its planification.

4. CONCLUSION, LIMITATIONS, AND ORIENTATIONS FOR FUTURE RESEARCH

4.1. Conclusion

In the paper, some related theories were researched to be theoretical fundamentals for the study. From the approaches and results of qualitative research with an in-depth interview, the research model was established. After that, the quantitative research method was used to define the significant level of the abovementioned factors to the planification of coal mining companies in Vinacomin. However, the main goal of the study was exploring research; therefore, the independent variables were only counted the mean to define the effecting level of these factors. The result showed that all factors affect more than the mean level to the planification of coal mining companies in Vinacomin. From the mean, the practical level ranking of the elements was defined. Finally, some managerial implications were given to improve the quality and effectiveness of the planification of these companies.

4.2. Limitations and orientations for future research

Some limitations remains in this study. For example not all factors that affect the planification of coal mining companies in Vinacomin were found; in quantitative analysis, only testing the quality of the scale and counting the mean of the items and the independent variables were implemented. These are the research gap that would be continued to research in the future.

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Appendix.

Table 5. The scale of independent variables in the research model

Item No.	Independent variables	Definition	Items
1	Mining-geology condition (**MG**)	Natural conditions, especially the mining-geology condition of mines that effect to production and the planification of coal mining companies.	- Coal seams structure (thickness; slope…) (MG1) - The hardness of rock and coal (MG2) - Humidity, cohesion (MG3) - Exploitation depth (MG4)
2	Production technology (**PT**)	Technical factors could affect production and also the planification of coal mining companies.	- Technology for exploiting and transporting (PT1) - Number of equipment (PT2) - Quality of equipment (PT3) - The synchronization of equipment (PT4)
3	Qualification of staff who do the planification (**QS**)	Qualification, experience, and attitude of staff when doing the planification	- The degree of staff (QS1) - The experience of staff in the mineral sector (QS2) - The expertise of staff in implementing the planification at companies (QS3) - The attitude of staff in implementing the planification at companies (QS4)
4	Laws and policies system (**LP**)	Laws and policies system of the State that guide and control the planification of companies	- Laws are complete and synchronized (LP1) - By-law documents are particular (LP2) - The intervention of state organizations into the operation of companies (LP3) - Sanction to penalize violations (LP4)
5	Management mechanism of Vinacomin (**MC**)	The management, effective mechanism of Vinacomin to coal mining companies	- Policies and regulations that Vinacomin established to manage coal mining companies (MC1) - The stability of these policies and regulations (MC2) - The intervention of Vinacomin into the operation of companies (MC3) - Directing regularly of Vinacomin (MC4)
6	Quality of support activities (**SA**)	The quality of other support activities to the planification, such as providing information, etc.	- Quality of exploration works (SA1) - Quality of statistical results (SA2) - Capability to apply information technology (SA3)

Item No.	Independent variables	Definition	Items
			- Coordination of different jobs in companies (SA4)
7	Qualification of top managers (**QM**)	Qualification, experience, reputation, and attitude of top managers about the planification	- The degree of top managers (QM1) - The experience of top managers (QM2) - The reputation of top managers (QM3) - The attitude of top managers (QM4)
8	Business scale (**BS**)	The scale of out-put, in-put of production	- Number of products and revenue (BS1) - Number of labors (BS2) - Infrastructure for production (BS3) - Size of capital (BS4)
9	Business management model (**BM**)	The model for management and relationship between the parts	- Number of hierarchies in structures of companies (BM1) - Number of parts into companies (BM2) - The function and mission of the role are clearly (BM3) - Obtaining and communicating information is accessible (BM4) - Adaptability with changes (BM5)

(*Source: Developed by the authors*)

PREDICTION MODEL FOR QUANTITY OF MECHANDIZED LONGWALLS IN HA LAM COAL JOIN STOCK COMPANY - VINACOMIN

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Abstract: *Vinacomin is among firms applying successfully merchandise to coal mining. However, the company's output depends on many factors such as height mirror stage, Length oven mechanization longwall, recovery height, length extraction column (oven longwalls), labor organization and specific geological conditions. Therefore, it has caused difficulties for the company in the implementing of production plan. The authors conducted the survey, and collected data from 2017-2019 as a basis for building a prediction model for quantity. Research results help the company to proactively plan, thereby to overall improve productivity and profits and to decrease general manufacturing costs for company.*

Keywords: *merchandise; production plans; prediction model for quantity; mining technology motorization synchronized*

1. OVERVIEW

Ha Lam Coal JSC., - an underground coal mining company in Vietnam Coal - Mineral Group (Vinacomin) is a pioneer of merchanization application in… The company has accompished positive quantity results of… However, the company still has some difficulties and struggles in mining process in CGH: Production organizing charts of mines are consecutively destroyed by changes of mining conditions, concurring incidences affecting significantly planned quantity and proactive deduction of planning of the company.

In order to enhane and optimize technological data that helps the company completes production organizing charts, assign employees and plan proactively mining quantity, the research group has surveyed and collected real data in…. of the company from 03/2015 to 03/2020

Based on collected data, the authors establish a model to forecast mining quantity scale of the company to reduce time, labor for establishing and launching company plans.

2. METHODOLOGY

Multi-variables linear method: The authors use multi-variables linear method to predict quantitative norm with independent variables. After establishing model, the group assess models based on standard criteria to choose the best one for prediction.

Criteria of model selection in research: To choose the optimal model, the research is based on the following criteria

- R2: The model with the same variables, whichever higher R2.
- RMS: The model with the mean square of the lowest residual is selected.
- AIC: The model with the lowest AIC is selected.

3. DATA

The company has 2 CGH lines with a capacity of 600,000 tons / year (CGH1) and 1.200.000 tons / year (CGH2).

* Market furnace with a capacity of 600.000 tons/year: 3 shifts in one day and night deploy 03 flow, equal to 3 cycles. A mining unit includes the following works: mining,

supporting, lowering the ceiling to withdrawn coal on the roof of the market furnace with the progress of 0.6 m/flow, withdrawning for supporting in the transport furnace, the ventilation furnace. The total number of employees as assigned in 1 day and night is 72 employees, with 24 employees per shift.

* Chain-line market furnace with a capacity of 1.200.000 tons/year: 3 shifts in one day and night deploy 02 mining flow, equal to 1 cycle. A mining stage includes the following works: mining, supporting, lowering the ceiling to withdrawn coal on the roof of the market furnace with the progress of 0.6 m/flow, withdawning for supporting in the transport furnace, the ventilation furnace. The inspection and maintenance of market furnace equipment are performed at the beginning of each shift. The total number of employees as assigned in 1 day and night is 90 employees, 30 employees per shift.

Table 1. Parameters of 2 CGH market furnaces

No.	Indicator	Unit	600,000 tons/year	1,200,000 tons/year
1	Seam thickness average	m	14	23.3
2	Seam angle average	degree	5-:- 12	0 -:- 15
3	Length in the direction of the area to the size limit	m	548	325
4	Excavation heigh	m	2.6	3
5	The thickness of the coal layer of lower the ceiling	m	11.4	20.3
6	Length of the market oven	m	118.5	154
7	Exploitation coefficient	-	0.95	0.95
8	Coal recovery coefficient	-	0.75	0.85
9	Number of flow exploited per cycle	shift	1	2
10	Coal mining quantity per flow	T	1284	2372
11	Coal mining quantity per cycle	T	2.182	2.135
12	Mining cycle time	shift	2	3
13	The number of cycle in 1 day and night	cycle	1.5	3
14	Cycle completion factor	-	0.85	0.9
15	Coal exploitation quantity in 1 day and night	T	3273	4270
16	Transition time	day	45	60
17	Coal exploitation quantity in 1 month	T	8.,098	106.745
18	Mining capacity (rounding)	T/year	800.000	1 280 000
19	The number of employees in 1 day and night	Person	72	90
20	Direct labor productivity	T/labor unit	45.5	47.4

The authors surveyed and collected data from March 2015 to March 2020 that are gathered in Table 2 in the order of the months.

Table 2. Summary of database collected about market furnaces

THA	PXU	SLD	SCO	TSL	TKG	TTH	CDV	CCK	CTH	DLC	DCK
03/2015	CGH1	91	25	1.927	1.927		12.6	2.6	10.0	108	
04/2015	CGH1	103	23	18.934	3.912	15.022	13.7	2.6	11.1	108	8.2
05/2015	CGH1	104	25	36.000	7.095	28.905	14.4	2.6	11.8	108	11.0
…											
01/2016	CGH1	126	22	47.794	14.154	33.640	9.1	2.6	6.5	108	31.4
…											
01/2017	CGH1	90	20	65.491	13.597	51.894	13.8	2.6	11.2	121	21.3
01/2017	CGH2	104	20	53.452	7.370	46.082	21.83	3	18.83	155.7	9.8
02/2017	CGH1	88	23	83.946	15.211	68.735	14.4	2.6	11.8	122	31.4
…											
01/2018	CGH1	90	23	36.875	1.788	35.087	5.51	2.6	2.9	118.5	37.4
01/2018	CGH2	106	23	63.610	8.990	54.620	23.75	3	20.75	158.4	11.75
02/2018	CGH1	86	16	41.612	11.973	29.639	9.39	2.6	6.8	118.5	25
…											
01/2019	CGH1	97		78.144			16.4	2.6	13.8	118.5	
01/2019	CGH2	125		75.710			24.6	3	21.6	155.5	
02/2019	CGH1	73		52.590			16.4	2.6	13.8	118,5	
…											
01/2020	CGH1	87		55.315			14.7	2.6	12.1	106	
01/2020	CGH2	90		52.090			24.15	3	21.15	155.5	
03/2020	CGH1	114		83.061			14.7	2.6	12.1	106	
03/2020	CGH2	135		107.621			24.15	3	21.15	155.5	

The collected and described data are according to the results in Table 3. Specifically, the main parameters of the two market ovens as follows:

- In terms of total quantity: CGH1 market furnace has an average monthly quantity of 53.800 tons/month, and CGH2 market furnace’s an average monthly quantity is 74.800 tons/month. Combining with Fig 1 to assess the data distribution, it is found that the quantity norm of the CGH2 furnace almost obeys the standard distribution rule, with a distinct bell shape. In contrast, the quantity norm of the CGH1 furnace during this period has large fluctuations and uneven distribution. This is aligned with the reality, because during this time, the CGH1 furnace has changed to a new exploitation site, with different parameters from the original design time.

- In the term of the seam thickness: The average thickness of the coal seam of CGH1 market furnace is 13.3 meters (min 5.00, max 18.7), while that for CGH2 market furnace is 22.9 (min 12.3, max 27.6).

- In terms of mining coal and recovered coal: Most of the mining quantity of the market furnace comes from the recovered coal, because with a very large seam thickness, the company has applied technology to recover coal after mining, contributing to reduce product price.

Table 3. Describe data of 2 market furnaces CGH1 and CGH2

	CGH1 (N=61)	**CGH2 (N=42)**	**Overall (N=103)**
SLD			
Mean (SD)	105 (24.9)	115 (18.8)	109 (23.1)
Median [Min, Max]	101 [9.93, 165]	118 [71.0, 159]	105 [9.93, 165]
Missing	2 (3.3%)	2 (4.8%)	4 (3.9%)
TSL			
Mean (SD)	53800 (29600)	74800 (28300)	62200 (30800)
Median [Min, Max]	58200 [1210, 103000]	74200 [7000, 129000]	65200 [1210, 129000]
Missing	2 (3.3%)	3 (7.1%)	5 (4.9%)
TKG		,	
Mean (SD)	11300 (5860)	12000 (5470)	11500 (5710)
Median [Min, Max]	12000 [1080, 22700]	9750 [1630, 22000]	10300 [1080, 22700]
Missing	18 (29.5%)	22 (52.4%)	40 (38.8%)
TTH			
Mean (SD)	40300 (25900)	66100 (28200)	49200 (29200)
Median [Min, Max]	34700 [0, 86500]	67000 [5370, 108000]	48500 [0, 108000]
Missing	19 (31.1%)	20 (47.6%)	39 (37.9%)
CDV			
Mean (SD)	13.3 (3.18)	22.9 (2.75)	17.0 (5.58)
Median [Min, Max]	14.3 [5.00, 18.7]	24.0 [12.3, 27.6]	16.0 [5.00, 27.6]
Missing	4 (6.6%)	6 (14.3%)	10 (9.7%)
CCK			
Mean (SD)	2.60 (0)	2.98 (0.0905)	2.75 (0.194)
Median [Min, Max]	2.60 [2.60, 2.60]	3.00 [2.60, 3.00]	2.60 [2.60, 3.00]
Missing	2 (3.3%)	4 (9.5%)	6 (5.8%)
DLC			
Mean (SD)	114 (6.29)	155 (6.24)	130 (20.8)
Median [Min, Max]	119 [106, 124]	156 [119, 158]	119 [106, 158]

	CGH1 (N=61)	CGH2 (N=42)	Overall (N=103)
Missing	2 (3.3%)	5 (11.9%)	7 (6.8%)
DCK			
Mean (SD)	23.3 (12.9)	15.9 (7.24)	20.9 (11.8)
Median [Min, Max]	25.2 [0.600, 46.5]	12.9 [2.20, 29.1]	19.4 [0.600, 46.5]
Missing	19 (31.1%)	22 (52.4%)	41 (39.8%)

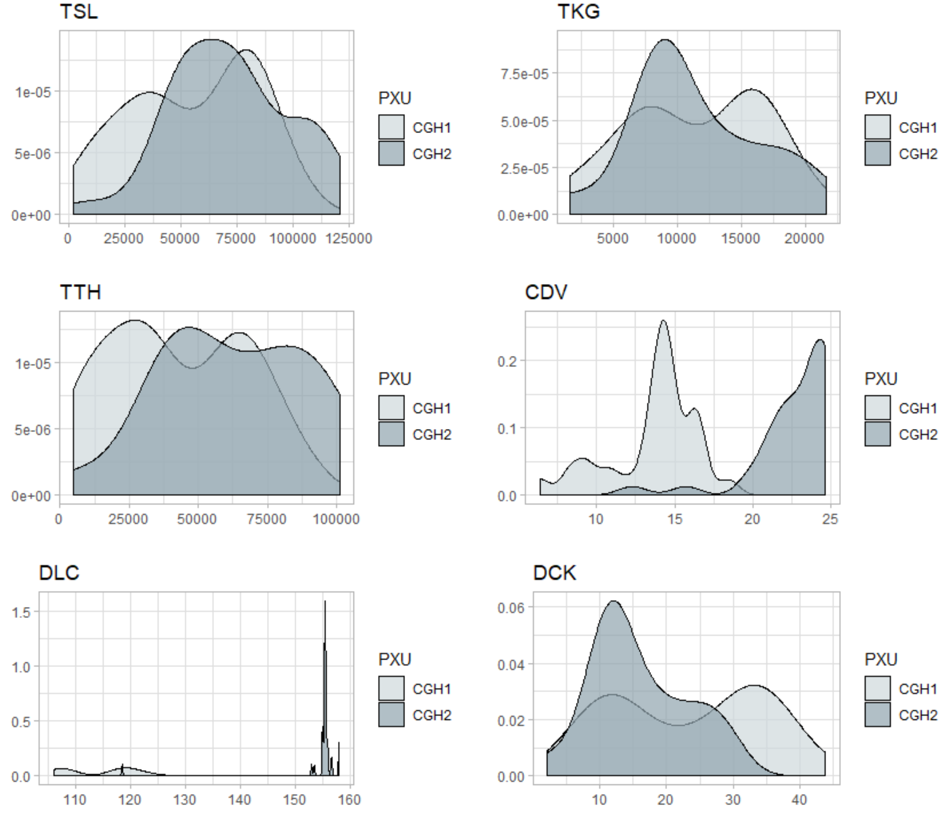

Fig 1. Distribution of data of CGH market furnace parameters

In order to have an overview of the data and correlation level between the furnace parameters, the research team builds the correlation chart in Fig 2.

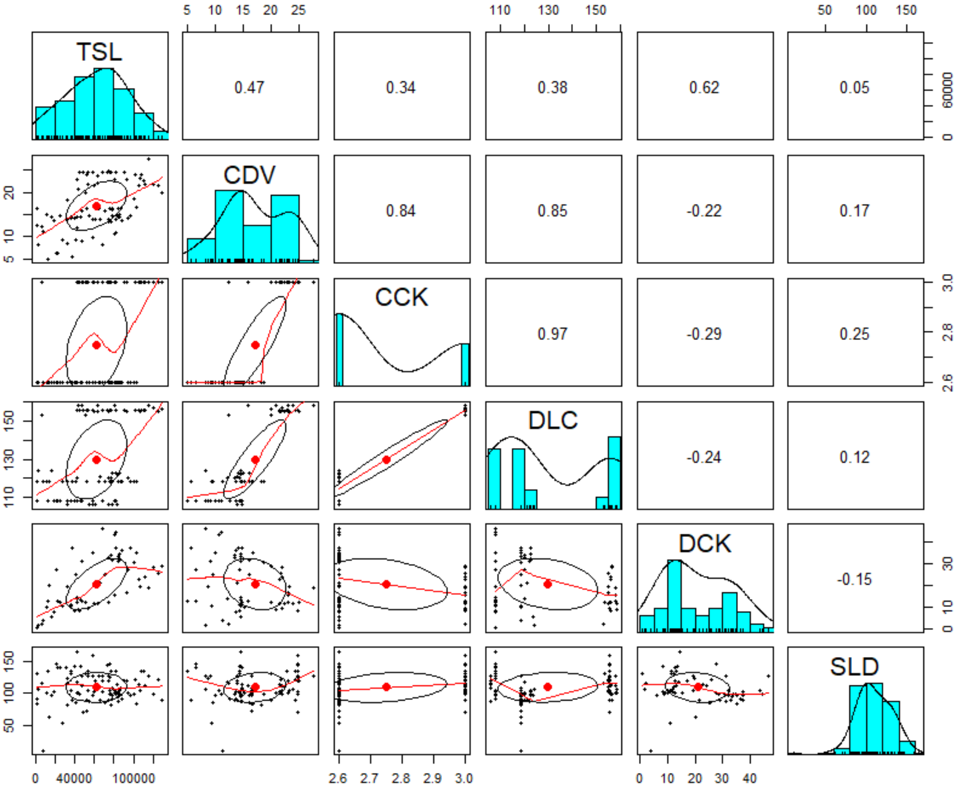

Fig 2. Correlation chart between parameters of the CGH market furnace

Through the chart above, the group found that the quantity norm has the greatest correlation with the length of the stage with a correlation coefficient of 0.62; followed by the seam thickness with a correlation coefficient of 0.47. These can be forecasted as two main factors affecting the company's quantity norm.

4. RESEARCH RESULTS

Run a multivariate regression model between the dependent variable of Total Production (TSL) and the independent variables as seam length (CDV), stage height (CCK), kiln length (DLC), stage length (DCK) and the number of employees (SLD).

Start: AIC=1161.33

TSL ~ CDV + CCK + DLC + DCK + SLD

Df Sum of Sq RSS AIC

- SLD 1 5.0481e+07 9.6627e+09 1157.0

- CCK 1 1.1993e+08 9.7322e+09 1157.4

- DLC 1 1.9243e+08 9.8047e+09 1157.9

<none> 9.6123e+09 1161.3

- CDV 1 8.4671e+09 1.8079e+10 1194.6

- DCK 1 3.3304e+10 4.2917e+10 1246.5

Step: AIC=1157.01

TSL ~ CDV + CCK + DLC + DCK

Df Sum of Sq RSS AIC

- CCK 1 7.0571e+07 9.7333e+09 1152.8

- DLC 1 1.4347e+08 9.8062e+09 1153.3

<none> 9.6627e+09 1157.0

- CDV 1 8.7358e+09 1.8399e+10 1191.0

- DCK 1 3.3258e+10 4.2921e+10 1241.8

Step: AIC=1152.81

TSL ~ CDV + DLC + DCK

Df Sum of Sq RSS AIC

- DLC 1 1.0301e+08 9.8363e+09 1148.8

<none> 9.7333e+09 1152.8

- CDV 1 8.6713e+09 1.8405e+10 1186.4

- DCK 1 3.5607e+10 4.5341e+10 1240.5

Step: AIC=1148.8

TSL ~ CDV + DCK

Df Sum of Sq RSS AIC

<none> 9.8363e+09 1148.8

- CDV 1 3.0342e+10 4.0178e+10 1228.6

- DCK 1 3.6052e+10 4.5888e+10 1236.6

It is showed that the quantity norm (TSL) is significantly influenced by two factors: seam thickness (CDV) and the length of the stage (DCK).

Residuals:

Min 1Q Median 3Q Max

-31602 -8626 460 7722 32201

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) -50209.1 6692.3 -7.503 4.62e-10 ***

CDV 4245.6 320.2 13.260 < 2e-16 ***

DCK 2165.6 149.8 14.454 < 2e-16 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 13140 on 57 degrees of freedom

(43 observations deleted due to missingness)

Multiple R-squared: 0.8467, Adjusted R-squared: 0.8413

F-statistic: 157.4 on 2 and 57 DF, p-value: < 2.2e-16

The model deliver below outcomes:

The quantity norm = = -50.209 + 4245.6 * Seam thickness + 2165.6 * Stage length

The model has the coefficient R2 = 84.67% and the adjusted R2 coefficient is 84.13%. Thus, 2 factors affecting the output level can explain the difference of 84.67% of the quantity norm. The difference is statistically significant.

Considering the model selection criteria for R2, RMS, AIC, the above model is the best model to explain and forecast the quantity norm for mechanized market furnaces at Ha Lam Coal Joint Stock Company - Vinacomin

Evaluation and analysis of the model residue show the appropriateness of the research model.

The authors continue to analyze the relationship between the model parameters.

Fig 4 shows that with the higher seam thickness, the yield will increase, but with CGH2, the seam thickness of 25 meters is the best, if seams is thicker, the yield tend to decrease. This can be explained that it take more time to withdrawn too thick seams, and the auxiliary work and safety work will be affected, so the quantity may not be reached as expected.

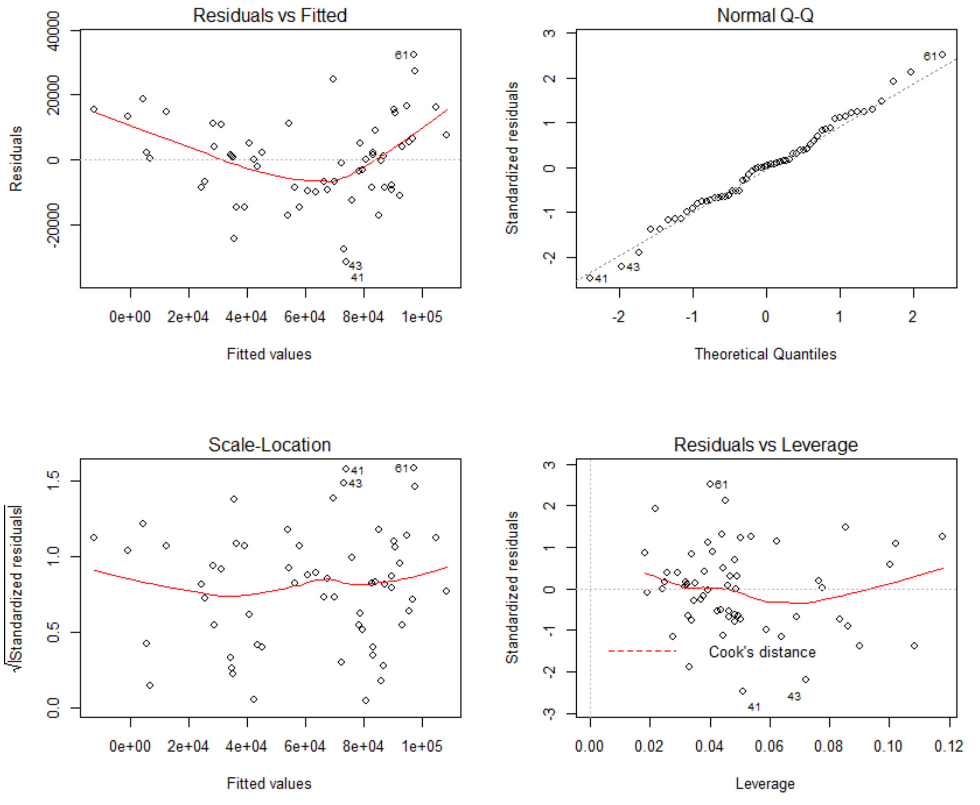

Fig 3. Analysis of the model residue

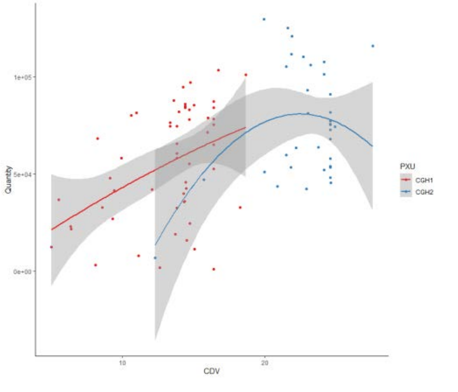

Fig 4. The relationship between the the seam thickness (CDV) and the quantity norm (TSL)

Fig 5 also gives a similar result, the more the length of the stage increases, the more the quantity increases. However, the market oven CGH2 should also remain at 35-40 meters for the best quantity.

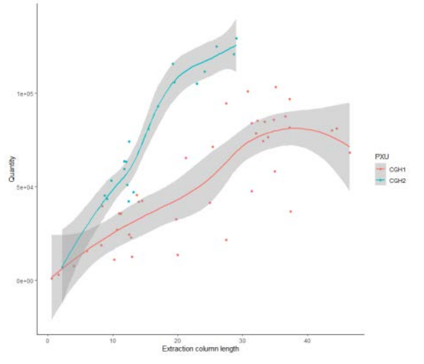

Fig 5. The relationship between the Length of the Stage (DCK) and the quantity norm (TSL)

5. DISCUSSION OF RESEARCH RESULTS

The research has built a model to forecast the quantity norm based on only 2 factors: seam thickness and the length of the stage. The model helps to explain the difference in the yield level of the months with the coefficient R2 = 84.67%.

- The relationship between the parameters of the market furnace helps the company choose the optimal parameters to achieve the expected quantity norm.

- The research still has the following limitations:

+ There are quite a few missing data that makes the model not good.

+ The general forecast for the 2 furnaces having different technological characteristics and technical parameters is not fully reflected in the research results.

+ The study has not analyzed the effects of specific geological conditions on the company's quantity performance.

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RETAINING - TALENT IN THE INDUSTRY OF OIL AND GAS EXPLORATION AND PRODUCTION - THE MAIN RETENTION STRATEGIES OF VIETNAM OIL AND GAS GROUP

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Abstract: *The article provides the theoretical frame of retaining talented labor and retention strategies to maintain human resources in the oil and gas industry and analyzes the situation of retaining Vietnam Oil and Gas Group workers. Data collected by interviewing the workers about their decisions to enter and stay working at the company shows that development opportunities, compensation, leadership, recruitment and training are highly evaluated. The article also brings solutions to retain talents in the oil and gas industry.*

***Keywords**: retaining talent, retention strategies, oil and gas*

1. INTRODUCTION

Nowadays, the labor market is competed by 86 % of employers experiencing difficulty attracting new employees and 58 % experience difficulty retaining their employees (Sunil Ramlall, 2004).

Kamalaveni et al. (2019) pointed out engaging and retaining employees of the 21st workforce in the competitive era is the toughest job for human resources people. The almost organization is driven by technology, but human resources are needed to carry out technology works. So human resources are the life energy for the organization for its survival, growth and development. It is the challenge of a human resources manager to retain the talents in an organization for the long run in a dynamic environment.

In the context of international integration, the labor has the freedom to move from an organization to another, a trend of restructuring occupations, so every organization is facing some challenges of retaining employees. The hunt for talented people of competitors has become "the war for talent". Therefore, some organization must identify the factors influencing to retain the talent the employee, as the organization has incurred cost on recruitment and has invested

huge money on each and every employee for giving the training to develop them to fit for the organization and to improve the efficiency of employees. In order to confront the problem of attrition of employees, organizations are making policies with wage standards, recruitment, selection, training and development, compensation, benefits, designing job, evaluation of the job, etc., which in turn helps to retain the employees in the long run.

Vietnam's oil and gas industry has a particularly important role in energy security and financial security, protecting the country's sovereignty. So, to ensure international integration and enhance competitiveness, one of the solutions is to retain and develop high-quality human resources with scientific and technological capabilities and international management qualifications. As for the upstream E&P (Exploration and Production), which is the core area of the oil and gas industry system, talent management is more urgent than ever at Vietnam National Oil and Gas Group.

- Employee retention helps in human resource planning in an organization because that estimates the gap between the demand and supply of workforce required for the future based on the organization's objectives.

- Retaining talent, which also helps in succession planning, whereas it aims to determine the competent strategic positions in an organization.

- It helps to have a talented and committed workforce that would reduce costs and training, development costs.

2. LITERATURE REVIEW ON EMPLOYEE RETENTION

2.1. Employee retention

Employee retention refers to practices utilized as a part of the human management to keep key workers from leaving the association. Employee retention is the business's exertion to keep attractive laborers with a specific and goal to meet business targets. It keeps the capable well-performing employees in the organization for a longer period to achieve competitive advantage (Mitt S, Saini S, Agarwal A -2014).

According to Das & Baruah (2013), encouraging employees to remain in the organization for a long period can be termed as employee retention. As Berry & Morris (2008), retention is a continuation of the workers' employment, particularly high productive, performance workers. Hom & Griffeth (1995) described that the process of encouraging employees to stay for a long period or till the project completion is termed as retention.

Deo (2014) defined employee retention as the process in which the employer encourages the employees to remain with the organization for the maximum period or until the completion of the project. Employee retention is a long-term initiative by employers to ensure that the best individuals join their organizations and remain (Idris-2014). Kashyap and Rangnekar (2014) explained that retention is a possible outcome of a social exchange process between employer and employee.

Therefore, employees' retention can be defined as a methodical process by employers to generate and foster an atmosphere that boosts current employees to remain employed by having strategies and practices in place their varied needs to encourage talented employees and be loyal to the organization a long time.

However, we need to distinguish between retention employee and turnover employee (turnover may be voluntary or involuntary), Terence et al., (2001), Tripati, B.K., Kshama Ganjiwale et al., (2011), David G.Alleen et al., (2014).

- Voluntary turnover refers to leaving of an employee in an organization voluntarily e.g., the employee himself decides to leave (such as family situation, career growth and attractive job offers, etc.) or resign from the organization (lack of promotional opportunities, unfair treatment among employees and mismatch between personal values and organization value, etc.). Voluntary turnover management is important because this force's loss affects the organization's benefits, so managers keep to retain these employees.

- Involuntary turnover, the employer expels the employee, the employee leaves the organization unwillingly (such as low performance, conflict, or due to employment-at-will.

Table 1. Employee Retention Factors

No	***Employee Retention Factors***	***Authors'/ Year***
1	**Recruitment** (the systematic organization approach to recruitment and selection which would help in the decrease in turnover of employees)	Fankeiss (2008) Beardwell and Wright (2012) N.R.A.S.S Wijesiri et al., (2019)
2	**Development opportunities** (it helps personal as well as professional growth and it's the promotion opportunities which can improve the commitment of employees to retain employees in the organization)	Holtom et al., (2008) Kroom (2013) K M.S. Kamalaveni et al., (2019) Kossivi và Kalgora (2016)
3	**Compensation** (discussed the monetary pay is an essential factor in keeping the employee, reward, benefits contribute, direct and indirect financial reward)	Shaheeb Abdul Azeez (2017) M.S. Kamalaveni et al., (2019) Sadaf Zahra et al., (2013) Kossivi và Kalgora (2016)
4	**Work Environment** (the fun working environment is a conducive factor of retention, gave more importance towards, competitive environment, the systematically with HR practices so that the work environment can be improved)	M.S. Kamalaveni et al., (2019) Tiwari (2012) Kossivi và Kalgora (2016)
5	**Leadership** (manager's attitude also impacts on the commitment of employee in the organization, the leadership style and employee turnover stated that increase in turnover is due to unbalanced treatment of employees, employees do not leave the organization, they leave their managers)	Taylor (2010) Budhiraja & Malhotra (2013) Alkhawaja and Arwa (2017) Sadaf Zahra et al., (2013) Shaheeb Abdul Azeez (2017)
6	**Training** (is investing in employees to build and develop their skills, the competency and professional advancement are acquired through training and the growth and successful survival; the way to improve retention and commitment is providing on the job training opportunities to the workforce)	Sarah Leidner et al., (2013) Kossivi và Kalgora (2016) M.S. Kamalaveni et al., (2019) Shaheeb Abdul Azeez (2017)
7	**Job Satisfaction** (career growth, the identity of a company and financial rewards, responsibility, work, good supervisor and employee recognition, if employees are dissatisfied, it is a struggle for the employer to retain the knowledgeable people in the organization)	Shaheeb Abdul Azeez (2017) Noltemeyer and Patrick (2014) Bidisha Lahkar Das, Dr. Mujulesh Baruah (2013)
8	**Performance appraisals** (Both the employer as well as the employee is benefited out of performance appraisal, to help employees to realize their strength and weakness, increasing monetary as well as a non-monetary benefit like rewards, recognition, career development, management support)	M.S. Kamalaveni et al., (2019) Jonathan P et al., (2011)

No	*Employee Retention Factors*	*Authors'/ Year*
9	**Work-life balance** (The balance between the professional life and personal life, flexible working hours, flexible working arrangement, providing adequate resource, training opportunities, giving adequate breaks in a day, staff reward, inviting staff families for staff functions, wellness opportunities, effective management practices)	Holtom et al., (2008) Sadaf Zahra et al., (2013) Kossivi và Kalgora (2016) M.S. Kamalaveni et al., (2019)
10	**Employee Commitment, Engagement** (in a competitive environment, the survival of an organization becomes very tough because there is an increase in poaching of employees and hence it is highly essential for retaining committed employee in the organization; employee engagement drive are job satisfaction, feeling valued and involved, equal opportunity, health & safety, total service, ethnicity, communication and co-operation)	Goulet and Frank (2002) Rashmi (2016) Mike Johnson (2004)

2.2. Employee retention factors

Many researchers carry out literature study factors affecting employee retention. I summarized the findings of many studies and highlighted suggestions in terms of the management practices that can be helpful to improve absenteeism, employee retention and better quality of work (table 1).

3. RETAINING TALENT IN E&P INDUSTRY OF VIETNAM

3.1. Labor characteristics in E&P of Vietnam

The oil and gas industry has been important in fuelling the rapid growth of the Vietnam economy. The oil and gas industry is usually divided into three major sectors: upstream, midstream and downstream. The upstream oil sector is also commonly known as the exploration and production (E&P) sector. In Vietnam, E&D activities are mainly of the offshore continental shelf more than 70 km, on offshore drilling platforms, drilling ships and floating equipment. Employees' working time is continuous from 2-4 weeks per month, every 12 hours, without holidays to ensure continuous drilling and exploitation, which requires employees to have highly technical and technological, competence, well healthy. The employee level is higher lever from college with 4/7 workers, must have a certificate of seaworthy safety, good health (6-month periodical check). E&P workers have to concentrate and make high efforts to minimize errors and unsafe in production due to the high-risk upstream segment. They have been trained basically and undergo practical testing, but there are complicated stages and job positions that require high technology, so they must hire foreign employees and lead to increased costs because their wages are the same international labor market. However, working with foreign experts to help Vietnamese employees also grow their qualifications and skill quickly, so they can own and replace foreign experts and high-tech workers to operate, directly working on many projects.

The employees of the E&P sector are required high knowledge and skill; they have access to international qualifications, well healthy, endure and have the spirit of observing labor discipline. The oil and gas industry is completely unlike other industries, working out specific conditions, so HR management in Vietnamese oil and gas companies have to recruit and retain talented employees in the long run work which is important in the development process of Vietnam National Oil and Gas Group.

3.2. Policies of retaining talent employees of the oil and gas group and E&P sector in particular

- The Group's policies have been given rights and obligations between the employer and its employees, which is very specific, clear. There are many policies i.e., recruitment, training, salaries, working environment, housing support, policies for employees' children, safety and labor protection, pension and welfare regimes profit. In addition, there are specific policies of the oil and gas industry to attract, respect, treat and create a working environment for talent to work with and provide long-term service to PVN, such as an intensive subsidy regime, high-liability insurance regime and education allowance and training funding for employees' children.

- "Regulations on payment of wages of the management and administration of Vietnam Oil and Gas Group" and "Regulations on the management of labor, wages and income for units under the parent company" which is the basis to ensure consistent guidance in PVN. The multi-step salary scale system for engineers in the E&P sector (9 levels), main experts (8 levels) and senior experts (5 levels) which is the basis for arranging good employees into titles with salary corresponding to the qualification or have salary level of senior experts more than the salary coefficient of the head of the department.

- "The policy of seconded employees working in joint venture and projects in E&P fields in Vietnam", the allowance fund to attract employees highly up to 30 percent of their salary fund. If employees are working in remote and difficult areas, they have had allowances from 50-70 percent of salary according to the project's ranking. Also, "The policy of seconded employees working for oil and gas projects abroad," which has stipulated position salary, allowance far from the home country, regional allowance and attraction fund is up to 30 percent of the seconded employee's fund when they work on foreign projects. Moreover, high-quality worker, knowledge and high human resources are leading experts, qualifications, experience who have reached the working-age; they are invited to consult and joined the advisory council the contracts to promote the oil and gas intellect, ensuring the inheritance among generations of petroleum workers.

- Building the Petroleum culture to make a sustainable mental foundation for the workers

- The task of ensuring safety and health is always the top priority for E&P employees. The safety management system of health, environment built based on international standards such as "Quality safety policy" and "Environmental health safety", "Assessment of impact environment" of entities and contractors.

- "Regulations on organization and management of training", "Regulations on recruitment and student who funded by PVN management". The processes for implementing and managing the training are built and comply with the ISO system. The strategy in training and developing human resources was issued following each stage of the Group's development.

In general, PVN has always determined that attracting and retaining talents is an important task, so the Group has developed many policies to attract and retain highly qualified workers. However, PVN still appears "brain drain" even though the oil and gas industry is considered to be an attractive industry with high income. Why? The answer that questions, we have been surveyed of factors of talent employee retention in the E&P field.

3.3. Factors of talent employee retention in E&P field

The following are the suggestions put forth to retain talented employees in E&P Vietnam after reviewing various research papers. The study has based on the above studies to conduct surveys by asking the employees who are working on the rig of Vietnam-Russia joint venture projects of PVEP with 105 talented employees. The questionnaire is surveyed employees of the importance of their decision to join and stay in the organization, which was sent their mail and phone call. The question test with a choice of 5 levels, including (1) Very important, (2) Important, (3) Normal, (4) Less important and (5) Not important. Workers are asked to work for five years or more, have a 4/7 degree qualification, engineer title or above, chief, foreman, project expert, etc.

The statistics results show that 98.3% of respondents and opinions on the surveyed factors are ranked according to the level rated important of their decision to join and stay in the organization (including level 1, level 2 and level 3) with the percentage is as follows:

- Development opportunities (important evaluation rate is 78.2 %): enhanced capacity, skills for development, senior managers must commit to their employees in the long term.

- Compensation (76.9 %): such as salary, reward and welfare incentives. Recognized, assessed and rewarded based on individual and collective contributions, competency salary, a competitive salary, and pay increase. Petroleum culture is always renewed following the organization’s development.

- Leadership (71,9 %): the leader ensures trust; they have a spirit of cooperation with subordinates, ensures fairness in their evaluation.

- Recruitment and staffing factors (69.7 %): Having openness and transparency, the employees arranged to be suitable with qualifications and capacity.

-Training (65.7 %). The training program must be practical and flexible, with many objectives and quality levels.

4. RETENTION STRATEGIES OF TALENT EMPLOYEES IN VIETNAMESES E&P SECTOR

Many studies have concluded that retention strategies nowadays are recognized as a vital one in most industries. Suitable employee retention strategies help in achieving the goal of organizations. The following strategies are recommendations in the study, which are retention Strategies of talented employees in the Vietnamese E&P sector.

-The employees have got a good start: Smart hiring is essential because the employee to be selected should be fit to the job as well to the organization's culture, the right person for the right job. It is crucial to keep in mind the qualification, skill, experience, and attitude required for the job and make the employee fall in life with the organization.

- Make the employees proud of their sector and industry: Implementation of policies and practices reflects how management views employees and how friendly the management is with them. The organization can keep up and integrity. The leaders have a clear vision for the future, powerful strategies to succeed. Between the employer and employee must be created to bring the feeling that employees are part of the organization and they are working not only for their benefit but also for the benefit of the organization and as well as for the benefit of the society.

- Create a compensation system towards the market, worthy of their position and role. Further flexible payments such as "hot achievements, hot skills" and bonuses are signed according to the project or contract stage. There must be a balance between the employee's personal life and professional life.

- Training and personnel planning to create opportunities for promoting talented employees require a strategy to allocate sustained efforts. Investing money on the training is not a cost; it adds value and the organization's strategy is reflected through train for growth and successful survival.

- Conducting an exit interview to identify the reasons behind leaving employees in organizations that would help strengthen the strategies for employee retention.

In addition, organizations build a strategic process to retain workers with several steps, which must be taken to develop retention strategies: The first step is assessing the existing situation and measuring the organization's turnover rates. The next step is to create positions in an organization such as "Officer for Recruitment & Retention talent". The third step is to build a program for comprehensive retention management, which would provide correct data about how many employees are leaving and the reasons they are leaving and without this accurate information, the facts behind leaving cannot be found out. Finally, organizations with a view to retaining employees must conduct interviews and exit interviews.

5. CONCLUSION

Talented and excellent human resources are the asset that every company aspires to have. Managing the talents is a great challenge to retain the best employees; the framing of policies and practices is highly essential. Retaining them will help the organization grow in the long term, have an advantage over competitors. Like other companies in the field, human resources-talents in the E&P industry are always the key goals of the success and development process. Therefore, the Oil and Gas Group must have flexible recruiting policies, using and retaining good people.

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COMPLETING THE PROCESS OF PRODUCTION COST ACCOUNTING AND PRODUCT COST CALCULATING OF OPEN-PIT MINE COMPANIES IN VINACOMIN

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Abstract: *With open-pit mining technology, raw coal is only derived after removing large quantities of rock and soil. It is necessary to consider the technical peel coefficient for safety in mining. The coefficient will affect the product cost of coal mining. In fact, it is often reduced to reduce the cost of exploitation, leading to the infringement of the technical peeling coefficient. If the coefficient has been reduced for a long time, mining activities will be stopped for rehabilitation. Therefore, to create capital for peeling offsets and ensure the correct, sufficient, and stabilization of the product cost, applying the advanced cost method of rock peeling when accouting the coal product cost is necessary.*

The author uses the method of investigation and survey of open-pit mine technology lines to assess the applying method of production costs aggregating and calculating the coal product cost in open-pit mine companies and proposing how the peeling cost is determined based on the technical peel coefficient. The method will help open-pit mine companies achieve exploiting safety, the reasonable and stable coal product cost and ensuring economic efficiency.

Keywords: *open-pit mine companies; coal product cost, VINACOMIN*

1. BACKGROUND

The coal industry plays an essential role in providing burning fuel for production and consumption. Futhermore, coal is also a neccessary reserve source of the national energy security strategy. As an important input for many industries such as thermal power, metallurgy, construction materials, etc, coal expense takes a significant rate in their product cost (about 60 % to 70 %). Therefore, the calculating coal product cost method has great significance for improving the economic efficiency of the coal mining industry in particular and the whole economy in general.

Although the output of open-pit mines accounts for around 50 % of the coal industry's output, most of them are nearly 50 years old and enter the final stage of the life cycle. Therefore, open-pit mining enterprises face great difficulties which make mining product cost higher, such as high peeling

coefficient (up to 13-14 m^3/T), deeply exploiting leads to longer transportation, etc.

On the other hand, the major factor leads to coal product cost increase is natural features of mining area such as geographical factors, mining terrain characteristics, geological structure of coal seams (the depth, thickness of mineral seams, surrounding rock, slope, physical and mechanical properties of coal seams) and economic-technical characteristics, the production organization and management of coal industry. Therefore, it is necessary to suggest a reasonable method of calculating the coal product cost to ensure exploiting safety and the economic efficiency of open-pit mine companies.

2. THE PRODUCTION CHARACTERISTICS OF THE OPEN-PIT MINE COMPANIES

2.1. The Technical – technology characteristics of production

Coal production in open-cast mining process consists of the three phases: (1) mining preparation; (2) raw coal exploitation and transportation; (3) coal selection and distribution.

a. Mining preparation phase

The preparation for exploitation includes the following stages:

Drilling → Blasting → Loading (rock) → Transportation (rock) → Dumping

This phase is responsible for preparing resources for exploitation and includes the stages: drilling, blasting, loading and unloading of soil, rock and dump. The output of the steps in the order are the number of drilling meters, the number of cubic meters of crumbled rock, the number of cubic meters of rock transported to the waste dump, the number of cubic meters of wasted rock. The final output of this phase is the volume of completed rock (m^3).

b. Raw coal exploitation and transportation phase

The phase includes the following stages: Coal loading and Coal transportation to the trough

Coal loading → Coal transportation → Coal storage yard

The final output of this phase is the volume of delivered coal

c. Coal selection and distribution phase

The phase includes the following stages: raw coal transportation to the storage yard → Coal sieving and preparation → coal distribution

This phase ends the technological process of coal production, which includes:

- Transport of raw coal to the storage yard;

- Sieve, prepare and classify coal into quality levels, based on grain size, calorific, ash content, volatile matter, moisture ...

- Gather clean coal to the storage yard for distribution;

- Load clean coal for distribution.

This phase's output is the amount of clean coal with 10 different quality types, including 5 types of lump coal and 5 types of dust coal.

2.2. Organizational characteristics of open-pit mining companies

All open-pit companies have large capacities and space facilitates, creating advantages for achieving the goal of productive mechanization, automation, modernization and effectively reducing coal product cost.

In general, open-pit coal exploitation is specialized according to the technological phase, which is specialized in stages and operates according to internal economic accounting principles.

2.3. Economic and economic accounting characteristics

- Unlike other processing industries, the labor object of open-pit coal exploitation is underground resources, so that they have not the main materials expense item.

- The output of each phase and the final output of coal production are only one product, which is coal. Clean coal with different quality grades is the final product of the coal industry and is mainly affected by natural conditions rather than the selection and processing.

- Open-pit coal exploitation has a short production cycle, so there is little or no unfinished product.

- The expenses for labor force in open-pit coal exploitation is much higher than other sectors, account for over 30% total cost.

The transport means and the mining machineries and equipments take a major proportion of total value of the open-pit mine enterprises' fixed assets. Therefore, fixed capital is often increased in proportion to the exploitation size of mines. Sometimes the increasing proportion of fixed assets is higher than that of output and the expense of 1 ton of coal will increase through the extra depreciation.

- Open-pit coal exploitation always needs to expand production areas, go into deep, move workers and machineries, and workplaces.

3. THE SITUATION OF PRODUCTION COST ACCOUNTING AND CALCULATING PRODUCT COST OF OPEN-PIT MINING COMPANIES

All of the open-pit mining enterprises: (1) apply the vouchers diary accounting method with the accounting period is month, quarter and year; (2) use the simple method (Total cost) for calculating product cost and the method of regular declaration for gathering cost; (3) classify production costs according to the current accounting regime.

3.1. Content of production costs

a. Production cost by factors

Based on the economic content of production costs arising in the course of production activities, production costs by factors including:

+ Purchased auxiliary materials;

+ Purchased Fuel;

+ Purchased motivation;

+ Salaries of main and secondary labor;

+ Salary deductions;

+ Depreciation of fixed assets;

+ Expenses for outsourced services;

+ Other costs in cash;

b. Production costs by items

Based on the economic nature and use of each type of production costs arising in the technical and technological process, expense items include:

+ Directly raw material costs;

+ Directly labor costs;

+ Productive general costs;

+ Selling costs;

+ Enterprise management costs.

3.2. Subjects and methods of production cost accounting

a. Objects of production cost accounting

Based on the characteristics of production organization, technological process, production nature, and internal economic accounting requirement, the object of production cost collection is each phase of technological line. Each phase's costs are divided into technological stages and directly gathered into the finished products of the stage.

b. Method of production cost accounting

The production cost accounting method is based on the technology stages and all stages have the same product - clean coal, which is divided into diferent types. Thus, the production cost incurred in each phase is the constituent of their product cost.

3.3. Objects and methods of calculating product costs

a. Subjects calculating product costs

Clean coal is divided into 10 types according to different quality and they are the objects of calculating product costs. However, in order to meet the requirements of internal economic accounting and evaluate the production results of workshops, companies calculate the product cost according to technology lines such as:

+ Rock peeling product-cost (VND/m^3);

+ Raw coal product cost (VND/T);

+ Sieving and preparation product cost (VND/T);

+ Car transport product cost (VND/km).

b. Cost calculation method

The coal production process is in the form of simple production, producing only a single commodity product. Semi-finished products of each stage are transferred to the next stage, not sold out, so product prices can be determined by the method of total costing (parallel transfer of the total cost of the stages involved in product cost) and the direct method.

3.4. Process of production cost accounting and product cost calculation

a. Process of production cost accounting

+ Accounting of directly raw material costs;

In open-pit mine enterprises, auxiliary materials are accounted directly for finished products of the period according to the actual prices of purchased materials. Vouchers are the basis for making an allocation table of materials and accounting into the finished product with two optional methods:

- The cost of raw materials directly related to each separated object of production cost collection is directly collected to that object.

The cost of raw materials related to many objects of production cost collection is indirectly distributed to each related object.

After the allocation results are made, all costs of raw materials are aggregated into the allocation table No.2 according to each object of production cost collection.

+ Accounting of direct labor cost items:

Direct labor cost is the amount of money paid for workers who directly participate in the production, such as main, supplementary salaries and wage-nature allowances.

Besides, direct labor costs also include contributions to social insurance, health insurance, union funds, and unemployment insurance paid by the enterprise.

The direct labor cost item is aggregated in table 1 and accounted directly into the product cost of each stage.

+ Accounting of productive general costs

Productive general costs are those incurred for production or business within the workshop, such as expenses for workshop staff, expenses for materials, tools, depreciation of fixed assets, and other workshop expenses.

Workshop management expenses are recorded in List 4 of each production stage and accounted directly for the stage's finished products.

b. Gathering production costs according to accounting subjects

To gather production costs by accounting subjects, the accounting department of enterprises shall open a detailed accounting card in production costs for each phase of production (according to the phase of production preparation, exploitation, Sieving and preparation). In the card, production costs are gathered by stages of the phase (drilling, shot-blasting, transportation, etc.)

The monthly production costs are reflected in the cost accounting card of each phase and detailed for each production stage. These data are the basis for calculating phased costs and for internal accounting.

c. Coal product cost calculating

Coal product cost is calculated by the method of total cost of technology stages is as follows:

producs cost in workshop	=	Total cost of rock peeling	Driling Rock loading Transportation Dumping	+	Total cost of exloitation	Coal loading Transportation Gathering	+	Total cost of Sieving and preparation	Sieving and preparation Gathering
Z_{TS}		Z_1		+	Z_2		+	Z3	

Fig 1. Diagram of product cost calculating of raw coal and clean coal of open-pit mine enterprises

Advantages: simple, easily calculation.

Disadvantages: the peeling coefficient is not considered when accounting and all the actual rock peeling cost in the period is fully transferred to the coal product cost.

In fact, open-pit mine enterprises often have the phenomenon of "less peeling, more exploiting" that leads to the two cases: i) if the actual peeling coefficient is lower than the designed peeling coefficient, their product cost will be unreasonably reduced because of a violation of mining technology, unsafe in exploiting, and occurring the rock peeling debt which may have to stop production to renovate the mine; ii) if the actual peeling coefficient is higher than the designed peeling coefficient, the calculated cost will increase, affecting the business results of enterprises.

4. RECOMMENDING METHOD OF TRANSFORMING THE COST OF ROCK PEELING INTO COAL PRODUCTION COST

To avoid the above disadvantages and to ensure the exploitation safety and have a reasonable coal product cost, the author proposes a method of allocating the rock peeling cost into coal product cost according to the designed peeling coefficient. The order of accounting is as follows:

Step 1: Calculate the cost of the rock peeling phase

$$Z = G_{ddđk} + C - G_{ddck};\ VND$$

$$z_{đđ} = Z/Q_{đđ};\ VND/T$$

Notations:

Z: Total cost of rock peeling in the period;

$G_{ddđk}$; G_{ddck}: Total unfinished expenses of rock peeling at the beginning and the end of the period;

C: Total cost of rock peeling in the period;

$z_{đđ}$: Unit cost of rock peeling;

$Q_{đđ}$: The output of rock peeling.

Step 2: Allocation the rock peeling cost into coal product cost according to the designed peeling coefficient

$$Z_{TNK} = (k_{tk} \cdot Q_{TNK}) \cdot z_{đđ} + C_{kt}$$

$$z_{tnk} = Z_{TNK}/Q_{TNK};\ VND/T$$

Notations:

Z_{TNK}: Total product cost of raw coal; VND

k_{tk}: designed peeling coefficient;

Q_{TNK}: Raw coal output; Ton

z_{tnk}: Unit product cost of raw coal; VND/T

C_{kt}: Total cost of exploitation; VND

Step 3: Calculating the cost of clean coal

$$Z_{TS} = z_{tnk} \times Q_{ST} + C_{ST}$$

$$z_{ts} = Z_{TS} / Q_{TS}$$

Notations:

Z_{TS}: Total cost of clean coal; VND

Q_{ST}: Coal output put into screening; Ton

Q_{TS}: Output of clean coal in stock; Ton

z_{ts}: Cost of clean coal unit; VND/T

C_{ST}: Total cost of preparing and dumping; VND

Step 4: Allocation the spread expense between actual rock peeling expense and that according to the design peeling coefficient.

$$\Delta K = K_{tt} - (k_{tt}.Q).z_{dd}; \text{ VND}$$

+ If $\Delta K > 0$, the difference is transferred to the cost waiting for being allocated cost, record:

Debit in Account 242/Credit in Account 154: the surplus values

+ If $\Delta K < 0$, the difference is transferred to accrued expenses, record:

Debit in Account 154/Credit in Account 335: the shorted values

5. CONCLUSION

The method by allocating the rock peeling cost into coal product cost according to the designed peeling coefficient will ensure rationality and suitability with the production technology of the coal product cost. It will also ensure mining safety and avoid the situation of less peeling, more coal mining, fake cost reduction. With the suggested method, companies can create the fund for supplemental peeling and achieve a stable product cost by accruing the cost of rock peeling.

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ENVIRONMENTAL AND ENERGY TRANSITION

A REVIEW OF MINE CLOSURE REGIME IN THAILAND

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Abstract: *Mine closure is important to the management of mining impacts on society and environment. Policy framework plays a significant role on mine closure planning and implementation. The objective of this paper is to review the legislation framework related to mine closure to identify weaknesses of the current regime. The Mine Closure Checklist for Government developed by Asia-Pacific Economic Cooperation (APEC) is used as a basis for this assessment. The result reveals the need for Thailand to close three main gaps in the current mine closure regime, namely, conceptual, mechanism, and standard gaps.*

Keywords: *mine closure, Thailand, policy review.*

1. INTRODUCTION

Mine closure is an important issue in mine planning and management since mine life is definite and dependent on the mineral market and the impacts of the projects can last or occur after the project's termination. The transform of mine sites to the areas that fit in new development opportunities and safe for human and the environment is a challenge for mine closure planning and practices. This task not only involves technical tasks like landscape and engineering designs but also requires consideration on socio-economic and political contexts which would determine the acceptance, practicality, and success of the plan.

In Thailand, mine closure has gained more and more attention from policy-makers. There are also efforts on both public and private sides to make use of the post-mining lands. Legislation framework plays an important role on facilitating mine closure planning and implementation and promoting investment in these transforming projects. However, the idea of planning for post-mining development from an early phase of the project life has not yet been a well-known practice in Thailand, so mine closure-related requirements are regulated unsystematically by various laws, not united in a specific law. Since each law has its own objectives, the measures and targets specified by different laws are sometimes contradictory and can hinder the development and implementation of mine closure plan. In order to encourage and promote good mine closure practices, the Thai government needs to identify strengths and limitations of its current regime, which will make it possible to create improvement in this area. Therefore, the objective of this paper is to gather the regulations relevant to mine closure in Thailand and identify the missing links that might hinder constructive mine closure practices for future improvements.

2. APEC'S MINE CLOSURE CHECKLIST FOR GOVERNMENT

In this paper, the Mine Closure Checklist for Government (APEC, 2018) developed by the Mining Task Force (MTF) of Asia-Pacific Economic Cooperation (APEC) in 2018 is used as a basis for analysis. The APEC Checklist was developed to be a guideline providing key components for a successful mine closure governance framework to policy makers in the APEC region. It is divided into 4 phases, namely, getting started, developing policy for the closure plan, developing policy for managing closure, and implementing the closure policy. It contains two scorecards for assessing current policy and identifying gaps. The first one is related to the policy set up for the closure plan, and the second one concerns the policy regarding the implementation of the closure plan. The main topics in the Checklist are summarized in Table 1.

Table 1. A summary of the scorecards' topics in APEC's Mine Closure Checklist for Governments

Scorecard: Developing policy for closure plan	Scorecard: Developing policy for managing closure
• The closure plan - ensure all mines have a closure plan in place	• Relinquishment - Is there a pathway?
• Evaluating technical content - ensure the plan is technically sound	• Administration of documentation - key requirements
• Post-closure land use - define objectives	• Temporary and sudden closure - policy needs
• Chemical and physical stability - key requirements	• Orphaned and abandoned sites - how to manage
• Design criteria and planning horizons - key requirements	• Managing expectations
• Climate change - issues to address	
• Social impacts and benefits of mine closure - issues to address	
• Financing closure - elements of financial assurance	

3. LAWS AND REGULATIONS RELATED TO MINE CLOSURE

In Thailand, the requirements related to mine closure planning and implementation are imposed under various laws. The main ones include the Constitution of Thailand, mining laws, environmental laws, and land use laws. Their essences are summarized below.

3.1.1. The Constitution of Thailand B.E. 2560 (2017)

The Constitution of Thailand B.E. 2560 (2017) states the duties of the Thai citizen and the Thai government in Section 4 and 5. The citizen's duties relevant to mine closure include the respect for rules of law, rights, and liberty and the participation and supports for environmental protection (Article 50), whereas the government's duties related to mine closure are to efficiently implement the laws (Article 53), securing public access to basic infrastructure (Article 56), ensuring balanced uses of natural resources and enhance public participation on the matter (Article 57), and ensuring a thorough study of environmental and health impacts with a public hearing for the projects that might cause intensive impacts are carried out and considered during the approval process (Article 58). The Constitution also requires the government to plan for efficient land, water, and energy uses (Article 72) and authorizes the Local Administration Office to provide local public services and activities.

3.2. The Minerals Act B.E. 2560 (2017)

The Minerals Act B.E. 2560 (2017), the key law regulating mining activities throughout the project life, makes mine closure planning and implementation mandatory to every mining project and ensures adequate funds for related activities. It requires an issuance of a mining license prior to any commencement of mining activities, and the mine rehabilitation and environmental monitoring plans for the operation and post-closure phases must be submitted and approved during the process of consideration (Article 52, 54, and 81). The concessionaire is required to pay special fee, which is intended for mineral-related research and mine rehabilitation purposes (Article 54), and holds a responsibility to rehabilitate the mining area and monitor environmental quality and community's health conditions during the operation and after the project's termination as well as to place financial guarantee for the purpose of mine rehabilitation and damage compensation (Article 68), which will be returned to the mining license holders when the rehabilitation requirements have been completely fulfilled (Article 70). The relinquishment of mining rights can be done when there are no unpaid debts, the area has been rehabilitated, and all requirements according to the licenses are fulfilled (Article 61).

3.3. Environmental Laws

The main environmental laws related to mining is the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) and its amendment in B.E. 2561 (2018). It specifies components and mechanisms for environmental management. The most important element in the context of mining and mine closure is related to environmental impact assessment (EIA). Most mining projects are required to conduct an EIA (or its variation) during the project approval process (Article 46-51). Measures for impact mitigation are identified during the EIA approval and imposed upon the issuance of mining license, including those related to mine closure and environmental monitoring. The measures for pollution control and management mechanisms, especially for the areas critically affected by pollutions, are also specified in this law (Section 4).

3.4. Land Use Laws

In Thailand, different land use categories are regulated by different laws and under different authorities. Therefore, mine closure planning and management is linked to several land use-related laws. The main ones are listed in Table 2 together with their short descriptions.

Table 2. Key land use-related laws in Thailand in the context of mine closure

Law	Description
The Land Code B.E. 2497 (1954)	This law concerns the land rights and the rights for land use. The use of public land for mining and forestry cannot be done without the rights or the land use permission from the authority (Article 9).
Forest Act B.E. 2484 (1941) and its ministerial regulations	This Act does not allow any activity in the forest area unless a permission is given (Article 54). It also specifies permit approval process and criteria and additional conditions upon the permit issuance as appropriate (Article 58).
National Reserved Forest Act B.E. 2507 (1964) and its ministerial regulations	Land use in a national reserved forest is not allowed unless a permission is given (Article 14). The permitting conditions are varied by the type of projects and forest conditions (Article 16-20). Criteria for granting permission and the conditions in the permit are specified in its subordinated regulation (2005), which also include the requirements for post-mining land reclamation and reforestation (triple mining area offset).

Law	Description
Cabinet Resolutions related to watershed classification and land use in watershed area	The resolutions contain the classification and the conditions for land use in watershed areas. The use of highly sensitive watershed area for mining requires an approval from the Cabinet.
National Park Act B.E. 2504 (1961) and its amendments	A list of prohibited activities in national park areas is stated (Article 16). Using national park area, including for mining, requires permission from the authority (Article 16 and 30). However, Article 17 of the Minerals Act B.E. 2560 specifies that national park cannot be designated as mining zone.
Wild Animal Reservation and Protection Act B.E. 2535 (1992)	Land possession, construction, deforestation, mining, setting animal free, diverting water way, and dewatering or flooding or toxifying natural reservoir are not allowed unless permitted (Article 38 and 42). However, Article 17 of the Minerals Act B.E. 2560 specifies that wild animal reservation area cannot be designated as mining zone.
Agricultural Land Reform Act B.E. 2518 (1975)	This law specifies conditions for the acquisition, management. and allocation of the areas for agricultural land reform. The use of agricultural land reform areas for mining was possible according to Article 19 and its subordinate regulation (1998). Permit holders were liable for additional payment and land reclamation practices imposed by the authority. However, the National Council for Peace and Order issued Order 31/2560 (2017) to amend the criteria for non-agricultural land use in the agricultural land reform area. Its subordinate regulation on 29 December 2017 does not allow new mining project in the area. Nevertheless, land uses for other activities related to agricultural land reform are still permissible (Article 30).

4. ASSESSMENT OF EXISTING LEGISLATION FRAMEWORK

The assessment of the current legislation framework is carried out in two parts, following the scorecards in APEC's Mine Closure Checklist for Governments mentioned previously. The first assessment concerns the policy for closure plan, and the second one is about the implementation-related policy. By following the questions and issues in the Checklist, the components that are present and lacking are identified below.

4.1. Scorecard: Developing Policy for Closure Plan

4.1.1. The closure plan - ensure all mines have a closure plan in place

According to the current legislation framework, the components related to mine closure plan is mainly included in the environmental impact assessment (EIA). All operating mines must have a 'mine rehabilitation plan' approved during the EIA approval, prior to the issuance of mining license and project commencement. The EIA measures generally include requirements for a regular report on environmental monitoring results and the progresses of mine rehabilitation according to the plan. A major gap in this issue is the lack of requirements for a comprehensive mine closure plan, of which the scope is broader than a rehabilitation plan and reforestation activities. More importantly, the current framework lacks the process of periodic updates and approval of the plan. Although a plan alteration can be done with an order of the authority as needed (Article 68 of the Minerals Act B.E. 2560) or as requested by the license holders on a voluntary basis, the change of mine rehabilitation plan does not generally happen when the operation runs smoothly. As a result, the conceptual mine rehabilitation plan approved at the early stage of project life is normally kept in its original form and not adjusted to match with the detailed plans and the changes during the operation, which can result in ineffective mine closure and poor financial management. Strengthening the framework requires an extension of the scope of the plan and the mechanisms to update the plan over time. Adding the improvement on documentation to include technical details and archiving system would allow Thailand to ensure a complete cycle of mine closure planning.

4.1.2. Evaluating technical content - ensure the plan is technically sound

In terms of technical evaluation, the current framework sets requirements to collect the information necessary for the assessment of environmental and health impacts as well as the review of mine rehabilitation plan, including the descriptions of current environmental states (Regulation under Article 46-51 of the Enhancement and Conservation of National Environmental Quality Act B.E.2535) and a study of environmental and health baseline conditions (Article 32 of the Minerals Act B.E. 2560). However, the process of technical reviews and justification of the mine closure strategies and plans can still be improved in many aspects. The first aspect regards reviewers. Mine closure plans are reviewed under the EIA approval process by a group of experts in various fields assigned as a committee. They are third-party, competent experts but not specifically specialized in mine closure. Moreover, the review and approval of mine rehabilitation plans relies mainly on the committee’s knowledge and experiences rather than on specified technical guidelines or international standards. Therefore, there are the possibilities of oversight and ignorance. Hiring external experts on a regular basis can be helpful for improving the review performance but it is uncommon and mostly done when problems or special interests emerge. The second aspect concerns the justification of mine closure strategies and landform design. Some legal conditions, especially those in land-use permits, can place constraints on mine closure plan since they predetermine land use objectives and targets and lead to the lack of strategic concept and consideration of local needs, development and integration possibilities, and alternatives. Improvements on these two aspects would allow Thailand to ensure more technically-sound mine closure plans.

4.1.3. Post-closure land use - define objectives

The definition of post-closure land use objectives is not an apparent process in the current framework. The objectives are often connected to the legal conditions in the permits and the original land use. As mentioned earlier, the current framework sets requirements on a mine rehabilitation plan rather than a mine closure plan, so the main target is to physically reclaim and reforest the site. In some cases, such as in forest or agricultural land reform areas, post-closure land use is clearly defined in the permits. Since the rights on post-closure land are returned to the landlord or the responsible authority, who hold responsibilities to manage and regulate the land use, the requirements for post-mining reclamation are often related to the original land use purpose. The conditions state, for example, to reclaim the land to its former state (forest or agricultural land) and to create a water reservoir. The predetermined objectives reflect the connection between regional planning and post-closure land use since the rehabilitated site is to be transformed back to its original state. However, if the land use objectives are to be changed, these conditions can place constraints to mine closure management. The post-closure land use would be considered a different project and needs to conform to the legal conditions for those specific purposes. In the current legislation, processes, incentives, or fora to encourage regional land use strategy development and implementation are not obvious. Article 137 of the Minerals Act B.E. 2560 allows fee exemption for 'socially and environmentally responsible operation'; the criteria relevant to mine closure have yet to be defined.

4.1.4. Chemical and physical stability - key requirements

In the current legislation, the characterization of mine wastes in terms of geochemical and physical properties and the life-of-mine quantities as well as the final landform design are supposed to be included in mining plan and EIA study, in which the design of mine waste facilities and the measures to prevent or mitigate impacts are provided. There is no concrete requirements or guidelines for the design of waste facilities, but the proposed documents are reviewed by engineers and environmentalists and approved by the EIA expert committee during the approval process based on personal knowledge and judgement and on a case-by-case basis. This process allows the consideration of chemical and physical stability issues as well as related social concerns, and environmental quality monitoring requirements are entailed upon the EIA approval to ensure the environmental quality standards are met. The approval of EIA and mining license also allows the links between mine closure management and the management of water and ecosystem through the participation of related authorities in the consideration committees. However, the lack of solid framework for reviewing the site and waste characterization, submitted designs, mitigation measures, and mine closure project feasibility is an important weakness since there is no guarantee that all key issues are identified and instructions are given appropriately and adequately. The addition of related guidelines is possible under Article 32 of the Minerals Act B.E. 2560, which allows supplementary conditions on environmental and health baseline studies, control of pollutions and environmental impacts from mineral-related operations, and safety protection to be specified and imposed.

4.1.5. Design criteria and planning horizons - key requirements

The current legislation framework provides a flexible mechanism for the mining license applicant to develop the mine closure design based on the site data and submit it to the authority during the approval of mining plan and EIA. There is no requirement on the method, but it has to correspond to the land use requirements and maintain environmental and social impacts within acceptable levels. Risk assessment can be included in the EIA to determine the effectiveness of the mitigation measures but is not compulsory unless the approval committee requires one.

The planning horizon can extend beyond the mine life and is adjustable. The planning duration is determined by the conditions in EIA, which contain not only the measures for rehabilitation works but also the requirements for environmental quality monitoring. Thus, the duration can continue for a period of time after the project ends to ensure stable environmental conditions. Similar to other EIA conditions, it can be adjusted upon the concessionaire's request or the revision of EIA or the order of related authorities (Article 68 of the Minerals Act B.E. 2560).

Based on the Checklist, the current requirements contain key elements on design criteria and planning horizons for mine closure. Despite their flexibility and adaptiveness, they are more objective-based, lack of guideline for defining planning horizon and periodic revision, and are not synergize with other socio-economic strategies and goals. These weaknesses might not have a significant effect on quarry sites, which are the major application, but they can result in a significant difference in case of larger scale mining projects. An addition of risk-based analysis and a development of mine closure planning and revision guideline can contribute to an improvement on this issue.

4.1.6. Climate change - issues to address

The current legislation framework does not address the effects of climate change on mine closure and post-closure management, especially that of mining and waste facilities. However, a weak connection between mine closure planning and climate change is present through the government's and company's efforts to transform mining sites into water reservoirs to mitigate drought. To strengthen the current legislation framework on mine closure, related authorities could consider gathering historical climate data and natural disasters in the country and developing a guideline for including climate change issue in the mine closure design and management criteria.

4.1.7. Social impacts and benefits of mine closure - issues to address

Stakeholder participation is a requirement for the EIA study (Announcement of the Ministry of Natural Resources and Environment on 20 June 2012 according to the Enhancement and Conservation of National Environmental Quality Act B.E.2535 and its relevant documents). However, the Announcement is not specifically made for a mine closure plan development but an overall project planning. As a result, stakeholders are informed about the mine life, mine closure plan, and post-closure land use, and their feedbacks are gathered for plan adjustments. This process, however, does not guarantee the emphasis of mine closure-related information and the connection of the plan with the development strategy.

Communication about plan updates and modification to the relevant authorities are required in forms of approval of changes and regular reporting of operating progresses and environmental monitoring results. Nevertheless, public communication about mine closure progresses during and after the operation is not compulsory and depends mainly on the practices of each mining license holder.

According to the Checklist, the requirements related to separate participation processes for vulnerable stakeholders, transition strategy for local economics and workers, regular communication on mine closure-related issues with stakeholders, and connection between mine closure plan and socio-economic development strategies are lacking. The latter two issues, in particular, should be improved to ensure information sharing and an integrative planning.

4.1.8. Financing closure - elements of financial assurance

The current legislation framework requires financial guarantee for mine rehabilitation and insurance for damages to other parties or their assets (Article 68 of the Minerals Act B.E. 2560). The costs are estimated based on the proposed rehabilitation activities and the reference costs. When the plan is completely fulfilled, the financial guarantee is revoked and the remaining money is returned to the mining license holder (Article 70 of the Minerals Act B.E. 2560). It is remarked that the costs are calculated for rehabilitation works but not post-closure activities after the end of mining license term. If the calculated costs are not sufficient, the holder of mining license is liable for additional costs of mine rehabilitation and related activities. It is noted that financial guarantee also exists for the use of forest land under the Forest Act B.E. 2484.

The Checklist reveals a few weaknesses in the current system, including the lack of measures to encourage progressive reclamation, mechanisms for third-party audit, and concrete guideline for calculating and re-calculating financial assurance. These lacking components can complement the current framework and enhance the performance and transparency of mine closure policy implementation. Another possibility for improvements is the establishment of criteria on financial assurance options and institutions to allow flexibility to the concessionaire.

4.2. Scorecard: Developing policy for managing closure

4.2.1. Relinquishment - Is there a pathway?

Relinquishment of post-mining land is an important step to discharge mining lease holder from his liability, so it requires that the site be in safe conditions. Article 61 of the Minerals Act B.E. 2560 specifies that the relinquishment of mining rights, either fully or partially, is possible when the holder of mining license does not have unpaid debt and has fulfilled all the conditions in the mining license including mine rehabilitation works. It indicates the requirements to rehabilitate the site before ending liability. However, the ability to ensure the fulfillment of mine rehabilitation requirements in case of automatic relinquishment upon the end of mining license term is still questionable since the conditions are tied to mining license and its enforcement without a valid mining license can be unfeasible. The final inspection is done by the assigned officer unless the conditions are stated otherwise; however, it mainly aims for checking all the requirements are fulfilled rather than a technical audit to certify the result. After the relinquishment is confirmed, the liability of the mining license holder ends, and the financial guarantee is revoked. The arrangement for residual liabilities such as monitoring, treatment, and site maintenance could be specified as conditions in EIA or orders of the relevant authorities, which means no financial assurance or fund for the next land owner who assumes the residual liability. Extraordinary events after closure are not well-addressed in most cases.

4.2.2. Administration of documentation - key requirements

The current policy framework does not contain mechanisms for administration of documentation mentioned in the Checklist, including mechanism for undertaking and documenting closure trials, consistently and transparently collating monitoring data and reporting, and having a peer-review or benchmarking process for closure monitoring and reporting.

4.2.3. Temporary and sudden closure - policy needs

Mechanisms for temporary and sudden closure is an important weakness in the current mine closure policy. There is no requirement for this issue. Although the financial guarantee (from financial institution) and insurance claim can provide funding for rehabilitation works and costs of damages, it does not guarantee that the secured amount is sufficient for the case of temporary and sudden closure. Also, specific procedures regarding the management of the temporary and sudden closure sites are not available. Although some conditions such as site inspection, reporting, and environmental monitoring are still applicable, the lack of specific conditions can be a pitfall, especially in case the mining license holder loses its business status and cannot continue its activities.

4.2.4. Orphaned and abandoned sites - how to manage

The documents of every mining license are kept by the relevant authorities, including abandoned and orphaned mines. However, there is no assessment of the sites and their remediation priorities according to their risks or potential benefits. This can be problematic, especially for the projects terminated long before the requirements on mine rehabilitation and financial guarantee are enforced, since the problems are not identified and the government is in charge. To remediate the sites, related authorities have to find budget and create a project. This process has been facilitated by an establishment of mineral royalty fund and special fee fund (Article 46 and 136 of the Minerals Act B.E. 2560), both of which allow the spending on mine rehabilitation. There is no mechanism for third-parties to remediate abandoned sites without assuming liabilities or for other parties to remediate the sites as an offset for other impacts. This could be an addition to encourage reclamation activities in abandoned areas.

4.2.5. Managing expectations

Expectation management is a rarely-addressed issue in the current mine closure framework. However, it is believed that the regime does not trigger unrealistic expectation on special exemptions to requirements for specific operators. However, the unrealistic expectation of community regarding post-closure economic opportunities and a complete removal of risks associated with closure cannot be guaranteed since it depends on the communication between the mining license holder and the communities or other stakeholders.

5. CONCLUSIONS

According to the assessment, several weaknesses of the current mine closure regime are identified. The gaps can be classified into three main groups, namely, conceptual, mechanism, and standard gaps.

Conceptual gap concerns how mine closure is defined. In Thailand’s case, the distinguish between mine closure and mine rehabilitation is needed. This will also lead to the attention on different kinds of closure.

Mechanism gaps are the lack of mechanisms for some key issues. In this case, the important ones include the definition of mine closure objective, periodic revision of mine closure plan, management of sudden/temporary closure, documentation and compilation of data related to mine closure, independent technical audit, relinquishment and post-relinquishment management, and integrative planning with other development strategies.

Standard gaps refer to the lack of guideline or standardized practices for people who carry out the tasks. Key guidelines that should be developed are technical guideline for mine closure planning and review, waste characterization and waste facility management, risk assessment for mine closure and management, design and management criteria adjustment due to climate change, public communication on mine closure issues, and mine closure cost estimation.

By adding the missing components into the current regime, the mine closure system would be strengthened. This step requires a close communication among related parties to identify and remove constraints in the current regime and put the conditions in place in a synergizing way. These preliminary steps of policy development are then to follow by an observation and adjustment iteratively to keep the system adaptive and compatible with changing situations and contexts.

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APPLICATION OF SWOT MATRIX IN ENVIRONMENTAL MANAGEMENT OF COAL MINING ACTIVITIES IN VIETNAM

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Abstract: *Coal mining activities in Vietnam have been causing negative impacts on the environment and society, such as dust pollution, noise, water pollution, ecosystem degradation, adversely affecting the health of workers and people living around the mining area. Although, in recent times, coal mining enterprises have applied many environmental management measures, ecological pollution issues in coal mining activities are still inadequate. Therefore, it is necessary to assess the advantages and disadvantages of the environmental management of coal mining activities and, on that basis, propose solutions to improve environmental management in mining activities. The report uses the SWOT matrix to analyze: Strengths, weaknesses, opportunities, risks in environmental management practices of coal mining enterprises, to show the advantages and disadvantages arising from inside and outside coal mining enterprises when performing ecological management. Thereby proposing some recommendations and solutions to strengthen the environmental management in coal mining activities in Vietnam today.*

Keywords: *SWOT, Environment, Environmental management, Coal mining activities*

1. INTRODUCTION

Currently, the exploitation and supply of coal to the domestic market include units such as Vietnam National Coal - Mineral Industries Group (Vinacomin), Dong Bac Corporation, 319 Corporation, Vietmindo (FDI enterprise), etc. In particular, Vinacomin accounts for a significant proportion with an average output of 30 million tons per year. The coal mining industry is an important economic sector of our country, providing the main fuel source for other sectors such as production of electricity, construction materials, chemicals, domestic fuels and export. In recent years, the coal mining industry has been developing strongly to meet the increasing demand for domestic consumption and export. However, this activity also causes negative impacts on the environment and society, such as dust pollution, noise, water pollution, ecosystem degradation, adversely affecting the health of workers and people living around the mining area.

According to a view on the development of coal industry, "Coal industry development associates with environmental protection and improvement; harmonizes with tourism development, minimizes impacts on cultural preservation areas; makes positive contributions to socio-economic development, associates with the task of consolidating and strengthening national defense and security in the area; and ensures safety in production" (Decision No. 43/QĐ-TTg, 2016). To achieve the above objectives of the coal industry, environmental management in the coal industry in general and ecological management in coal mining enterprises in particular play a vital role. Although coal mining enterprises have applied many ecological management measures, they have not overcome environmental pollution. The outstanding issues may be due to the internal causes of the enterprise and also the external impacts, so it is necessary to have measures to assess the environmental management of coal mining activities to find out the advantages as well as the outstanding issues on that basis, measurements can be built to improve environmental management activities.

SWOT analysis is an analysis tool on an object based on systematic principles, in which: Analysis of strengths (**S**-strength), weaknesses (**W**-weakness) is an internal assessment, self-assessment about the capacity of the system (object) to achieve a goal, taking the goal as a standard to rank a particular feature of the internal environment as a strength (supporting the goal) or a weakness (obstructing the goal); Analysis of opportunities (**O**-opportunities), threats (**T**-threats) is the assessment of external factors that govern the development goals of the system (object), taking the goal as a standard to rank a particular feature of the external environment as an opportunity (supporting the goal) or threat (obstructing the goal).

SWOT analysis can be a useful tool for strategic planning of environmental management activities. According to Lozano and Valles (2007), "SWOT is widely recognized and forms a essential basis for assessing the current situation and developing strategies in the future." The use of this method has several advantages and disadvantages as follows: The advantage of this method is straight forward and everyone can use it without advanced knowledge or external technical support. The disadvantage of this method is that the analysis is quite subjective and straightforward, and the data is fixed. The application of SWOT to analyze the advantages and disadvantages of environmental management activities is to answer four questions: 1. What are the strengths of organizations when conducting environmental management activities? 2. What are the weaknesses of organizations when conducting environmental management activities? 3. What are the opportunities for organizations when implementing environmental management activities? 4. What are the threats to organizations when conducting environmental management activities?

Due to the need to assess the environmental management of coal mining and the benefits of SWOT as analyzed above, the application of SWOT in the environmental management of coal mining activities in Vietnam is vital to analyze the internal strengths and weaknesses, external opportunities and threats to find out the advantages and disadvantages in the environmental management of coal mining enterprises in Vietnam today.

2. CURRENT SITUATION OF ENVIRONMENT MANAGEMENT IN COAL MINING ACTIVITIES AT ENTERPRISES OF VINACOMINVINACOMIN

2.1. Environmental management plan

Based on the guiding documents of Vinacomin and the reality of production and business, enterprises make an annual environmental management plan with the main contents of environmental protection measures and the implementation costs. The cost of serving the environmental protection of enterprises is from the cost of coal production. However, there is no mechanism to allow/ enforce enterprises to set aside capita to actively spend on environmental protection. It is worth noting that since 2018 Vinacomin had to cancel the concentrated Environment Fund. The current maximal spending is deducted to 1.5% production costs. The limited funding source for environmental protection drove many urgent projects to be delayed. The environmental quality in coal mining areas, hence, cannot be improved.

2.2. Organization of environmental management

- Environmental management apparatus in enterprises: The environmental management apparatus of enterprises has been gradually built, including the team, group, and workshop. Enterprises also organize a department in charge of the environment. However, due to funding and staff qualification, etc., the effectiveness of environmental management has not been fully promoted. In addition, at present, some enterprises have an environmental management division in other technical departments. The environmental management division is a small-scale one with 3-5 people, mostly mining engineers with additional training of environment. Therefore, the division is insufficient in terms of human resources for environmental management.

- Environment management system in enterprises: most of the enterprises in Vinacomin are gradually building and organizing the environmental management system, so it has a significant impact on some contents such as the quality of environmental inspection, the process of monitoring the performance of environmental works, and the result of technical solutions on the environment, etc.

- Quality assessment system for environmental management in enterprises: although enterprises have implemented many different ecological protection measures in coal mining activities to reduce negative impacts on the environment, however, at present, there is no model or method for assessing the quality of environmental management in enterprises, so enterprises and managers do not know the results of ecological management implementation of enterprises with achievements and remains.

2.3. Inspection and supervision of environmental management

Inspection and supervision activities of environmental protection at enterprises are currently conducted by a division in charge of the environment (environmental group). Still, the quality of these activities is limited. There is a lack of sanctions to handle violations of environmental protection within enterprises. In some cases, the division in charge of the environment is not objective when organizing the implementation of environmental protection measures and inspecting and supervising environmental protection.

3. APPLICATION OF SWOT TOOL TO ANALYZE ENVIRONMENTAL MANAGEMENT IN COAL MINING ACTIVITIES IN VIETNAM

In this section, the authors focus on analyzing the strengths and weaknesses to identify the internal advantages and disadvantages, and external opportunities and risks when performing environmental management in coal mining activities. Through practical research, the strengths, weaknesses, opportunities, and threats in the ecological management of coal mining enterprises are showed, including:

3.1. Determination of strengths (S-strength)

- Cost reduction: Good management help reduce operating costs of enterprises in the long term, such as: reducing the cost of energy and raw materials used, reducing the cost of the amount of production waste.

- Productivity improvement: Well-implemented environmental management activities will help to recover resources and save input materials, thereby improving the productivity of enterprises.

- Development and innovation: Good environmental management means enterprises must invest in new, environmentally friendly production technologies or technologies to treat air, water, and dust pollution, etc. These technologies are beneficial for the image, profit, and competitive position of enterprises.

3.2. Determination of weaknesses (W-weakness)

- The source of costs for environmental management is limited: The fee of environmental protection of coal mining enterprises is deducted from production costs. The perspective of Vinacomin is to prioritize financial resources, only spend 1.5 to 2.0 % of production costs for environmental protection. Among them, the cost of regular environmental protection for environmental protection activities in the production areas is 0.5%, and the rest is approved by Vinacomin. This fund is to serve primarily for ecological protection works in residential areas adjacent to the production areas of enterprises.

- Quantity and qualification of the staff: According to the current regulations, coal mining enterprises do not have their environmental management department, but organize an environmental management division in other technical departments, management staff of this division is usually only from 3 to 5 people, including mainly mining engineers trained in the environment, so there is not enough quantity and quality in terms of human resources for environmental management. Also, the education level of workers in enterprises is still low, leading to difficulties for training and propaganda to raise awareness of environmental protection in production.

- Compliance with legal policies on environmental protection faces many difficulties: There are too many administrative procedures, regulations are impractical, there are no strong enough policies to create incentives to promote recycling and reuse of waste, the decentralization of management in the field of environmental protection is not apparent, there are overlaps, regulations on environmental protection taxes and fees for mineral exploitation are still too high, reducing financial resources for production technology innovation as well as for environmental protection of coal mining enterprises.

3.3. Determination of opportunities (O-opportunities)

- Reducing pressure from regulators and the community: The main reason coal companies need to perform environmental management well is related to complaints from the community about environmental pollution from coal mining activities. Besides, if the environmental pollution situation exceeds the prescribed standards, enterprises will also be administratively sanctioned by the State management agencies, forced to overcome pollution issues. Coal mining may be forced to stop if the situation is more serious.

- Opportunities for new market development and competitiveness are higher for mining companies with appropriate environment perspectives. Coal mining enterprises can attract domestic and foreign customers, given the increasing green consumption trend. Thereby their competitiveness in the market can improve.

- Advanced financial opportunities come from good environmental management. Coal mining enterprises ensure sustainable development, thereby attracting financial resources from investors, shareholders, and financial institutions. For example, enterprises can access the "green credit" loan package with the criteria of better lending and preferential interest rates of banks currently applied or may be given priority to access capital from funds such as Science and Technology Development Fund, Environmental Protection Fund, and National Technology Innovation Fund, etc.

3.4. Determination of threats (T- threats)

- Impact on the annual budget of enterprises: To effectively manage the environment in coal mining, enterprises are required to implement many solutions both before, during, and after mining. These activities need to be improved continuously, which will cost enterprises more and affect their annual budgets.

- Strict legal requirements in the future: Vietnam increasingly integrates more deeply into the world, requiring the changes of our environmental protection legislation following the global practices, thereby showing that when integrating with the world, the ecological regulation framework will become more and more stringent. The strict compliance with these regulations may affect the formulation of operations and other essential strategies of coal mining enterprises.

- Lack of environmentally friendly customers: There is a small number of consumers who are conscious of using eco-friendly products, especially industrial customers. Hence, managers have less consideration to invest in improving environmental quality. However, the main focus of enterprises is still determining the future needs for eco-friendly products or in foreign markets.

4. SOLUTIONS AND RECOMMENDATIONS FOR IMPROVING ENVIRONMENTAL MANAGEMENT IN COAL MINING ACTIVITIES

4.1. Some solutions for enterprises of Vinacomin

4.1.1. Organization of the environment management apparatus in enterprises

To effectively implement environmental management programs for all coal mining and processing activities, enterprises need to have good organizational and personnel structure for environmental management.

Enterprises should set up a unit in charge of environmental management (Environmental Management Department), specialize in environmental management staff to avoid the situation of a team holding multiple job titles, resulting in insufficient time and capacity to perform the assigned task.

4.1.2. Organization of the environment management system in enterprises

The organization of the environmental management system set regulations and rules related to the environment and consistency in implementation through resources, responsibilities, and the ongoing assessment of procedures and processes. Consequently, these activities create the basis for environmental management and set out the rules forcing people to comply on-site to reduce the impacts on the environment. According to the provision of Article 25 of Decree No. 19/2015/NĐ-CP, establishments conducting production, business, and service activities must certify the environmental management system for the first time within 12 months from the effective date of this Decree. Therefore, the organization of a strict environmental management system also helps enterprises comply with legal requirements.

4.1.3. Development of a method for assessing the environmental management quality in enterprises

The assessment of ecological management in coal mining provides managers appropriate information on the advantages and disadvantages of environmental management. In addition, the results of the environmental management quality assessment will help managers to adjust the organization and implementation measures, etc. to achieve the objectives of the environmental management. The evaluation of the environmental management quality needs to be based on the purposes of the environmental management towards sustainable development, so it is necessary to make an overall assessment based on three items: environment, economy, and society, in which the most crucial objective is the environment. The proposal of the method for assessing the environmental management quality in enterprises is our next research direction.

4.1.4. Improvement of the human capacity for environmental management

Enterprises need to have a plan of specialized knowledge training for staff, meeting the requirements: understanding of the company operations, technical knowledge as well as legal documents, the capacity of science, technology, and environment, the understanding of the environmental standard system, etc. Besides, they are also capable of operating treatment systems, analyzing, and testing the level of assurance of environmental standards of products and wastes. They can assess environmental impacts throughout the production process. Also, the participation of consultants, economic analysts in environmental management such as research, planning, and formulation of environmental policies is required to both achieve financial goals and ensure ecological and social goals. For employees, enterprises need to organize short-term training courses for all employees, to consolidate and propagate knowledge about environmental protection. Enterprises need to maintain and expand ecological protection movements, going deep into quality rather than just stopping at the formal level.

4.1.5. Improvement of financial capacity for environmental management

Enterprises need to find different sources to increase funding for environmental management, such as support policies of the Government and Vinacomin of the locality, from corporate funds, cooperation funds, or calling for investment ... For environmental protection activities and investment projects on prevention, remediation of pollution, degradation, and environmental incidents with significant influence, the company may get funding from concessional loans or apply for financing from Vietnam Environment Protection Fund. This fund has a financial support mechanism depending on the scale and scope of the project. The company makes deposits for environmental renovation and restoration to ensure financial resources for ecological renovation and restoration after mining.

4.2. Some recommendations on State policies

Through SWOT analysis on the advantages and disadvantages of environmental management in coal mining activities, the authors propose some recommendations as follows: (Table 1)

Table 1. Some recommendations for environmental management policies based on SWOT analysis

<table>
<tr><th colspan="2">SWOT Analysis</th><th>Policy recommendations</th></tr>
<tr><td>Strengths:
- Reducing the cost
- Improving productivity
- Developing innovation</td><td rowspan="2">Advantages and disadvantages arising from internal issues of coal mining enterprises</td><td rowspan="2">- Management agencies need to regulate the expansion of financial sources in service of environmental management
- Organizing seminars for managers and employees on environmental management
- Regularly updating the appropriate environmental management policies</td></tr>
<tr><td>Weaknesses:
- Limited cost
- Insufficient of human resources
- Inadequate policies</td></tr>
</table>

SWOT Analysis		Policy recommendations
Opportunities: - Reducing pressure from management agency and the community - High opportunities for market development and competition - Improving financial opportunities	Advantages and disadvantages arising from external issues of coal mining enterprises	- Developing financial support solutions for enterprises in environmental management - Developing plans on new regulations in environmental management - Developing solutions to raise the awareness of consuming eco-friendly products
Threats: - Being costly - Strict legal requirements in the future - Lack of environmentally friendly customers		

(Source: Analysis and summary of authors)

- Authorities need to regulate the expansion of financial resources for environmental management. It is necessary to have mechanisms and policies to create capital for Vietnam Coal Environment Fund, as agreed with enterprises to determine a reasonable percentage of deduction on coal production revenue (besides of publicizing the plan of using the Fund with appropriate principles), collect fees from the benefit of coal mining activities: restoring areas with surface destruction during coal mining, dumping rocks and soils to the sea and marsh to create land for construction of residential areas, industrial parks, and other social needs, etc.

- Organizing seminars for managers and employees on environmental management: State management agencies, especially VINACOMIN, should regularly organize short-term workshops and classes with the sharing of domestic and foreign experts, require the participation of the environmental management staff of enterprises to learn from the experience and improve the quality of the team in charge of environmental management.

- Regular updating of the appropriate environmental management policies: Regularly reviewing and completing the provisions of the environmental protection legislation in the direction of reducing administrative procedures, enhancing compliance monitoring in reality. Formulating mechanisms and policies, especially financial mechanisms (for example, setting up environmental funds from production costs) to create favorable conditions for enterprises, are a few measurements. These measurements help companies to take the initiative in environmental protection and encourage enterprises to invest in treating and recycling wastes.

- Developing financial solutions in environmental management: Authorities should design financial incentives such as granting support packages and other funds to enhance environmental management activities in companies. These policies are intended to assist enterprises to overcome financial barriers in environmental management.

- Developing plans for new regulations in environmental management: Management agencies should regularly review rules to innovate following international practices. Changes need to be planned in stages before implementation to avoid passive, causing difficulties for the performance of enterprises.

- Developing solutions to raise the awareness of using eco-friendly products: In recent years, issues such as green consumption and understanding of the consumption of eco-friendly products have gained generous social support. This trend will likely motivate coal mining enterprises to improve environmental management activities to meet the requirements of consumers. The market for coal products does not make a product difference between enterprises, but rather a distinction based on environmental protection costs. However, many scientists believe that good environmental management can bring potential profits for enterprises in the stock market. Therefore, authorities need to propagate and improve public awareness of consuming eco-friendly products, to create a difference among companies and promoting them to focus on environmental protection.

5. CONCLUSION

Environmental protection has increasingly received the attention of the State, enterprises, and communities. Therefore, the introduction of solutions to improve environmental management in general and environmental management in coal mining activities, in particular, is even more necessary. However, the proposed solutions should be based on situations of mining companies, given their advantages and disadvantages arising from internal and external issues in performing environmental management. Through practical research, the article has applied SWOT tool to assess the ecological management of coal mining enterprises in Vinacomin. The assessment of strengths, weaknesses, opportunities, and threats has pointed out the internal and external advantages - disadvantages that affect the environmental management of enterprises. From the results of the analysis, the article has presented several solutions and recommendations to improve the quality of environmental management in coal mining and minimize negative impacts.

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A REVIEW OF CORPORATE SOCIAL RESPONSIBILITY FOR ENVIRONMENT IN VIETNAM NATIONAL COAL-MINERAL INDUSTRIES HOLDING CORPORATION LIMITED

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Abstract: *This study was conducted to evaluate social responsibility's implementation of the environment at Vietnam National Coal - Mineral Industries Holding Corporation Limited (Vinacomin). Thereby recommended several solutions to help Vinacomin to perform its social responsibility to the environment in a better way, ensuring the sustainable development of the Corporation.*

Keywords: *social responsibility, Vietnam National Coal-Mineral Industries Holding Corporation Limited.*

1. INTRODUCTION

Coal and minerals are an indispensable source of energy and raw materials for the development of the world's economy and Vietnam. However, the industry of mining, processing and using coal and minerals is the industry with many negative impacts on the environment, from destroying terrain, depleting flora and fauna, reducing water sources to generating wastewater, exhaust gas, solid waste and other specific types of waste in large quantities; in which the generation of greenhouse gases is one of the factors contributing to global warming and climate change in an increasingly extreme direction.

Vinacomin is a state-owned economic corporation in charge of ensuring national energy security, providing raw materials for the country's economy and export. The main business lines are mining and processing of coal and minerals, production of electricity, mine chemicals, construction materials; Repair, assembly and manufacturing of mining equipment. Vinacomin is now one of the three pillars of national energy security. It is the largest coal producer and supplier, the only alumina producer and the largest non-ferrous metal producer for its economy and export.

In response to sustainable economic development requirements, ensuring national energy security and protecting the environment, great requirements and challenges for Vinacomin are set in implementing corporate social responsibility to the environment. Being aware of the dangers of environmental pollution caused by mining and mineral processing activities, Vinacomin has actively implemented many solutions to protect the environment for the last time. With the initiative to implement environmental protection measures for recent years, Vinacomin has basically overcome the environmental pollution caused by the previous mineral mining process and is treated and prevented from an environmental population just arising. The environmental and landscape quality of coal and mineral mining areas has been improved dramatically, creating stable conditions for the industry's development, contributing positively to the development of localities.

However, the process of implementation of social responsibility to the environment of Vinacomin has still had certain limitations such as dust, dirt from the transportation of coal, minerals and rocky soil have not been completely overcome; industrial hygiene, the environmental landscape of production areas of the mines have not been performed well in some factories, still dusty, dirty and muddy. The rainwater from mining sites, mine dumps, production grounds with large volumes have still washed away soil and rock, causing sedimentation in draining rivers and streams. Wastewater generated in mining depends on rainfall, so sometimes, they have not been collected and treated thoroughly in some places under environmental standards. Thermal power plants sometimes discharged unconventional emissions to the environment due to equipment failures. Some electro-thermal slagged ash dumps have been full, the expansion and new allocation of dumps face many difficulties, thereby affecting the factories' operation. There are also some incidents involving the environment such as landslide of dumping sites caused by heavy rain; broken dams, overflowing mud and water of ore sewage reservoir; leaking of caustic soda solution to the environment from alumina factories; discharging emissions not meeting environmental standards due to equipment failures at thermal power plants.

This set out the fact that Vinacomin has to have appropriate solutions to implement social responsibility to the environment in a better manner, ensuring the sustainable development of the Corporation.

2. RATIONALE FOR CORPORATE SOCIAL RESPONSIBILITY TO THE ENVIRONMENT

2.1. Concept of corporate social responsibility

So far, there had been quite many different concepts and perspectives on corporate social responsibility. Each organization, company, the government saw social responsibility from different angles and perspectives depending on their conditions, characteristics and development level (Nguyen Ngoc Thang, 2010; Nguyen Dinh Cung & Luu Minh Duc, 2008), different subjects had different perspectives on social responsibility (Wood, 2010). Therefore, so far, there had been no consistent concept of social responsibility (Skudiene & Auruskeviciene, 2012).

The term social responsibility had been known for a long time since the economist Bowen (1953) released the book "Social Responsibility of Entrepreneurs" in 1953 with the aim of calling businesses not to harm their rights and benefit of others in proposing and implementing policies. Bowen was considered one of the pioneers of the concept of social responsibility. Bowen (1953) argued that enterprises should pursue valuable policies, decisions and actions for society. Davis (1973) said that social responsibility was the interest and response of businesses to issues beyond the satisfaction of legal, economic and technological requirements. Carroll (1999) considered social responsibility to have a scope greater than all economic, legal, ethical and other areas that society expected from businesses in each given time. Henri and Ane (2012) viewpoint on social responsibility included factors such as community responsibility, environmental responsibility, human rights, and behavior manner to employees. Social responsibility was a complex category and expressed from each researcher's perspective, depending on the context of the study (Dahlsrud, 2008; Garriga & Melé, 2004). Dahlsrud (2008) said that the social responsibility included components: economy, related parties, social scope, environment and charity.

Although there were many different concepts in general, the concepts showed that the social responsibility referred to the relationship and interaction between the enterprises and parties related to enterprises in terms of benefits on a voluntary basis. Therefore, in this study, the concept of corporate social responsibility is understood as the enterprise's self-operation to bring good benefits to the environment, the related parties, and the enterprise.

2.2. Corporate social responsibility to the environment

In the field of environment, the enterprises must be responsible for the impacts on the environment and community life, through behaviors such as pollution prevention, rational use of resources, mitigation and adaptation to climate change, environmental protection, biodiversity and improvement of natural habitats

* Pollution prevention

To improve the prevention from pollution caused by its activities, the enterprises need to: Identify the aspects and impacts of decisions and activities of the organization on its surrounding environment; identify sources of pollution and waste related to the organization's activities; apply measures to prevent from pollution and waste, use waste management system and ensure appropriate management of pollution and waste that is potentially avoidable; engage with local communities on actual and potential emissions and wastes, associated health risks as well as practical and recommended mitigation measures; statement of the relevant and significant amount and types of used and discharged toxic and hazardous materials; avoid the use of banned chemicals such as ozone-depleting substances, durable organic pollutants, dangerous chemicals and pesticides, chemicals causing cancer, causing mutations, affecting reproduction, endocrine disorders or long-term and toxic biological accumulation.

* Sustainable use of resources

In order to maintain resources in the future, the current size, consumption volume and production need to be changed so that they operate within the capacity of the earth. The sustainable use of renewable resources means that they are used at a rate less than or equal to the additional rate of nature to non-renewable resources (such as fossil fuels, metals, minerals); long-term sustainability requires a use rate lower than the rate of replaceable resources. The organization can look forward to sustainable resource use by using electricity, fuel, raw materials, treated materials, and land and water more responsibly.

* Mitigation and adaptation to climate change

Greenhouse gas (GHG) emissions from human activities such as carbon dioxide, methane and nitrous oxide are among the causes of global climate change, having a significant impact on the natural environment and human. Every organization needs to be responsible for greenhouse gas emissions and will be affected by climate change in a certain way.

To mitigate the impacts of climate change-related to activities, the enterprises need to: Identify sources of direct or indirect GHG emissions and define their scope of responsibilities; measure, prepare documents and report significant GHG emissions of the organization; adopt optimal measures to reduce direct and indirect GHG emissions within the organization's control and encourage similar actions within the organization's scope; implement energy saving; take measures to cope with existing or anticipated impacts and contribute to improving the adaptive capacity of stakeholders within their influence scope.

* Environmental environment, biodiversity and recovery of natural habitat.

The organization can become more socially responsible by activities to protect the environment and recover its natural habitat and many other functions and services provided by the ecosystem (such as food and drinking water, climate conditioning, soil formation and regeneration opportunities. Aspects of this issue include: Determine the value and protect biodiversity, determine the value, protect and restore services of the ecosystem, use land and natural resources sustainably, develop urban and rural areas with a good environment.

3. ACTUAL SITUATION OF TAKING SOCIAL RESPONSIBILITY TO THE ENVIRONMENT AT VINACOMIN

3.1. Pollution prevention

To enhance the management and control of environmental pollution, in addition to periodic environmental survey according to the environmental impact assessment report, Vinacomin also organizes centralized environmental survey in potentially affected areas outside the boundary of concentrated production areas such as Quang Ninh, Thai Nguyen, Lang Son, Lao Cai and Central Highlands; invest in automatic environmental surveying stations of wastewater and exhaust gas as regulated, connect and transfer data directly to Departments of Natural Resources and Environment of localities and Vinacomin.

Construct dams to block soil and rock at the dumping sites to prevent soil and rock from drifted, ensuring safety for inhabitants and the environment. Regularly improve, dredge the system of rivers and streams to drain water, prevent the soil and rock from sedimentation, flooding of residential areas and downstream areas. Relocate more than 400 households from potential landslide and flooding areas in Quang Ninh province.

Invest in building Vinacomin's industrial hazardous waste treatment plant in Cam Pha - Quang Ninh with a capacity of 6,900 tons/ year, capable of handling hazardous waste generated during the production of member units and other enterprises in Quang Ninh province, overcome the situation of waste transfer for treatment in other provinces/ cities, prevent from the risk of incidents during inter-provincial transportation and post-treatment products for reuse for production of over 50%. Ordinary industrial solid wastes (coal sorting compact, electrothermal slagged ash, etc.) are collected and dumped as planned. For domestic solid wastes, local environmental sanitation companies are hired to collect and treat as regulated.

The aluminum factory's red mud is discharged and stored in construction reservoirs with prescribed equivalent standards for hazardous wastes, absolute waterproofing, always 01 active compartment, and 01 backup compartments without red leakage mud into the environment. Aluminum factories have additionally invested in blocking door systems, detecting and automatically closing in case of incidents, limiting the risk of caustic soda leakage outside the factory. The tailings of mineral sorting factories will be discharged to the reservoirs designed as regulated for the irrigation reservoirs; dams are regularly monitored for dynamic movement, promptly consolidating to ensure safety.

3.2. Sustainable use of resources

In addition to direct investment in environmental protection, Vinacomin has also arranged, invested in restoring and renovating loading and unloading technology at ports, contributing to reducing dust and dirt in coal consumption process; invest in renewing technologies of exploiting coal and minerals towards mechanization and modernization with least effect on the environment (hydraulic pillars, hydraulic supporting trusses, stripping machine, etc. in underground mining); excavators with bucket capacity of 10 m3, trucks with 100 tons in open-cast mining, etc.), thereby reducing long wall supporting wood from 45-50 m3/ 1000 tons to 7.5 m3/ 1000 tons of coal, reducing resource loss rate in underground mining from 45-50 to 21.7% and from 15-18% to 4.5% in open-cast mining; invest in mud filter press of coal sorting plants to increase the rate of recovery, use circulating water, reduce discharge to the environment; Thermal power plants invest in Circulating Fluidized Bed Combustion technology to reduce greenhouse gas emissions, use low quality coal to utilize resources and contribute to environmental protection.

3.3. Mitigation and adaptation to climate change

The exhaust gas of metallurgy, thermal power, cement plants of Vinacomin has a dust filtration system, synchronous investment treatment and technology lines, ensuring standards before being discharged into the environment. Install an automatic environmental monitoring system for emissions, directly transmit data to the local Department of Natural Resources and Environment as prescribed.

Invest in construction of specialized motor roads; therefore, since 2008, coal will no longer be transported on national and provincial roads; additionally, invest in 01 railway line and 08 conveyor belts to replace cars, conveyors mainly carry out the current transportation of coal to ports and power plants in Quang Ninh, Thai Nguyen and Lang Son, railway; conveyor carries out bauxite concentrate transported from the refinery to an aluminum plant; thereby minimizing dust and dirt that affect the transportation process to habitat and urban areas. Regular anti-dust activities (covering cars and yards with canvas, spraying and sprinkling water for anti-dust, building barrier walls and planting trees to prevent from dust, etc.) are interested in implementing.

3.4. Protection of the environment, biodiversity and recovery of natural habitat

Building and putting into operation 50 mining wastewater treatment stations with a total capacity of over 150 million m3/ year, basically having enough capacity to treat the wastewater generated in production in compliance with environmental standards. Coal sorting plants have sludge pressing, filtration, and sedimentation systems that use water circulation and do not discharge into the environment. Thermal power and metallurgical plants have a wastewater treatment system with uniform investment, automatic control and production lines. Install an automatic environmental monitoring system for wastewater, transfer data directly to the Departments of Natural Resources and Environment of the localities as prescribed.

Renovate and restore the environment, plant trees on 1,000 ha of the waste dumping site, and coal and mineral mines are ended. In some areas near residential areas and urban areas, plant trees with fast green cover with high density, shorten the greening time to 2-3 years. The rehabilitation and restoration of the environment of bauxite mines are carried out simultaneously with the mining process. The active dumping sites basically apply low-level dumping with a height of ≤15m to reduce the risk of landslide and dust generation, limit soil erosion.

4. SOME RECOMMENDATIONS TO IMPROVE THE IMPLEMENTATION OF SOCIAL RESPONSIBILITY TO THE ENVIRONMENT OF ENTERPRISES UNDER VINACOMIN

Continue to implement environmental protection solutions synchronously: Plant trees to rehabilitate the environment; continue to invest in conveyor lines, enhance solutions against dust and noise; industrial sanitation, improve environmental landscape; prevent from and limit drifting soil and rock; collect and thoroughly treat waste types; prevent from environmental incidents, especially for waste dumping sites, dams, reservoirs, chemical plants, etc. Study to combine environmental rehabilitation and restoration with the development of other environment-friendly economic sectors on post-mining lands (eco-tourism, solar power, industrial trees, forestry, etc.); treat and recycle wastes generated in production into products for reuse for production of the industry and supply to the economy.

Continue researching and renewing production technology towards modernization, using less energy and raw materials and less emitting into the environment. New projects must select modern technical technologies and synchronously invest in environmental protection work items before putting the works into production. Strengthen international cooperation, research and apply new environmental protection technologies to improve efficiency and reduce costs for environmental protection.

Priority is given to financial resources, with a minimum of 1.5 - 2.0 % of production costs for environmental protection. Maintain and develop a professional environmental protection unit in the industry. Organize a specialized and unified management system of environmental protection from the Corporation to its member units. Strengthen training to improve professional skills for staff working in environmental protection; promote propaganda, and raise awareness of environmental protection.

Participate in completing the provisions of the law on environmental protection to reduce administrative procedures, strengthening compliance monitoring. Develop mechanisms and policies, especially financial mechanisms (deducting environmental funds from production costs, minimum expenditures for environmental protection, etc.) to create favorable conditions and initiatives for environmental protection, encouraging enterprises to invest in treating and recycling waste.

5. CONCLUSION

Implementing social responsibility to the environment is a relatively new field for Vietnamese enterprises in general and enterprises of Vietnam National Coal-Mineral Industries Holding Corporation Limited - Vinacomin in particular. The article has systematized and clarified the contents of implementing social responsibility to the environment that mining enterprises must implement, based on which recommending specific solutions to improve the implementation of social responsibility to the environment of enterprises under Vinacomin.

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IDENTIFYING THE METHODS FOR GREENHOUSE GAS EMISSION INVENTORY AND APPLICATION FOR THE METALLURGY INDUSTRY

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Abstract: *Metallurgical processes require vast energy from primary (coal, oil, gas) and secondary (electricity) sources. Therefore, this is one of the main sources of greenhouse gas (GHG) emissions in total national GHG emissions. The article has selected two typical steel factories to represent two popular steel production technologies in Vietnam, namely Electric Arc Furnace (EAF) and Basic Oxygen Furnace (BOF). The study applies methods of environmental observation and analysis, sampling, sample preservation, on-site measurements, and laboratory analysis methods. The results show that, for EAF steel production technology, the CO_2 emission of EAF technology is from 3800 - 7160 mg/Nm^3, the CH_4 emission is from 1.86-3.05 mg/Nm^3, and the N_2O emission is from 0.69 - 1.02 mg/Nm^3. The calculation of the GHG emission factor for the steel production sector will be compensation for future GHG inventory and calculation.*

Keywords: *Emission factor; GHG inventory, metallurgy industry*

1. INTRODUCTION

The metallurgical process requires enormous energy from primary (coal, oil, gas) and secondary (electricity) sources. Also, coke is an input fuel source for the product. In general, the burning of fossil fuels, the usage of electricity, and coke are the main drivers of emissions in the metallurgical process. However, metallurgical technologies such as fire, hydration, and electrolysis will cause different emissions. Therefore, it is necessary to identify metallurgical processes and inputs of materials and fuel to develop a scientific basis for calculating and forecasting emissions. It is also essential to determine the exhaust gas and the exhaust gas composition at each stage in the metallurgical process. Based on this information, the research team has been developed calculation methods suitable for the characteristics of raw materials, fuels, and technologies in Vietnam.

The GHG emission assessment process is based on the content of resource inventory. Resources are focused on assessing emissions of production facilities with different levels of technology investment and thereby building the main range of greenhouse gas emission factors for this industry.

The emission source inventory (or pollution source inventory) is the process of developing a complete list of sources of environmental pollution and discharging their estimated amount in a specific geographic area over a specified period. Inventory types may include emissions inventory; inventory of water pollution sources, inventory of solid waste disposal, hazardous waste discharge inventory, inventory of a particular substance, etc.

The emission source inventory helps identify the sources of pollutants, the types of activities causing the emissions, and the extent of the processes that discharge pollutants into the environment, thereby assessing the scale and scope of the emissions.

This method is a crucial tool in environmental assessment, management, and production efficiency improvement. Through calculation tools to capture the actual emissions situation, it forecasts the amount of GHG emissions, implements emission source controlling measures. The development of policies for emission sources management is the basis for developing other related general systems. Appropriate guidelines are proposed on reliable data from emission source inventory.

Typically, each emission source inventory program will have two main compulsory processes, including:

1.1. Reviewing the facilities having GHG emission activities

This process conducts a review to fully list the production facilities that emit GHG into the environment and to determine the characteristics of the production processes related to the GHG emission. Information of interest in this process includes:

- List the production facilities, types of industrial production in the region

- For each facility, some requirements are needed:

• Identify emission sources of the production facility: exhaust through chimneys, sewers, or scattered emission from equipment, storage, etc.

• Determine the emission of the production establishment, such as exhaust gas, wastewater, solid waste, etc.

• Survey the facility's production technology, capacity, etc.

• Determine the demand for raw materials, fuel, and water, etc.

• Determine the characteristics of the existing wastewater, exhaust treatment systems, and environmental protection solutions

1.2. Estimating the amount of GHG emission into the environment

Based on the list of emission sources from the step of reviewing the production facilities, the authors analyze selected methods for emission source inventory to find the appropriate emission estimation method. The necessary data information for the calculation is collected accordingly.

2. OVERVIEW OF THE RESEARCH OBJECT

2.1. Thai Nguyen Iron and Steel Joint Stock Company - Luu Xa steel refinery factory

Raw materials for the production of steel billets are rich iron ore and iron ore concentrate. Fuel used is coke coal and anthracite. Also, there are other coolants, additives, and fluxes, such as iron scrap, limestone, dolomite, and iron alloys, etc.

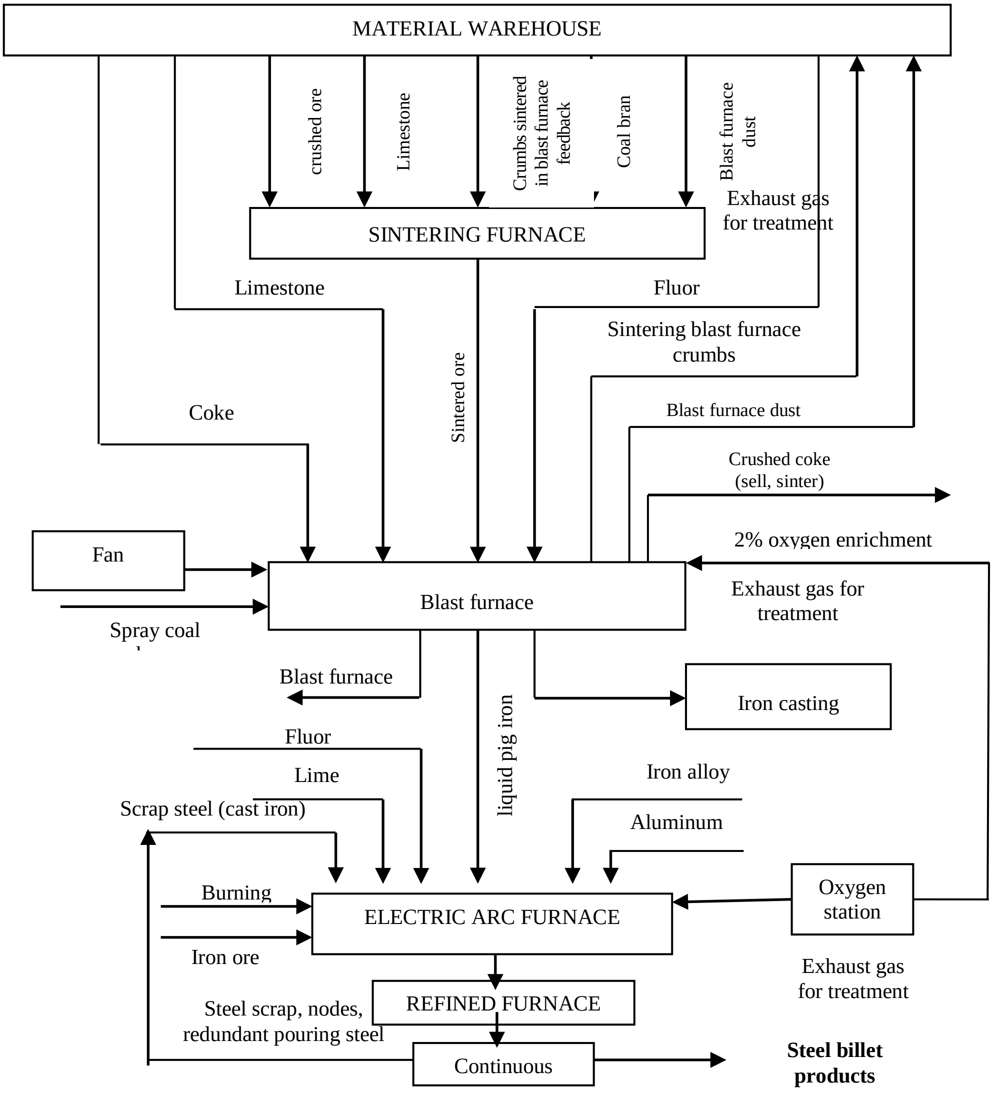

Fig 1. Production technology diagram at Luu Xa steel refinery factory

The production process includes the main stages of sintering iron ore, blast furnace iron, blast steel in a refining furnace, and casting steel billets continuously.

Sintering iron ore concentrates to bond iron ore and scrap iron ore into a larger particle size suitable for blast furnace iron smelting, and at the same time, reducing impurities in the ore such as sulfur. Sintering equipment includes conveyor belts, including sintering tape, cooling tape, crushing machine, collecting dust and cleaning gas, etc. Ore is mixed with additives to create suitable alkalinity, using blast furnace coal gas as pilot fuel.

Blast furnace iron refining is used for smelting sintered ores and a part of lump ore into liquid iron before it is transferred to steel refining. Fuel used for the blast furnace is mainly coke with high durability and high calorific value burned to create high temperatures and a reconstituted environment for the blast furnace. Besides, there is a coal dust injection system to reduce consumption, loss of cup, reduce production costs.

Liquid iron from the blast furnace, removed from the furnace through a container, is transported to the steel refining stage to perform the steel refining process, blow impurities reduction, steel water refining, and steel grade alloying. Finally, it transforms into billet products, under quality check, and will be sold in the market. Industrial oxygen production station is used to provide 99.5 % O_2 gas for iron smelting, sintering, drying, etc.

2.2. Hoa Phat Steel Joint Stock Company

Steel billet production

Raw materials for the production of steel billets are rich iron ore and iron ore concentrate. Fuel used is coke coal and anthracite. Besides, there are other coolants, additives, and fluxes such as scrap iron, limestone, dolomite, and iron alloys, etc.

The production process includes the main stages of sintering iron ore, blast furnace iron, blast steel in a refining furnace, and casting steel billets continuously.

Sintering iron ore concentrates for bonding iron ore and scraps iron ore into a larger particle size suitable for blast furnace iron smelting. At the same time, impurities are reduced in ore (sulfur is an example). Sintering equipment includes conveyor belts, sintering tape, cooling tape, crushing machine, collecting dust and cleaning gas, etc. Ore is mixed with additives to create suitable alkalinity, using blast furnace coal gas as pilot fuel during sintering.

Blast furnace iron refining is used for smelting sintered ores and a part of lump ore into liquid iron before it is transferred to steel refining. Fuel used for the blast furnace is mainly coke with high durability and high calorific value, which is burned to create high temperatures and a reconstituted environment for the blast furnace. Also, there is a coal dust injection system to reduce consumption and production costs.

Liquid iron from the blast furnace, removed from the furnace through a container, is transported to the steel refining stage to perform the steel refining process, blow impurities reduction, steel water refining, and steel grade alloying. Finally, it transforms into billet products, under quality check, and will be sold in the market. Industrial oxygen production station is used to provide 99.5 % O_2 gas for iron smelting, sintering, drying, etc.

Steel rolling

Embryos are cut into segments according to technical requirements and then checked. If satisfactory, it will be arranged in batches to prepare the furnace. For unsatisfactory types they will be separately handled and checked for further details before being reported as discarded.

The furnace is designed to feed hot billets through the transfer floor. Embryos taken from the billet yard are loaded into the furnace in sequence by a crane on a loading table through a roller to the door of the furnace, using two 40-ton pushers.

After the billet is heated to the rolling temperature, it is removed by a pusher device to a rolling machine. First, the billet runs on a roller system through the I-rolling system. Here, the billet is divided into two threads to produce different steel products. With the coil steel production stage, after going through the rolling system I, the head and the tail are cut, the remains are continuously going through the rolling machine to make blocks and then form the coils. With rebar product, the billet is going through the rolling machine is continuously cut into segments and cooled on the cooling floor. Finally, the billet is cut to the product size (11.7m) and move to bundle.

With steel production, there must be other stages. The billet, after going through rolling I, continues to run to rolling system II and III then saw into segments. At this time, the rolling object is checked for technical properties combined with cooling before being put into the straightening machine. All finished steel products must undergo a final inspection before being packaged and weighted.

The main equipment in the production line is shown in Table 2. Raw material demand is shown in Table 3. A water source is mainly taken from the Energy facility - Thai Nguyen Iron and Steel Joint Stock Company, with an average of about 160.000 m^3 per month. Domestic water used for the office and dining area is 600 m^3 per month, of which, clean water from the Tich Luong water plant is 300 m^3 per month, and 300 m^3 from well water. The ratio of factory sanitation water to manufacture water is about 0.06 %.

3. METHOD AND DATA

3.1. Measurement of GHG emissions in production stages

Through analysis of the production process diagram and technology of Luu Xa Steel Refining Factory - Branch of Thai Nguyen Iron and Steel Joint Stock Company, the consultant selected the points for GHG emission monitoring as follows:

Table 1. Point and frequency of greenhouse gas monitoring in Luu Xa Steel Refining Factory

No.	Point	Monitoring index	Frequency
1	Sintering furnace	- Gas emissions; - Air quality in the factory area.	Three times
2	Blast furnace	- Gas emissions; - Air quality in the factory area.	Three times
3	Coke production (Coking chamber)	- Gas emissions; - Air quality in the factory area.	Three times
4	Electric arc furnace	- Gas emissions; - Air quality in the factory area.	Three times
5	LF refined furnace	- Gas emissions; - Air quality in the factory area.	Three times
6	Main fuels	Analysis of samples of primary fuels: coal, oil	3 sample x 3 analysis times

Through analyzing the production process diagram and technology of Hoa Phat Steel Factory - Hai Duong, the consultant selected the locations for GHG emission monitoring, as shown in Table 2.

Table 2. Point and frequency of greenhouse gas monitoring in Hoa Phat Steel Joint Stock Company, Hai Duong province

No.	Point	Monitoring index	Frequency
1	Coke production (Coking chamber)	- Gas emissions;	Three times
2	Blast furnace	- Gas emissions;	Three times
3	BOF 3	- Gas emissions;	Three times
4	Sintering furnace 3	- Gas emissions;	Three times

3.2. The applied methods of environmental monitoring and analysis

The main methods of implementing an environmental monitoring program include:

- Methods of field survey, information collection, sampling, rapid measurement of environmental factors;

- Methods of selection, preserving, and analyzing samples on-site and in laboratories according to current Vietnamese standards (TCVN);

- Processing methods, data evaluation, statistics, and comparison with national and international standards.

The technical process of exhaust gas monitoring is applied according to the Circular No. 24/2017/TT-BTNMT on Technical Regulations for environmental monitoring-Section 7 (Chapter II): Monitoring of exhaust gases, specifically:

- Article 28: regulates the location and number of monitoring points following the U.S Environmental Protection Agency (U.S EPA) method 1 or method 1A, details in Appendix 01 attached to the Circular.

- Article 29: Compulsory parameters for direct observation at the field include: temperature, velocity, flow, moisture content, and molar mass of a dry gas molecule, exhaust pressure, details specified in Appendix 02, 03, and 04 attached to the Circular.

- Article 30: Time and quantity of monitoring samples: Samples are taken when the production reaches at least 50 % of the design capacity. The establishment must operate consistently throughout the entire sampling period. The number of samples in each monitoring time is at least 03 samples.

- Article 31: Regulations on methods of observation and analysis in respective current national technical regulations.

The monitoring equipment and methods are selected in detail in the following tables 3 and 4:

Table 3. Methods of taking samples, preserving samples, and measuring in the field

No.	Parameter	Method of application	Monitoring equipment
I	**Gas emission**		
1.	Speed and flow	U.S EPA method 2	
2.	Molar mass of dry gas	U.S EPA method 3	
3.	Moisture	U.S EPA method 4	
4.	Temperature, pressure	Direct measure	

No.	Parameter	Method of application	Monitoring equipment
5.	CO_2	TCVN 8712:2011	Testo 350
6.	N_2O	TCVN 8713:2011	Gas sampling equipment C5000, ES
7.	CH_4	TCVN 8715:2011	
8.	Total dust	U.S EPA Method 5	
9.	CO	TCVN 7242:2003	
10.	NO_x	U.S EPA Method 7	
11.	SO_2	U.S EPA Method 6	
II	**Sampling of raw materials and the fuel used**		
1.	Coal and coke sampling	TCVN 1693:2008	-
2.	Oil and oil-products sampling	TCVN 6777:2007	-

Table 4. Analytical methods in the laboratory

No.	Parameter	Method of application	Detection limit/ measuring range
I	**Gas**		
1.	CO_2	TCVN 8712:2011	0,01 mg/Nm^3
2.	CH_4	TCVN 8715:2011	<1.500 mg/Nm^3
3.	N_2O	TCVN 8713:2011	<200 mg/Nm^3
II	**Raw materials and the fuel used**		
1.	Carbon content	ASTM D3172	

In addition to the exhaust gas samples at the chimney, the consultant proposed to take additional samples of the air from the factory environment, which is directly affected by the gas emission source. The air sampling locations in the workshop areas are selected with the parameters above.

3.3. List of monitoring and laboratory equipment

a. Monitoring equipment

- Dust and flue gas sampling equipment, ambient gas sampling equipment, large-speed total dust sampling equipment, etc.

- Equipment for measuring flue gas flow, measuring device noise, vibration.

b. Analyzing equipment

- GC equipment

- UV-VIS, TOC, Fluorescence spectroscopy, etc.

3.4. Description of monitoring locations

The monitoring locations of the topic are described in Table 5 below.

Table 5. List of monitoring location

No.	Monitoring code	Monitoring type	Location	Monitoring location description
Air environmental composition				
1	KK1	Monitoring emission sources	X:02384756 Y:00434621	In the factory office area
2	KK2		X:02384875 Y:00434500	In the area of electric furnaces, treatment

No.	Monitoring code	Monitoring type	Location	Monitoring location description
				furnaces
3	KK3		X:02384894 Y:00434610	In the area of continuous furnaces and refined furnaces
4	KT1		X:02384875 Y:00434395	At the chimney of a steel furnace

4. RESULTS AND DISCUSSION

4.1. Luu Xa steel refinery factory

Steel furnace No. 1

Table 6. Results of GHG measurement in gas emissions at steel furnace No. 1

No	Parameter	Monitoring method	Unit	Result		
				LT-01.1	LT-01.2	LT-01.3
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	1.28	1.86	3.05
2.	N_2O		mg/Nm^3	0.76	0,69	0.75
3.	CO_2		mg/Nm^3	3,800	6,800	7,160

Sampling location: Gas emissions after treatment - gas treatment system for steel furnace No. 1, furnace LF3 (coordinates: 21º33'30"N; 105º52'07"E)

LT-01.1: First sampling

LT-01.2: Second sampling

LT-01.3: Third sampling

Steel furnace No. 2

Table 7. Results of GHG measurement in gas emissions at steel furnace No. 2

No	Parameter	Monitoring method	Unit	Result		
				LT-02.1	LT-02.2	LT-02.3
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	1.86	2.05	2.40
2.	N_2O		mg/Nm^3	0.85	1.02	0.94
3.	CO_2		mg/Nm^3	5,520	6,800	7,050

Sampling location: Gas emissions after treatment - gas treatment system for steel furnace No. 2, furnaces LF1 & LF2 (coordinates: 21º33'29"N; 105º52'07"E)

LT-02.1: First sampling

LT-02.2: Second sampling

LT-02.3: Third sampling

4.2. Hoa Phat Steel Joint Stock Company

The gas emission test results at the steel furnace No. 1 are presented in Table 8 and at the steel furnace No. 2 shown in Table 9 below.

Table 8. Results of GHG measurement in boiler No. 2

No	Parameter	Monitoring method	Unit	Result		
				KT1.1	**KT1.2**	**KT1.3**
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	0.29	0.28	0.28
2.	N_2O		mg/Nm^3	1.40	1.48	1.44
3.	CO_2		g/Nm^3	189.14	185.72	187.52

Sampling location: Boiler chimney No. 2 (post-treatment gas of residual heat-generator gas treatment system - coke furnace)

Table 9. Results of GHG measurement from the sintering furnace No. 2

No	Parameter	Monitoring method	Unit	Result		
				KT2.1	**KT2.2**	**KT2.3**
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	30.49	30.89	31.08
2.	N_2O		mg/Nm^3	12.69	12.43	12.62
3.	CO_2		g/Nm^3	54.35	55.96	56.68

Sampling location: Sintering furnace No. 2 (exhaust gas from sintering furnace)

Table 10. Results of GHG measurement from the lime kiln No. 2

No	Parameter	Monitoring method	Unit	Result		
				KT3.1	**KT3.2**	**KT3.3**
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	2.02	2.24	2.13
2.	N_2O		mg/Nm^3	0.87	0.88	0.94
3.	CO_2		g/Nm^3	118.69	118.77	120.21

Sampling location: Lime kiln chimney No. 2

Table 11. Results of GHG measurement from blast furnace No. 3

No	Parameter	Monitoring method	Unit	Result		
				KT4.1	**KT4.2**	**KT4.3**
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	40.70	38.94	40.44
2.	N_2O		mg/Nm^3	14.31	14.15	14.17
3.	CO_2		g/Nm^3	347.68	344.26	339.76

Sampling Location: blast furnace No. 3's chimney

Table 12. Results of GHG measurement from the BOF No. 3

No	Parameter	Monitoring method	Unit	Result		
				KT5.1	**KT5.2**	**KT5.3**
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	2.81	3.01	3.01
2.	N_2O		mg/Nm^3	5.75	5.98	5.85
3.	CO_2		g/Nm^3	351.46	363.88	360.82

Sampling Location: BOF No. 3's chimney

Table 13. Results of GHG measurement from pellet furnace No. 3

No	Parameter	Monitoring method	Unit	Result		
				KT6.1	KT6.2	KT6.3
1.	CH_4	EPA Method 18 + TCCS 27:2015/TTPT	mg/Nm^3	1.42	1.41	1.28
2.	N_2O		mg/Nm^3	2.39	1.72	1.80
3.	CO_2		g/Nm^3	38.69	37.43	39.59

Sampling Location: Pellet furnace No. 3's chimney

Table 14. Result analysis of coal (grease coal)

No	Parameter	Unit	Analyzing method	Result		
				TĐ1.1	TĐ1.2	TĐ1.3
1.	Moisture, W^{tp}	%	TCVN 172:2011	2.71	2.52	2.55
2.	Dry ash, A^k	%	TCVN 173:2011	6.94	7.06	7.05
3.	Heating value, Q^k_c	Kcal/kg	TCVN 200:2011	6,920	7,020	7,040
4.	Volatile content, V^k	%	TCVN 174:2011	21.74	20.88	20.95
5.	Sulfur content, S^k	%	TCVN 175:2015	1.21	1.16	1.14
6.	Carbon content	%	TCVN 255:2007	73.64	72.48	73.50

- *Sampling Location: Coal sample (grease coal) – input for coke production*

5. CONCLUSION

Metallurgy in general and iron and steel production, in particular, is an industry in which, despite the young age of Vietnam, serving the demand for raw materials for the increasingly diverse requirements of life and the national economy and security. However, the production of iron and steel belongs to a heavy industry that contains latent and toxic factors. The technology of producing cast iron, steel billet, rolling steel products has to go through many stages and use large quantities of raw materials such as mineral resources, chemicals. Each stage generates wastes (solid, gas, dust, and wastewater), causing environmental pollution if wastes are not treated. It is also an industry that produces many greenhouse gases, including CO_2, N_2O, and CH_4. However, GHG emissions from metallurgical activities in industrial processes have not been separated from GHG emissions from the energy sector because fossil fuels used for incineration and use cannot be separated input materials. Besides, these reports only use the first-order method with national statistics on product yields and default emission factors according to IPCC Guidelines 1996 revised. This calculation may meet international requirements for reporting GHG emissions but is not detailed enough to support the country in implementing and implementing GHG reduction activities in the metallurgical industry.

This paper aims to measure GHG emissions in the production stages of an iron and steel mill using traditional techniques with a separate coking process, taking and analyzing the carbon content in carbon. Fuel samples simultaneously take and analyze the gas samples burned by the burning (coal, oil, natural gas) used as the burning materials of the plant in the production processes.

The results from the study will be an essential premise for comparison with emission data from iron and steel production plants using advanced technology, from which to study methods to develop national GHG emission factors from the metallurgy industry in general, and iron and steel production in particular.

ACKNOWLEDGMENT

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REVIEW OF THE E5 BIO-FUEL FUEL FUND AND OUTLOOK DEVELOPING IN THE FUTURE

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Abstract: *On November 20, 2007, the Prime Minister signed Decision No. 177/2007 / QĐ-TTg approving the "Project of developing biogasoline to 2015, with a vision to 2025". On January 1, 2018, E5 biogasoline was officially put into use nationwide to replace A92 gasoline. Up to the present time, E5 gasoline is chosen by many consumers; accordingly, E5 gasoline consumption is increasing significantly. However, besides positive comments from consumers, E5 biogasoline has also encountered many mixed opinions. The article focuses on re-evaluating the E5 biogasoline market in the past time: market demand, consumption, price, distribution chfannels ... and provides basic assessments of prospects development of E5 biogasoline in the near future.*

Keywords: *Biogasoline, biogasoline E5, E5 market.*

1. INTRODUCTION

The world economy in recent years and for most of the 21st century depends heavily on fossil fuels. Although this resource (including crude oil) is a major environmental pollution agent and is alarmed to be in the process of being exhausted, it is indispensable for all finite natural resources when fully exploited. In addition, the need to protect the living environment on the earth for a long time and the need for economic development at high speed and on a large scale makes global energy security increasingly threatened. Therefore, the task of finding alternative sources for fossil fuels has been in place for nearly half a century and has become increasingly urgent.

Among alternative sources of energy (wind, solar, nuclear, etc.), bioenergy is an indispensable development trend, especially in agricultural and fuel importing countries due to its benefits such as not too complicated production technology, taking advantage of local raw materials, increasing agricultural economic efficiency, without changing engine structure, facilities, existing infrastructure and competitive price compared to petroleum.

Countries around the world have used biogasoline since the 70s of the last century, such as the United States, Brazil, New Zealand, etc. Up to now, over 60 countries in the world have used biogasoline. To put biogasoline into practical use, scientists worldwide have had numerous studies on physical and chemical properties, environmental impacts, and experimental studies on various types of dynamics and engines, varying to evaluate the impact of this fuel on the engine and its components. In Vietnam, some studies on the impacts of biogasoline (E5, E10) on engines have been conducted at Hanoi University of Technology, Ho Chi Minh City University of Technology, and Natural Science University - Hanoi National University. One of the most comprehensive and general studies conducted at the Research Institute of Dynamics - Hanoi University of Science and Technology. In particular, some studies are conducted in laboratories or field research. Research objects are some types of cars and motorcycles. The studies assess vehicles' technical properties when using biological fuel, material compatibility of engine components to biogasoline, and emissions. Test results have shown that using biogasoline is completely safe for the engine, increasing engine efficiency, significantly reducing environmental pollutants such as CO (down 27.76 %).), HC (down 16.23 %) ... compared to conventional mineral gasoline (because ethanol contains oxygen, the fuel burns out). Compared with ordinary RON92 gasoline, when using E5 the average capacity increased by about 3.31 %, fuel consumption rate decreased by 5.18 %.

Many domestic scientists have confirmed the benefits of using E5 biogasoline. The strong development of biogasoline has further strengthened the benefits and directions of development which is considered inevitable of biogasoline, in general, and E5 gasoline, in particular. According to the Government's biogasoline development roadmap, E5 biogasoline was officially used nationwide to replace A92 mineral gasoline from January 1, 2018. More than two years of being deployed up to the present time, E5 gasoline has gradually gained a position, accounting for a large market share in the national petroleum market. The recorded results of E5 petrol consumption show that domestic consumers are gradually accepting this product. However, there are also mixed opinions on the use of E5 biogasoline, which is reflected by a slight decrease in the proportion of E5 gasoline consumption compared to the total gasoline consumption. Therefore, the article focuses on re-evaluating the E5 biogasoline market in the past time (market, consumption, selling price, distribution channel ...), and at the same time offering a Some comments on the development potential of this product in the coming period.

2. BIOGASOLINE E5

Biogasoline in English is called gasohol or biogasoline to distinguish it from gasoline (ordinary gasoline). It is created by mixing anhydrous ethanol bio-ethanol with regular gasoline in a certain proportion. For E5 gasoline, the proportion is 5% ethanol and 95 % ordinary gasoline. This product is called biogasoline because the ethanol bioethanol used to mix gasoline is processed through the fermentation of organic products such as starch, cellulose, lignocellulose, usually from grains such as corn, cassava, wheat, soybean or from bark, bagasse, etc. Ethanol obtained after the distillation of fermented cereals is a mixture of water and ethanol. It is necessary to separate water to get anhydrous ethanol first when mixed with gasoline.

* Advantages of biogasoline E5

In Vietnam, ethanol is mainly produced from dried chips. Because this is new fuel for Vietnamese consumers, many people are worried that using E5 gasoline will damage the engine. But in fact, E5 gasoline suitable for all gasoline engines, whether cars or motorcycles, do not need to adjust or replace any equipment. Using E5 gasoline will significantly reduce the toxic emissions of CO and HC present in mineral gasoline ... Therefore, E5 biogasoline is considered environmentally friendly. In addition, the presence of oxygen component in E5 biogasoline is the factor that helps fuel to burn in conditions not too lack of oxygen and burn out. This is the basis to create less harmful emissions of CO and HC. Also, the new generation vehicles now have exhaust treatment function, combined with the use of E5 biogasoline, the amount of toxic gas released into the environment will be significantly reduced.

The use of E5 biogasoline contributes positively to environmental protection. It is the most suitable fuel source when the environmental pollution problem is extremely hot and urgent. The gradual exhaustion of underground fossil fuel resources is only one of the secondary causes for E5 biogasoline to take over and dominate the market, not the crucial condition. The production of raw materials to supply for ethanol plants also helps create jobs and increase income for farmers.

Therefore, increasing the use of biogasoline not only helps to protect the environment but also contributes to a positive change for the lives of people in the areas growing input materials for producing ethanol, ensuring national energy security. The development of biogasoline, in general, E5 petrol, in particular, helps Vietnam be proactive and less dependent on imported fuels.

* Disadvantages of biogasoline E5

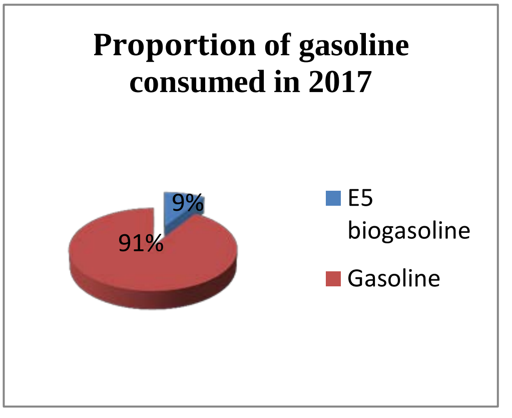
E5 bio-gasoline is the mixture of A92 mineral gasoline with 5 % ethanol. Therefore, users can use both regular gasoline and E5 gasoline. However, if the vehicle has not been used for three months or more, it should not be fueled with E5. The reason is that, as the air is always hot and humid in Vietnam, water in the air is very easily absorbed by gasoline, forming layers in gasoline, which reduces the quality of gasoline. This can cause engine damage, making it difficult to start the engine because water accumulates at the fuel tank's bottom. Simultaneously, E5 gasoline should not be used for motor vehicles before 1993, which uses carburateur. The acid in gasoline can adversely affect the engine's rubber, plastic and polymer seals.

3. BIOGASOLINE E5 MARKET

3.1. E5 gasoline consumption

In fact, E5 biogasoline has been mixed and widely consumed in Vietnam market since January 1, 2016. However, it is not until the Prime Minister signs the decision that from January 1, 2018 gasoline produced, manufactured, and traded for road motor vehicles consumed nationwide is E5 petrol and A95 gasoline. At this time, E5 biogasoline is officially distributed widely in various distribution channels nationwide. Since then, consumers have been aware, choosing to use E5 biogasoline more.

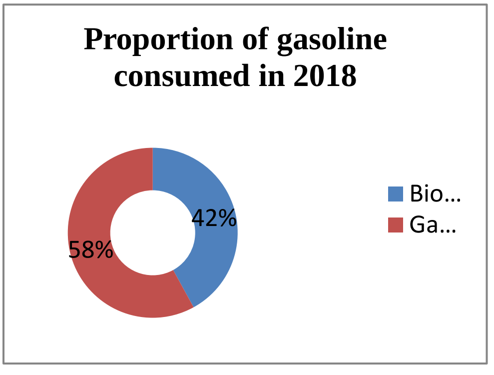
According to a report of the Ministry of Industry and Trade, by the end of 2017, the total gasoline consumption in Vietnam market was 6,904 million m^3, of which E5 consumed accounted for 9 %, equivalent to about 0.62 million m^3.



Source: 2017 Ministry of Industry and Trade Report

This proportion is deficient, indicating that at that time, consumers did not choose to use biogasoline. This can be explained by the habits of consumers. Petrol buyers tend to use traditional mineral petrol, which has been confirmed its quality and efficiency for a long time. Changing consumption habits takes time or needs strong enough impacts from the Government's policies to stimulate consumers to switch from traditional gasoline to E5 gasoline.

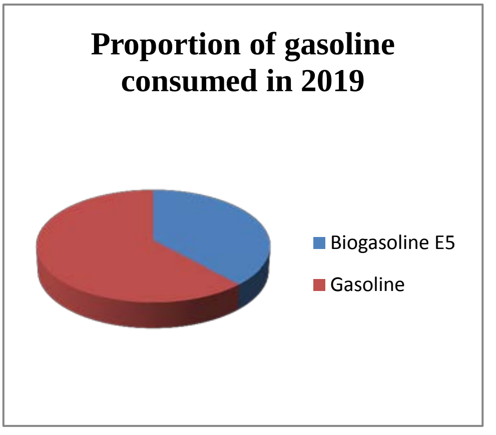
In 2018, after the Government's Decision on using E5 and A95 gasoline only for road motor vehicles was passed. According to data reported by key petroleum enterprises, the volume of E5 RON92 gasoline consumed domestically in the country in the first six months of 2018 reached about 1.78 million m^3, accounting for about 40 %, 18 % of total gasoline of all kinds, RON95 gasoline is about 2.65 million m^3, equivalent to 59.82 % of total gasoline of all types. In particular, some focal businesses have a relatively high E5 RON92 gasoline consumption structure compared to the total gasoline consumption, such as Military Petroleum Corporation reaching about 62.53 %; Vietnam Oil Corporation reached approximately 50.15 %; Vietnam National Petroleum Group achieved about 47.70 %. By the end of 2018, E5 gasoline consumption reached more than 3.1 million tons, equivalent to 42 % of the total gasoline sold in the market, an increase of about 31.18 % compared to 2017.



Source: Report of the Ministry of Industry and Trade in 2018

The sharp increase of E5 gasoline consumption in 2018 is attributed to the strong impact of the government's policy of "death" of A92 mineral petrol. At the same time, appropriate communication activities have helped consumers be more aware of the efficiency and benefits of E5 gasoline.

However, this momentum has not been maintained until 2019. The proportion of E5 gasoline consumed in the market decreased to 38% (equivalent to 3.018 million m^3) in 2019, proving that the volume of E5 gasoline sold on the market has not met expectations, especially, compared to the previous Ron 92 gasoline, the proportion is deficient (Ron 92 gasoline accounts for 75 to 80 %). The data reported by Ho Chi Minh City Petroleum Company Limited (Saigon Petro) also shows that the proportion of using E5 gasoline is tending to decrease in the market. If E5 sales volume reached more than 30 % in 2018, it would be just over 19.5 % by 2019.



Source: Report of the Ministry of Industry and Trade in 2019

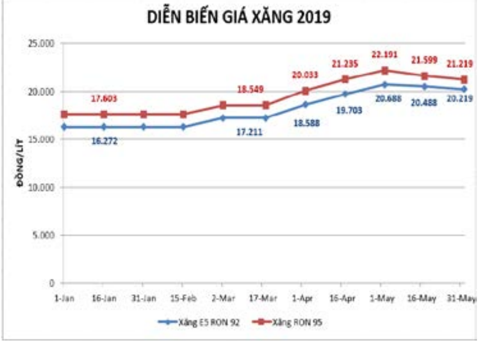
3.2. The price of E5

One of the factors affecting E5 gasoline consumption in the market is the price of E5 gasoline. The current decline in E5 gasoline consumption in 2019 is partly because the price difference between E5 and Ron 95 gasoline is only about VND 1.500/liter, making consumers not interested in this item. Although E5 petrol's price is lower than that of A95 gasoline, the price difference between VND 1.000 and VND 1.500/l is not considered attractive enough for consumers.

Currently, the environmental protection tax rate on each liter of E5 gasoline is about VND 200 lower than RON 95 gasoline, resulting in the price difference of these two types of gasoline of only about 1.000 VND – 1.500 VND, which will not encourage consumers to use gasoline E5. Therefore, petroleum enterprises said that the State should apply environmental protection tax on each type of gasoline's absolute value. Accordingly, the environmental protection tax of E5 is not calculated according to the current ethanol ratio to create a difference between E5 and RON95 gasoline from 2.000 to 2.500 VND/liter to stimulate consumer demand. The E5 petrol price policy is considered a decisive factor in changing consumers' behaviors and habits.

3.3. E5 gasoline distribution channel

For consumers to easily access and buy E5 gasoline, the distribution channel system plays a critical role. When a decision is made to put E5 biogasoline into mass sale, the key petroleum business enterprises must invest in improving storage, mixing and transporting equipment to supply E5 gasoline spread across the locality. According to the Ministry of Industry and Trade statistics, there are currently more than 15.000 petrol and oil retail stores in the country that can meet the demand for consuming E5 biogasoline products.



Source: Report of Vietnam Petroleum Association 2019

However, the fact is that many retailers are not interested in selling E5 gasoline at the moment. The reason is that profits, sales, discounts are not strong enough to encourage agents and petrol stations to participate in the E5 biogasoline business. The construction and installation of auxiliary equipment, tanks, E5 petrol dispensing poles at dealers and petrol stations require investment in premises and capital, making many store owners hesitate to invest.

Besides, the fact shows that E5 petrol distribution and trading enterprises have not been entitled to preferential policies on corporate income tax, import tax on equipment and materials (not produced in the country yet) for storage, transportation, preparation, and distribution of biogasoline, environmental fees, etc. Currently, environmental fees for E5 gasoline have not been exempted (only exempt for ethanol and not exempt for the base gasoline is used to make E5 gasoline). This is also why E5 gasoline trading and distributing businesses do not focus on developing this product.

According to petroleum enterprises and retail agents, E5 petrol trading is lower than that of RON 95 gasoline. Even the current situation is that the more they sell, the bigger losses they face because of the higher contribution to the petrol price stabilization fund. As a specific example, in April 2019, the discharge rate for E5 gasoline was more than VND 3.500/liter while that for Ron 95 was about VND 2.045/liter, making businesses and stores selling E5 more gasoline encountered losses. The release of the petrol price stabilization fund has a high difference, leading to the abandonment of selling E5 gasoline at some petro stations. With this policy, the price stabilization funds of stations selling a large amount of E5 petrol will be reduced more than that of stations that do not sell E5 gasoline, leading to businesses that prefer to sell Ron 95 gasoline than E5 gasoline because of avoiding fund deficit.

3.4. Communication activities

Recently, the Ministry of Industry and Trade has informed and propagated about the Party and State’s policies and laws on developing and using biogasoline in our country through mass media, seminars, training, publishing of E5 bio-fuel handbook, a section on E5 bio-fuel information on the website of the Ministry of Industry and Trade, and through implementing the process of applying the mixing ratio of biogasoline with traditional fuels to key petrol and oil distributors and businesses.

The Ministry of Industry and Trade has also cooperated with the Ministry of Information and Communications to implement the 2018 Plan of information and propaganda to encourage biogasoline use according to the Minister's Decision No. 450 / QĐ-BTTT of March 30, 2018. The Ministry of Information and Communications aims to promote the propagation and extensive dissemination of biogasoline use.

The forms of communication are diverse and suitable to the intellectual level of each target group, region and area to raise the awareness and responsibility of each individual, organization, enterprise and social community on the use of biogasoline, contributing to ensuring energy security goals, reducing dependence on mineral fuels, improving the environment, contributing to creating sustainable incomes for the agricultural sector, and promoting agricultural sector restructuring.

So far, consumers have been fully aware of E5 biogasoline and have positive moves in choosing E5 gasoline for use. Surveys at some petrol stations of Petrolimex show that consumers are no longer afraid to buy E5 at petrol stations. This shows the significant effectiveness of the Government's communication work. In addition to increasing communication to consumers, the Ministry of Industry and Trade has also issued directing and propagating documents to petrol enterprises and agents nationwide to promote E5 gasoline consumption in next time.

4. POTENTIAL FOR DEVELOPING OF E5

After more than two years of E5 mass distribution to replace A92 mineral petrol nationwide, many consumers have chosen E5 biogasoline. This is reflected through specific Figs of E5 volume and consumption in recent years. Besides the achievements, the development of E5 petrol also faces many difficulties in the future. However, the market development potential of this product is undeniable.

Firstly, the roadmap to develop biogasoline in general and E5 gasoline, in particular, is an urgent need of the future due to the exhaustion of mineral resources as well as environmental pollution. Accordingly, the State will focus all resources possible to continue developing this product in the future.

Secondly, biogasoline, in general, and E5 gasoline, in particular, are produced from bio-products, which Vietnam's bio-resources are considered diverse and have large reserves. According to calculations by the Vietnam Energy Institute, our country's total biomass is 118 million tons/year. This is considered a stable source of raw materials for E5 gasoline production in the long term.

Thirdly, biogasoline production and use have become a popular trend globally, searching for renewable materials. Many countries have achieved great success in this field such as Brazil, USA, Germany, Japan, China, Thailand. Vietnam will have many advantages from the lessons learned from those countries in researching, using and producing E5. These lessons will be the premise to help Vietnam accelerate the roadmap of bringing E5 gasoline in particular and biogasoline in general to the market.

Fourthly, according to Vietnam Petroleum Association’s report, the growth rate of petroleum consumption in Vietnam is still low compared to other countries in the region. This rate in Vietnam is about 7%, while that is over 10% in other countries in the ASEAN region. In the future, this index will increase rapidly when the volume of vehicles tends to increase. Accordingly, the amount of gasoline consumed nationwide will also tend to increase.

Fifthly, under the influence of the Government's communication activities, consumers' traditional consumption of gasoline products will change. Improving consumer awareness and confidence in E5 gasoline will make them change their product choice behavior. This is considered an important factor in ensuring the growth of E5 petrol in the near future.

Sixthly, after the initial deployment stage, the construction and installation of auxiliary equipment, tanks, E5 petrol dispensers at dealers and shops have been fully implemented. In the coming time, E5 petrol sales of these hubs will be carried out more smoothly. Policies on taxes, fees, discounts on E5 gasoline for business hubs will be revised. These policies will create trust and help agents and distributors to focus on developing E5 gasoline products even more.

5. CONCLUSION

Analyzing E5 biogasoline market over the past three years shows that E5 has been trusted and selected by many consumers. The Figs on consumption and proportion of total gasoline output in the market imply a remarkable step forward of E5 gasoline products in the market. Besides the achievements, E5 biogasoline also faces many difficulties. There are many reasons for this product's market penetration challenges. However, the main reason comes from the development of distribution channels and product communication strategies to consumers. Therefore, to comply with the given roadmap, the Government and businesses producing and trading E5 gasoline should take necessary and timely measures to change consumers' habits. When changing consumers' habits, surely the potential of E5 gasoline development in the future is huge.

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THE POTENTIAL TO DEVELOP RENEWABLE ENERGY IN VIETNAM IN THE FUTURE

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Abstract: *The trend of using clean energy sources, especially renewable energy, to replace emissions and polluting energy sources such as fossil fuels have been growing strongly in recent years. According to scientists and organizations around the world, Vietnam is a country with great potential for renewable energy such as wind energy, solar energy, biomass energy. However, the current reality shows that the proportion of renewable energy in primary energy in Vietnam is deficient, and Vietnam is heavily dependent on fossil energy. Can Vietnam develop renewable energy to solve the energy demand, energy security and mitigate climate change impacts as committed? This paper will analyze the potential development of renewable energy in the future in Vietnam.*

Keyword: *energy, renewable energy, fossil energy.*

1. INTRODUCTION ABOUT ENERGY DEMAND OF VIETNAM

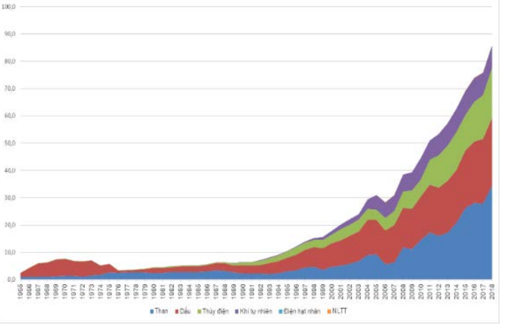
1.1. The situation of energy demand in the recent period

Like the other developing countries in Southeast Asia, the economic development of Vietnam has been fast, with the average Gross Domestic Product (GDP) annual growth rate of 6-7 %, with all sectors growing rapidly over the last two decades (Asian Development Bank, 2017). The rapid economic growth of Vietnam has resulted in a corresponding speedy increase in energy demand. Due to the quick industrialization, urbanization, and modernization, energy consumption growth levels have been double the Vietnam GDP growth levels, which is a high growth rate on average with approximately 12 percent per year during the last decade (Khanh Toan et al., 2011).

According to the study of energy organizations such as the International Energy Agency (IEA), British Petroleum (BP), total primary energy consumption in Vietnam has been increasing at a growth rate of 6.1 % a year during 1990-2016. In which the industrial, residential, and transport sectors accounted for about 93 % of total end-use consumption (BP, 2018; IEA, 2018). In 1990, almost three-quarters of primary energy consumption was from non-fossil fuels, and over 60 % of electricity came from hydroelectric generation (Asian Development Bank, 2017). Following the data of BP, we can see the consumption of all fossil fuels has been increasing rapidly throughout 1990-2016. The share of fossil fuel consumption over total energy use has been overgrowing in Vietnam, from 27.6 % in 1990 to 70 % in 2016 (Tran, 2019). The chart below shows the increase in the energy consumption of Vietnam over the past decades.

Besides, electricity demand is also constantly increasing in the recent period. Vietnam is one of the most efficient power markets in Southeast Asia. Most of the electricity output of Vietnam is driven by low-cost resources. According to BP's report in 2019, the increase in electricity demand in the 2007-2017 period was 11,6 %, higher than the economic growth rate (GDP) of 6-7% during the same period. The total electricity consumption of Vietnam in 2018 reached 212.9 TWh (see table 1). Most of its electricity generation comes from thermal sources (coal, natural gas, and oil), accounting for 60.2% of total generation; the remaining is hydro (39.5 %) and others (around 0.3 %) (Shigeru Kimura and Han Phoumin, 2019).

Fig 1: The energy consumption of Vietnam



Source: (BP, 2019)

Table 1. Total electricity consumption in Vietnam during 2008-2018

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Electricity consumption	71	80,6	91,7	101,5	115,1	124,5	141,3	157,9	175,7	192,5	212,9

Source: (BP, 2019)

Energy sources are diverse in Vietnam, ranging from coal, oil, natural gas, hydropower, and renewable energy. At present, Vietnam's electricity output still depends mainly on traditional sources of electricity, such as hydropower, coal power, and gas power. Although the government has different policies to encourage the development of renewable energy, but renewable energy sources currently just account for the smallest share (Duc Luong Nguyen, 2014). According to the report of EVN, the total installed capacity as of the end of 2019 was about 55,000 MW. Among the current energy sources, hydropower represents the largest share (38 %) in the total installed capacity, followed by coal-fired power (38 %), and gas firepower (18 %); renewable energy (include small hydropower) accounted for around 6 % of the total power generated in the country.

1.2. Energy demand in the future

Energy demand in Vietnam is expected to continue to grow significantly, driven by robust economic growth, industrialization, urbanization, and population growth. So that many research is anticipated that the energy demand in the coming years will keep increasing at a significant rate of 10 percent annually during 2016-2020 and by eight percent per annum during 2021-2030 (Shigeru Kimura and Han Phoumin, 2019). According to the Vietnam energy outlook 2019 of the Ministry of Industry and Trade of Vietnam in collaboration with the Danish Energy Agency. The total primary energy supply increases about four to five times in the period 2017-2050 depend on the scenarios (EREA & DEA, 2019).

According to the report of the Ministry of Industry and Trade 2017, Vietnam's total energy demand in 2020 is about 71 Mtoe increasing to 138 Mtoe by 2035. In the Vietnam Energy outlook 2017, the total final energy demand could rise from 54 Mtoe in 2015 to 81,9 Mtoe, 89,0 Mtoe, and 93,3 Mtoe in 2025 in the low, baseline, and high scenarios, respectively. The final energy demand in 2035 could reach 112.0 Mtoe, 134.5 Mtoe, and 156.5 Mtoe, respectively, in these three scenarios (see Fig 2).

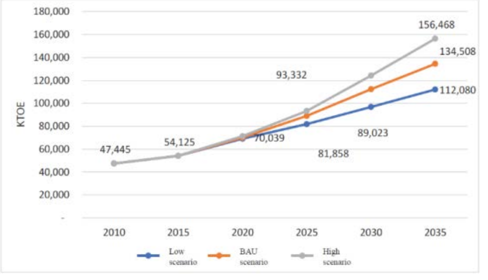


Fig 2. Forecast of total final energy demand in the period 2016-2035

Source: (Danish Energy Agency, 2017)

Throughout the period 2016-2035, the final energy demand increases by 4,7 %/year in the baseline scenario (in the Low scenario and High scenario, the growth is 3.7 %/year and 5.5 %/year respectively) (Danish Energy Agency, 2017).

According to the Ministry of Industry and Trade also, along with its rapid economic growth, Vietnam's electricity demand is also increasing strongly, at around 10 percent a year, causing huge pressure on the energy sector. Following the revised National Master Plan, the demand will increase from 86 Terawatt hours (TWh) in 2010 to 265-278 TWh in 2020 to 572-632 TWh in 2030. The electricity consumption in 2020 will be 233,558 GWh, and by 2035, the power consumption in Vietnam may be up to 686,567 GWh (N 428/QĐ-TTg, 2016). To meet the growing demand, Vietnam needs 60.000 MW of electricity by 2020, 96.500 MW by 2025, and 129.500 MW by 2030. Therefore, the country needs to increase its installed capacity by 6.000MW - 7.000MW annually and spend close to US$148 billion by 2030. The total installed capacity of power plants in the system will reach 103,7 GW in 2025; 133,1GW in 2030; 168,5GW in 2035. The power production in the base case will increase by 338 TWh; 551 TWh; and 741,6 TWh respectively in 2025; 2030; 2035 (N 428/QĐ-TTg, 2016).

2. THE POTENTIAL OF RENEWABLE ENERGY IN VIETNAM

Vietnam has a high potential for renewable energy, including hydro, solar, wind, biomass, and waste. Vietnam's available renewable energy sources could potentially contribute to satisfying the soaring electricity demand, mitigate polluting emissions, and enhance energy independence and security (Nguyen and Ha-Duong, 2009). In 2007, the proportion of renewable energy in the total primary energy supply was 37 %. However, this rate was gradually reduced to 22 % in 2017. Hydropower has been the primary type of renewable energy in Vietnam up to now. However, the medium and large hydropower sources (about 20 GW capacity potential) have been almost fully utilized. The small hydropower resource has a total potential of about 6,7 GW, with more than 3 GW already in operation. Although solar and wind have great potential, but they accounted for tiny amounts in the total primary energy supply. Renewable energy sources with high future potential for development are wind and solar power (EREA & DEA, 2019). The table below presents the installed capacity of renewable energy to compare with its potential to follow the Vietnam Renewable Energy Report 2018.

Table 2. The installed capacity of renewable energy in Vietnam until 2018

Renewable Energy Source	Installed capacity (MW)	Potential (MW)
Small hydropower	1.648	7.000 (technical)
Wind	189,2	26.763 (technical)
Biomass	270	318.630 (theoretical)
Solar	8	7.140 (commercial)

Source: Vietnam Renewable Energy Report 2018

2.1. Potential of solar energy

Although limited by the demand for land use, solar energy has the greatest potential to develop in Vietnam. Most of Vietnam is situated in the tropical zone with up to 5.000 hours of sunshine per year. The average number of sunshine hours in the North is from 1.500 to 1.700 hours of sunshine per year. The central and southern regions have higher average annual hours of sunshine, from 2.000 to 2.600 hours/year. The average normal direct irradiance of 4-5 kWh/m^2 in Vietnam, in the North is 3,69 kWh/m^2, in the South is 5,9 kWh/m^2. So that the country has huge potential for solar power (see table 3 and fig 3).

Table 3. Data on solar radiation in Vietnam

Zone	Sunshine hours in year	Solar radiation intensity (kWh/m^2, daily)	Rating
Northeast	1600 - 1750	3,3 - 4,1	Mean
Northwest	1750 - 1800	4,1 - 4,9	Mean
North Central	1700 - 2000	4,6 - 5,2	Good
Central Highlands and South Central	2000 - 2600	4,9 - 5,7	Very good
Southern	2200 - 2500	4,3 - 4,9	Very good
National average	1700 - 2500	4,6	Good

Source: Nguyễn Anh Tuấn, 2018

In its study of Vietnam's solar energy in 2018, the Vietnam Institute of Energy predicted the solar potential in Vietnam could be up to 380 GW. However, the distribution is not uniform across regions. The potential concentrated in the south, south-central and highland regions. Following the study of Polo et al., the theoretical potential according to the technology selected and the solar resource estimated across the country is placed in the range of 60-100 GWh year for CSP systems, and 0,8-1,2 GWh years in the case of PV systems. The areas available for CSP systems are limited to the Central Highlands and Southeast regions of Vietnam. In the case of PV, the available areas are limited to Southeast, Central Highlands, Mekong River Delta, all the coastal areas, and Northeast regions of Vietnam (Polo et al., 2015). The potential of solar energy is summarized in the table below

Fig 3. Vietnam's photovoltaic power potential

Source: World Bank

Table 4: Potential of solar energy in Vietnam

Theoretical potential	Technical potential	Economic potential
360.000 GW	1677,5 GW	385,8 GW

Source: author synthesis

Despite the great potential, until now, solar energy has grown slowly and inadequate. Solar energy accounting for only a small part of Vietnam's total energy supply. The Government Vietnam has the solar promotion mechanism ending in June 2019, solar power projects are currently booming in Vietnam. By August 2019, the total size of registered investment projects reached about 32 GW of which 10,3 GW is approved for additional planning up until 2025; however, not all may be realized.

2.2. Potential of wind energy

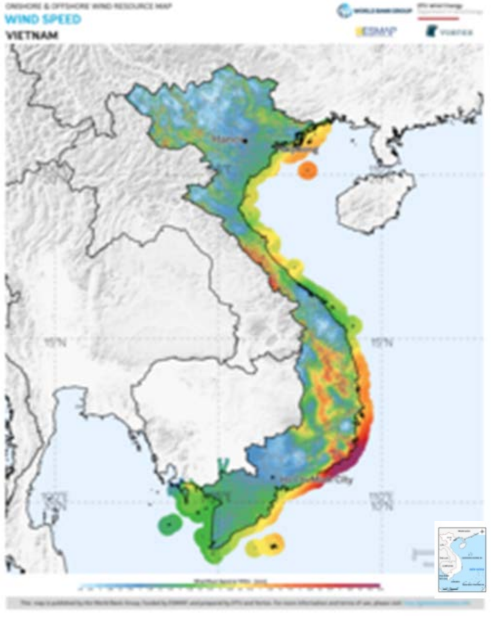


Fig 4: Vietnam's wind potential

Source: World Bank

With a coastline of more than 3.000 km, the hills and highlands of the North and Central, Vietnam has great potential for wind power development. To assessment of wind energy potential in Vietnam, several preliminary studies have been conducted during the last years. The World Bank (WB) carried out a study to prepare Wind Energy Resource Atlas for four Southeast Asian countries including Cambodia, Laos, Thailand and Vietnam for supporting the development of wind energy for the region(World Bank, 2001) (Duc Luong Nguyen, 2014). The study results showed that more than 39 % of Vietnam's total land area was estimated to have annual average wind speeds greater than 6 m/s at the height of 65 m above ground level - the wind speeds that suitable for the operation of large wind turbines. This developable land area is equivalent to a theoretical wind power potential capacity of 513.360 MW. In addition, about 8 % of the land area has an average annual wind speed of more than 7 m / s, equivalent to a total capacity of 110 GW, these areas are very suitable to develop large wind power stations.

Vietnam is also located in the monsoon wind zone, and wind density is estimated at 800-1,400 kWh/m^2/year on islands and at 500-1.000 kWh/m^2/year in the Central Highlands, coastal areas of Central Vietnam, and the Mekong River Delta. In other areas, the density distribution of wind energy is less than 500 kWh/m^2 per year. In addition, Vietnam has a long coastline and a great potential for offshore wind, especially in the South and South-Central regions, which have a relatively shallow seabed, convenient for offshore wind construction (EREA & DEA, 2019). The total potential of wind energy in Vietnam is estimated at 713,000 MW, of which 510,000 MW is on land, and 200,000 MW is on islands. The study results showed that the south-central coast, especially areas in Ninh Thuan and Binh Thuan provinces, have the highest potential of wind resources, mainly due to the deflection of the monsoon winds, especially in summer. Another area where has good potential is along the coast near Can Tho Province, the highlands west of Binh Dinh Province along the Dak Lak and Gia Lai provincial border (Duc Luong, 2015). However, the information about wind potential in Vietnam is still insufficient, so it needs to be studied more in the coming period (EREA & DEA, 2019).

Wind speed	Short < 6m/s	Medium 6-7m/s	Pretty high 7-8m/s	High 8-9m/s	Very high > 9m/s
Area (km^2)	197.242	100.367	25.679	2.178	111
Rate of area (%)	60,6	30,8	7,9	0,7	>0
Potential (MW)	-	401.444	102.716	8.748	482

Table 5: Vietnam's wind potential at an altitude of 65 m

Source: World Bank

3. ASSESSING THE CAPACITY OF RENEWABLE ENERGY DEVELOPMENT

3.1. Great potential to reduce emissions and combat climate change

Vietnam's energy demand is predicted to increase by over 10 percent by 2020, while energy consumption is projected to increase four-fold by 2030 compared to 2014. To meet the growing demand which cannot be fulfilled by sources like coal and hydro, the government is promoting other renewable sources such as biomass, solar, and wind to reduce the gap between demand and supply. Carbon emissions (dominated by fossil fuel use) in Vietnam has been increasing rapidly by 10,1% a year during 1990-2014 (CAIT, 2017). Energy and industries are indeed the key drivers of emissions in Vietnam. The CO_2 equivalent growth rate for energy and industries was 8.7% and 15,3% a year, respectively. Vietnam's GHG emissions are growing at a very high rate. In its Nationally Determined Contribution (NDC) to the UNFCCC, Vietnam has committed to reducing annual emissions with domestic means by 8 percent in 2030 when compared to the BAU scenario, or 25 percent on condition of international support (Vietnam's INDC, 2015). However, according to the scenarios of study of UNDP -Vietnam, if Vietnam would not take deliberate action to mitigate emissions, the total annual emissions would almost quadruple in the period 2010-2030. With the domestically supported target of 8 percent reduction compared to BAU, it would still more than triple annual emissions, from 226 to 725 million tons carbon dioxide equivalent (MtCO2e). If the conditional target of 25 percent reduction compared to BAU would be achieved, the increase in total annual emissions between 2010 and 2030 is still more than 2,5 times (UNDP in Vietnam, 2018). Therefore, in order to achieve the targets that Vietnam's INDC has committed, it is imperative that Vietnam must implement the efficient use of energy, focusing on the development of renewable energy to gradually replace the fossil energy. So, the role of renewables is vita for the future in Vietnam (Zimmer et al., 2015). To achieve the target of low carbon economic growth, the Vietnam government has clearly been focusing on exploiting and investing in renewables, especially wind and solar energy (Tran, 2019).

As mentioned above, Vietnam is a country with great potential for renewable energy, especially wind and solar. Compared to other fossil energy sources, renewable energy has almost no greenhouse gas emissions. It creates huge opportunities for Vietnam to develop renewable energies to meet the needs of the country is increasing as well as to help reduce greenhouse gas emissions in order to protect the environment and fight against climate change. Offshore wind has massive potential; it can contribute a significant share of the Vietnamese electricity mix in the coming decades. In addition, with the great potential, very high capacity factor, and technology has become affordable, offshore wind contribution will increase rapidly in the coming years. According to different analysis wind power installed capacity in 2030 could be 12-15 GW onshore, 10-12 GW offshore (Ha-Duong et al., 2020) (GreenID, 2017) (Badger et al., 2015).

According to the Institute of energy Vietnam, solar energy has the most significant potential. The average land use rate is about 1.1-1.2 ha/MW depending on efficiency. In 2014, the report of the Ministry of Industry and Trade under the support of the Spanish Agency for International Development Cooperation showed that the technical potential for solar energy could be estimated at around 85 GW (AECID and MOIT, 2014). However, according to a study by ADB (2015) and GreenID (2018), the estimation of solar energy potential in Vietnam are strongly dependent on assumptions about areas that can technically be developed. In 2019, the economic potential of solar energy was up to 380 GW follows the Danish Energy Agency (EREA & DEA, 2019). Thus, we can see that Vietnam has a lot of ability to develop wind and solar power in the future.

3.2. Increasing competitiveness compared to other energy sources

The increase of tariff

Vietnam has excellent wind and solar resources, and the cost of producing electricity from wind and solar has decreased continuously over the last decade (Ha-Duong et al., 2020). Since 2011, the Feed in tariff (FIT) was 7,8 USD/kWh, and that was not commercially viable for developers. The tariff was then amended, and since November 2018, the FIT for a wind power project in Vietnam is 8,5 USD / kWh for onshore wind power projects and 9,8 USD/kWh for offshore. Along with that, the price of solar power also increased. In 2019, the tariff for solar energy was 9,35 USD/kWh. And these trends will continue in the next years. The increase in the tax explains the success in capturing developers interest and the take-off of field wind and solar power at the end of 2019.

Cost reduction

Many studies recent show clearly that wind and solar power will play an essential role in the future by reason the rapid decline in the costs of renewable energy. This global trend over the past years and into the foreseeable future (REN21, 2018a). Recent studies have shown that wind energy production costs have dropped significantly. According to the report “Renewable Power Generation Costs in 2018” of IRENA, in most parts of the world today, renewables have become the lowest-cost source of new power generation. As costs for solar and wind technologies continue falling, this will be true in a growing number of countries (IRENA, 2019). The global weighted-average levelized cost of electricity (LCOE) from onshore wind power in 2018 was 0,056 USD/kWh, which was 13% lower than the value for 2017 and 35% lower than in 2010 (IRENA, 2019). While LCOE for offshore wind power in 2018 was 0,127USD/ kWh, decline 1% to compare with 2017 and lower 20 % than in 2010. Besides, the average total installed cost of wind power has also declined rapidly in recent years. According to the IRENA, the average total installed cost of onshore wind farms fell by 6 % in 2018, while the total installed fees of offshore wind farms have declined modestly since 2010, reduced by 5 % between 2010 and 2018 (IRENA, 2019).

With solar energy, in particular solar photovoltaics, its LCOE is falling faster than wind energy. In 2018, the global weighted-average LCOE of solar PV declined to 0,085 USD/Kwh, corresponding reduce 13 % to compare in 2017 and a decline 77 % between 2010 and 2018. With the concentrating solar power, the global weighted average LCOE concentrating solar power in 2018 was USD 0,185/kWh, 26 % lower than in 2017, and 46 % lower than in 2010. The global weighted-average total installed cost of solar energy also declined year on year. According to IRENA, the total installed cost of CSP was falling from around USD 7.200/kW in 2017 to USD 5.200/kW in 2018, corresponding to 28 %. Meanwhile, the total installed cost of solar PV declined by 13 % in 2018 (IRENA, 2019).

The results of the study show that renewable energy costs are rapidly decreasing, and according to many forecasts in the near future, the cost of producing this energy source may be equal or lower than the cost of fossil energy. This has created a positive impact on the development of renewable energy globally, including Vietnam. In fact, in Vietnam, the cost of wind power went down rapidly in recent years. The investment cost for wind projects in Vietnam is 1,8 million USD per MW of installed capacity on average (Ha-Duong et al., 2020). The Technology Catalogue considers that nominal investment in onshore wind will decrease to 1,31 million USD / MW in 2030, and decrease further to 1,11 million USD / MW in 2050 (EREA et al., 2019). Solar PV has become much cheaper in the three years since the formulation of the NDC (UNDP in Vietnam, 2018).

In 2018, Green Innovation and Development Centre (GreenID) analyzed the levelized costs of energy /electricity (LCOE) of all sorts of power technologies under Vietnamese conditions in different years based on technology and price assumptions for that year as deemed applicable in Vietnam (GreenID, 2017). Table 6 below presents a comparison of the levelized costs of electricity production from selected key technologies in years deference. With the conditions in 2017, we can see that solar PV LCOE was 8,84 USD cents/ kWh and wind power LCOE was 8,77 USD cents/kWh. The highest cost is that of rooftop solar photovoltaic 10,56 US cent/kWh. This LCOE was more expensive than LCOE of energy fossils like coal or gas (around 6,7 - 8,18 USD cents/ kWh).

Table 6: LCOE of key technologies invested in years difference in Vietnam

(US cent/ kWh)

Year / Technology	2017	2017 (external costs)	2020	2025	2030
Small hydro	4,92	4,92	4,92	4,92	4,92
Large hydro	4,20	4,20			
Ground mounted solar grade 1	8,84	8,84	8,07	7,30	7,30
Roof top solar PV grade 1	10,56	10,56	9,80	9,03	9,03
Wind grade 1	8,77	8,77	8,46	8,08	8,08
Ultra-supercritical coal-imported coal			8,35	8,53	8,71
Supercritical coal-imported coal			8,09	8,28	8,48
Pulverized coal-imported coal	7,30	7,03 (+5,08)	7,42	7,63	7,85
Pulverized coal-domestic coal	6,71	6,71 (+5,20)	6,81	6,98	7,16
Gas turbine-domestic gas	7,89	7,89 (+1,66)	8,37	9,86	9,86
CCGT - domestic gas	7,10	7,10 (+1,24)	7,47	8,60	8,60

Source: Collect from (GreenID, 2017) (Nguyen Quoc Khanh, 2018)

However, looking into the future, the competitiveness indexes of renewable energy technologies could change as their investment costs keep improving while fossil fuel cost tends to continue to increase. The results for 2020 are shown that the ground-mounted solar PV grade 1 now becomes more cost-effective than Ultra-supercritical coal and gas turbine. By 2025, wind grade 1 could compete with supercritical coal, and wind grade 1 is more cost-effective than coal and gas. Buy 2030, except solar PV are still not yet competitive with coal, other renewable energy can compete with fossil energy.

Currently, in Vietnam, coal power is still considered cheaper than renewable energy because external costs (costs on environmental, social, and health impacts) are not counted. These are costs that citizens and government are actually bearing, while investors are not paying for it. Hence, if external costs are taken into account, all renewable energy technologies can compete with coal power today (Nguyen Quoc Khanh, 2018). According study of GreenID also, when externalities are considered, the picture on economic level of technology changes, even at the present cost levels. All renewable energy technologies become more competitive than coal power, even rooftop solar and low grade wind (see table 6).

Thus, the results show that without internalizing external costs, solar and wind power will be competitive by 2025 or sooner. But internalization of external costs of energy production will make renewable energy more competitive. Renewable energy can already compete with coal and also gas power if the environmental, social, health and livelihood costs are internalized in the costs.

The competitiveness and choice of energy sources, especially in the field of electricity production, depend very much on production costs. In the world today, the calculation of the cost of producing electricity from other energy sources. There are many factors influenced by each of which is related to the cost of CO2 emissions (due to the different emissions per energy level). The price of CO_2 are very important factors, according to Kahrl, apart from the price factor, the cost of investment between power stations, the competitiveness of electricity production depends on the price of carbon (Kahrl et al., 2013). For example, the cost of carbon represents 35 % to 40 % of the LCOE of coal power plants, while this cost is about 10 % in natural gas power plants (NEA, IEA, 2015). This indicates that the price of carbon is a critical factor that most strongly influences the cost of electricity production. While renewable energy has almost no emissions, this will be renewable energy more competitive than fossil energy.

Currently, Vietnam has no carbon market, no taxes, and no carbon fee yet like other countries. Therefore, in calculating the LCOE of energy sources, there are no costs related to carbon emissions. This is also the reason why the LCOE of coal and gas electricity is cheaper than solar or wind power. But if in the future when the Vietnamese government develops the CO_2 market or promulgates the regulations on taxes and CO_2 fees, then surely the generation of electricity from renewable energy will be very competitive compared to other traditional power sources today.

In a study of the Danish energy agency in collaboration with the Ministry of Industry and Trade in 2019, with the assumption that the price of CO_2 in Vietnam is 20 USD/ton, showed that the LCOE of renewable energy like wind and solar is much cheaper than the LCOE of fossil energy sources (see Fig 5).

Thus, the forecast results show that with the current rate of cost reduction, only until 2020, even without the external factors, renewable energy is still able to compete with traditional energy sources. When adding external factors into account, especially the cost of carbon emissions, renewable energy will become the cheapest form of power generation in Vietnam. Therefore, it can be seen that the potential of RE development compared to traditional energy in the future of Vietnam is very good.

(Assuming a price of 20 USD / tonne of CO2)

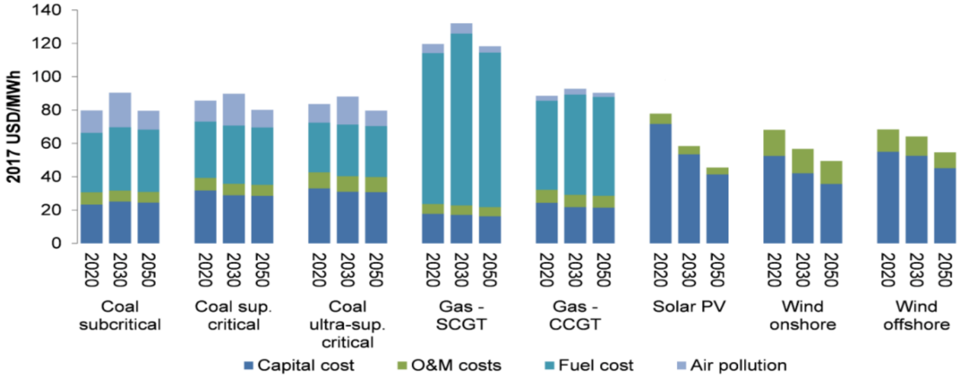


Fig 5. LCOE according to different sources in Vietnam

Source: (EREA & DEA, 2019)

4. CONCLUSION

Vietnam is one of the countries severely affected by climate change and related disasters. Aware of this, Vietnam is one of the first countries to ratify the United Nations Framework Convention on Climate Change. However, like other developing countries, rapid economic development in Vietnam has led to tremendous energy demand in Vietnam. The Government of Vietnam has also long displayed commitment to doing its part to reduce greenhouse gas (GHG) emissions by increasing the share of renewable energy and reducing the use of fossil energy to ensure energy security, climate change mitigation, environmental protection, and sustainable socio-economic development. This is an inevitable future trend for Vietnam.

Compared to many other Asian countries, Vietnam has good potential for wind and solar energy development. In recent years, the government has also issued many policy documents related to the development of renewable energy in Vietnam. However, the state's targets for renewable energy in its policies are shallow, not commensurate with the potential of renewable energy, especially wind and solar power. The application of renewable energy in Vietnam is still negligible; the development of renewable energy is still very slow at present. To promote the development and application of renewable energy, the government should continuously improve the existing policies and develop more comprehensive policies for supporting the development of renewable energy based on the real on-going development situation and lessons learned from international experiences.

The above analysis has shown that the cost of generating electricity (LCOE) from renewable energy is declining and that renewable energy is entirely able to compete with traditional fossil energy sources. Even if taking into account the external costs, especially the cost of carbon emissions, renewable energy is considered to be the cheapest energy source in Vietnam. In addition, the electricity price mechanism for renewable energy tends to increase. Therefore, renewable energy is highly competitive compared to fossil energy. The use of renewable energy to replace fossil energy in Vietnam to reduce emissions and ensure energy supply is feasible.

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CORPORATE SOCIAL RESPONSIBILITY IN THE PEOPLE'S REPUBLIC OF CHINA - OWNED ENTERPRISES AND THE LESSONS FOR VIETNAM NATIONAL COAL - MINERAL INDUSTRIES HOLDING COMPANY LIMITED

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Abstract: *In recent years, corporate social responsibility (CSR) has been increasingly mentioned in companies' production processes and business activities. The ISO 26000 standard is considered an internationally recognized standard for corporate social responsibility. This standard plays an important role in assisting businesses to perform their missions and helping them affirm their values. Furthermore, CSR has been developing to a higher level. It is simply a voluntary decision of an individual or an organization and a mandatory policy of any organization at all local, regional, national and international levels. CSR concerns many aspects of the production process, such as environmental protection, community benefits, protection of workers' rights, etc.*

In the process of constructing and developing country, the extractive sectors (such as mining, forestry and fisheries) have played a crucial role in enabling the country's development in terms of both industrial growth and providing employment. The Chinese government understands the importance of mitigating the negative consequences of Chinese economic activities. China has been active in most CSR mechanisms in the extractive industries such as the Equator Principles, ISO, Kimberley Process and The United Nations Global Compact by adopting standards, developing new standards and influencing existing standards. A successful example is the ISO guidelines, such as ISO 14001 Environmental Management. Starting approximately 15 years ago, there has been a noticeable increase in adoption and compliance with CSR principles in China through the awards of ISO 14001 which is a series of international standards for environmental management that aims to help organizations minimize the negative environmental impacts from their business operations. More recently, China also supported the newly implemented ISO 26000 on social responsibility. Thus, it is clear that China is a leading country in the implementation of CSR and it can be an example for countries in the group of emerging mining to learn positive lessons.

For mining activities in Vietnam, Vietnam National Coal - Mineral Industries Holding Company Limited (VINACOMIN) is the main organization allowed by the Government to carry out coal mining. Implementing an important task assigned by the State, right from the time of coming into being, the Group set up a plan for innovation of structure and management to improve operational efficiency, choosing the strategy of developing diversified businesses based on coal operation and the policy of growing with customers and partners. While the Vietnamese market still depending on coal to generate energy, VINACOMIN thrives as the main provider of coal for many industrial areas and plays their part in protecting the national energy security and regional shifting of economic structure. VINACOMIN possesses a board range of subsidiaries that span across various businesses, allowing flexibility in their operation. Additionally, VINACOMIN is in charge of some of the biggest coal and mineral *ores in Vietnam, giving them stable raw materials sources. Besides strong points, VINACOMIN also has some weaknesses. The first weakness lies in the lack of qualifying methods in terms of labor workers, which might reduce working efficiency because it induces extra costs on training. Also, the poor management of the environment and safety in the workplace from VINACOMIN can weigh down the potential attraction from employees, investors, customers, etc. Unlike the other case companies, the implementation CSR in VINACOMIN, which is the least impressive, has not been taken seriously.*

Therefore, with many similar characteristics about coal mining activities between China and Vietnam, VINACOMIN can thoroughly learn the positive points in CSR implementation in China.

Keywords: *corporate social responsibility (CSR), Vietnam, China, Vinacomin.*

1. INTRODUCTION

Nowadays, CSR plays an important role in countries around the world due to its benefits to society. The ISO 26000 standard has provided guidance on CSR's basic principles, recognition of CSR and stakeholder engagement, core topics, and issues associated with CSR. This standard is suitable for all types of organizations in the private, public, and non-profit sectors, from small and medium enterprises to large enterprises and enterprises that operate in developed or developing countries. In China, the government is always especially interested in CSR activities. Chinese State-Owned Enterprises usually have more comprehensive CSR programs than other organizations. CSR has been becoming an outstanding issue in Chinese academic and policy forums. Furthermore, many initiatives related to CSR have emerged, and the number of Chinese enterprises implementing CSR and reporting on CSR has been increasing. Therefore, it can be said that the implementation of CSR in China is highly effective and this is a typical example for other countries to refer to and apply, including Vietnam.

Recently, Vietnamese companies in general and Vietnam National Coal - Mineral Industries Holding Company Limited (VINACOMIN), in particular, have started approaching CSR activities. Besides the achievements and contributions to the development of Vietnam's economy, VINACOMIN also has certain limitations. Although CSR activities have been implemented, VINACOMIN has not paid more close attention to the implementation process and needs further improvement. Starting from the mining activities that have some similarities between China and Vietnam, this article proposes a number of recommendations related to CSR implementation in China that VINACOMIN can refer to and apply during its activities.

2. DEFINITION AND STANDARD

2.1. World Bank CSR concept

In 2003, the World Bank's private economic development group defined CSR, which was used most globally due to its clear and understandable. Particularly, corporate social responsibility is the commitment of business to contribute to sustainable economic development - working with employees, their families, the local community, and society to improve the quality of life, in ways that are both good for business and good for development. According to this definition, CSR must be associated with sustainable development, which is an objective and global requirement for current development. Additionally, this definition indicated that CSR is an organization's commitment to contribute to economic development and improve living standards of society. CSR is not only spontaneous actions but also an integral part of business strategy. As the competition in the market becomes increasingly fierce and the requirements from the society for enterprises are stricter regarding their social responsibility, in order to develop sustainably, enterprises must always comply with and ensure standards on the protection of the natural environment, working environment, the implementation of gender equality, labor safety, training workers to contribute to community development. From such specific contents on CSR, CSR activities have contributed to the sustainable development of businesses and society. Moreover, this definition illustrates that CSR implementation is associated with creating benefits for many various objects such as owners, shareholders, employees, customers, suppliers and the community. In addition to focusing on finding profits, enterprises need to become a part of the community and society, they must take responsibility for the benefits of subjects, for example, workers, consumers, even the local community where enterprises have been operating.

2.2. ISO 26000:2010

ISO 26000 was a set of standards of the International Organization for Standardization to provide guidance on CSR. This standard was published in 2010 with 07 core subjects: Organizational governance; Labour practices; The environment; Fair operating practices; Consumer issues and Community involvement and development. Core subjects and issues were demonstrated in table 1.

This standard guides on CSR's basic principles, recognition of CSR and engagement with relevant stakeholders, core topics, and issues associated with CSR. This emphasizes the importance of results and the improvement of CSR performance. It is useful for all types of organizations in areas such as the private sector, public and non-profit sectors, large or small businesses, operating in developed or developing countries, and transition economies. Furthermore, it can be used for organizations that begin to implement CSR and those with more experience in this. New organizations can read and apply this standard as a basic guide to CSR, while experienced organizations may use it to improve existing practices.

Table 1. Core subjects and issues of CSR

Addressed in sub-clause	Core subjects and issues
6.2	Core subject: Organizational governance
6.3	Core subject: Human rights
6.3.3	Issue 1: Due diligence
6.3.4	Issue 2: Human rights risk situations
6.3.5	Issue 3: Avoidance of complicity
6.3.6	Issue 4: Resolving grievances
6.3.7	Issue 5: Discrimination and vulnerable groups
6.3.8	Issue 6: Civil and political rights
6.3.9	Issue 7: Economic, social and cultural rights
6.3.10	Issue 8: Fundamental principles and rights at work
6.4	Core subject: Labour practices
6.4.3	Issue 1: Employment and employment relationships
6.4.4	Issue 2: Conditions of work and social protection
6.4.5	Issue 3: Social dialogue
6.4.6	Issue 4: Health and safety at work
6.4.7	Issue 5: Human development and training in the workplace
6.5	Core subject: The environment
6.5.3	Issue 1: Prevention of pollution
6.5.4	Issue 2: Sustainable resource use
6.5.5	Issue 3: Climate change mitigation and adaptation

6.5.6	Issue 4: Protection of the environment, biodiversity and restoration of natural habitats
6.6	Core subject: Fair operating practices
6.6.3	Issue 1: Anti-corruption
6.6.4	Issue 2: Responsible political involvement
6.6.5	Issue 3: Fair competition
6.6.6	Issue 4: Promoting social responsibility in the value chain
6.6.7	Issue 5: Respect for property rights
6.7	Core subject: Consumer issues
6.7.3	Issue 1: Fair marketing, factual and unbiased information and fair contractual practices
6.7.4	Issue 2: Protecting consumers' health and safety
6.7.5	Issue 3: Sustainable consumption
6.7.6	Issue 4: Consumer service, support, and complaint and dispute resolution
6.7.7	Issue 5: Consumer data protection and privacy
6.7.8	Issue 6: Access to essential services
6.7.9	Issue 7: Education and awareness
6.8	Core subject: Community involvement and development
6.8.3	Issue 1: Community involvement
6.8.4	Issue 2: Education and culture
6.8.5	Issue 3: Employment creation and skills development
6.8.6	Issue 4: Technology development and access
6.8.7	Issue 5: Wealth and income creation
6.8.8	Issue 6: Health
6.8.9	Issue 7: Social investment

The content that this standard provides include:

- Concepts, terms and definitions related to CSR;

- The background, trends and characteristics of CSR;

- Principles and practices related to CSR;

- Core topics and issues of CSR;

- Integrating, implementing and promoting CSR behavior throughout the organization and adopting its policies and practices within its sphere of influence;

- Identification and cohesion with stakeholders;

- Communicating commitments, implementation and other information related to CSR.

3. CURRENT CSR SITUATION IN CHINA

3.1. The development of CSR in China

The development of CSR in China can be divided into three different phases. A special focus is given to State-Owned Enterprises (SOEs) development.

3.1.1. First stage of development (before 1978)

Before the reforms started, all companies were part of the government apparatus in the planned economy. Besides production, the SOEs were responsible for providing lifelong employment for their employees, emphasizing their social responsibility. Furthermore, the companies built a part of the public administration and provided a certain degree of social security and education (Wang; 2007). “As the prototypical urban work unit (danwei), SOEs were responsible for the welfare, health, and political indoctrination of their workers” (Naughton; 2006, p. 300). Companies even built hospitals, schools and provided shopping opportunities (He; 2006, p. 24). The SOEs were the core of the command economy with numerous responsibilities, except the need to be profitable soft budget constraints led to low efficiency and productivity of the whole economy. While the companies were not allowed to make their own decision since the plan made the guidelines, providing social responsibility was one of their major duties during this period. “Managers had little flexibility and low rewards, and they were required to fulfill plan targets and carry out numerous other commands given by various parts of the bureaucracy” (Naughton; 2006, p. 300). Jobs were provided for all but many meaningless and low salaries were paid as well. The SOE’s social responsibility was a central aspect of China´s development in the planned economy. Nevertheless the burden was immense and limited their abilities to make profits.

3.1.2. Second stage of development (1978-2000)

After 1978 when the economic system started to change, the relation between state and companies became different. Gradual privatization and a more incentive-driven economy led to disengagement in providing social security. The companies had to start focusing on profits while raising productivity and the competition was highly encouraged by the state. The new economic conditions overburdened many of these companies, which had to face market conditions and competition for the first time. Budget constraints were hardened and the total number of industrial SOEs decreased massively from 120,000 in the mid-1990s to only 31,750 in 2004 (Naughton; 2006, p. 314). “[…] from 1993 through 2003, an official count of 28.8 million state enterprise workers were laid off” (Zu; 2009, p. 4). It is evident that this new profit orientation had a major impact on society and communities. With the initiated institutional change to converse the SOEs into public corporations in order to achieve profitability, the surviving SOEs gained access to more capital through the listing on stock exchanges (Opper et al.; 2007). With the company law (1994) organizational standards were introduced, which were modeled after the western example of Corporate governance (Opper et al.; 2007). The Chief Executive Officer (CEO) and the board of directors are started becoming the decision-makers in the companies (Wong et al.; 2004). Economic growth and competitiveness were the main goals of the reforms, while environmental and social concerns were secondary. The consequences were unemployment, increasing pollution of wider areas and rising inequality (He; 2006, p. 26). Zu (2009, p. 3) states that the restructuring caused a systemic erosion of labor interests. Ruthless labor rights abuse, deprivation of benefits and brutal working conditions occurred due to the new market orientation, combined with a lack of state protection and emerged despotic managerial power (Lee; 1999). Many of the SOEs, which were high polluting and offered low wages combined with minimal health and safety standards, have been highly profitable (Young & McRae; 2002). As Zu states (2009, p. 47), “[...] the more profits people are making, the less social responsibility they are assuming.” It can be stated that with this transformation and the new corporate governance approach, the “pure profit-making view” in the sense of Lantos (2001) was common among SOE´s managers. Therefore social responsibilities were regarded as costs which had to be cut.

3.1.3. Third stage of development (after 2000)

The third stage began around 2000 when the media, NGOs, academics and foreign consumers started to take up the idea of CSR, especially after China became a WTO member and Multinational Corporate (MNC)´s started expanding their businesses in China. Attention in western societies emerged regarding the business practices of multinationals in China. The demand for compliance, better working conditions and environmental responsibility started to rise. After this started in the toy factories of the southeastern coastal cities, where many export-oriented MNCs have been based, the

CSR concept became common in other industries and provinces (Habich; 2008). Extensive research and studies by Chinese academic institutions, NGOs and international organizations in China created more awareness as well. CSR was perceived in the first place as a trade barrier erected by the United States to weaken China´s economic power (Habich; 2008, p. 35, He; 2007). Especially the introduction of the social standard SA 8000 which is mainly focused on suppliers in the apparel and textile industry led to common resistance. Many suppliers started complaining about the new pressure put on them by the MNCs which introduced their CSR standards in their supply chains. Trade authorities started showing deep concerns about the social development and its effect on foreign trade and called on all interest parties to adopt CSR principles to avoid the potential negative impact on their exports (Zu; 2009). With World Trade Organization (WTO) membership and Chinese companies facing more global competition, the demand for CSR increased as well (He; 2006, p. 26). CSR then became an element of the Chinese Communist Party (CCP)´s policy in order to balance the relationships between different economic groups (Pullam; 2006). Therefore, CSR is a highly discussed topic (Qingfeng; 2006) in recent times, encouraged and promoted by the CCP with various initiatives by different bodies of the government (GTZ; 2008, p. 6). The latest CSR survey conducted by Fortune China in March 2009, which asked 20,000 decision-makers in business and government about their opinion regarding CSR found that 56 percent, compared to 49 percent in the year before, stated that “CSR is a trend that is here to stay in China” (Zadek; 2009).

3.2. The role of SOEs in the Chinese economy

After two decades of restructuring, SOEs still play an important role in the Chinese economy, dominating strategically important sectors such as infrastructure construction, telecommunications, financial services, energy and raw materials (Yang; 2008). 69.8 percent of the top-500 Chinese enterprises, regarding revenue in 2007 were SOEs, accounting for 94 percent of asset value and creating 88 percent of the total profit, contributing 92.7 percent of overall taxes and employing 89.3 percent of the workforce within the grouping. Due to their size and impact on society and the environment, the SOEs are crucial for the development of CSR in China. They are expected to engage in CSR and implement the guidelines issued by the government. “State Assets Supervision and Administration Commission indicates that SOEs, as key players in the People´s Republic of China economy, influence important industrial sectors and people´s lives. Therefore CSR is not only the mission of SOEs but a public expectation” (Levine; 2008).

3.3. Measuring CSR practice

In order to analyze the CSR practices and performance, The Chinese Communist Party constructed an index by using a formative measurement model for a comparison of different countries. This index will be modified for the Chinese context and applied to analyze and compare the largest Chinese SOEs of different industries. All CSR initiatives that are open for Chinese companies were considered an indicator to build this index. However, the following criteria led to the final selection. First, the used indicator must be related to CSR by covering environmental or social activities. Second, the indicator must have a general application. Therefore international and national initiatives and rankings were included. Regional, industry-specific or sector-related initiatives and rankings were not considered due to the lack of comparability among different industries. All companies in the sample must have the opportunity to take part in the activities. Third, the indicator must involve a minimum of 50 companies. Fourth, reliable and comparable data must be publicly available at the company level. 12 CSR indicators could be identified which fit these requirements. These are divided into four broad categories, based on the index by Gjølberg (2009) as shown in table 2:

Table 2. Indicators determining the CSR practice index

Category	Indicators in the CSR Index
Ratings based on social investment criteria and CSR performance	Dow Jones Sustainability Index (DJSI)
	Dow Jones Sustainability Asia Pacific Index
	Global 100 most sustainable corporations Hurun ranking
Membership in CSR initiatives	UN Global Compact
	World Business Council for Sustainable Development
	Chinese Business Council for Sustainable Development
CSR reporting practices	Releasing CSR report
	Using GRI guidelines
	Report audited by third party
Certification Schemes	ISO14001
	OHSAS 18001

Source: Own data, based on Gjølberg, 2009

4. VINACOMIN'S SOCIAL RESPONSIBILITY IMPLEMENTATION

4.1. Some advantages

Vietnam's coal industry has a history of over 100 years of exploitation; since then, VINACOMIN has achieved great achievements and contributed to Vietnam's economy's overall development. As a large economic group under the control of the State, VINACOMIN has many subsidiaries operating across the country and abroad. VINACOMIN and its members are always aware of their responsibilities to the community and society. According to the Ministry of Industry and Trade of the socialist republic of Vietnam, in 2019, VINACOMIN's growth rate reached 14%, the highest in Vietnam's industrial sector. Currently, the average annual coal production of VINACOMIN is 40 - 45 million tons; this group has exploited 700 million tons and consumed 715 million tons after 25 years of construction and development. There was a dramatic increase in the total coal revenue from 1.3 trillion VND in 1994 to 62.26 trillion VND in 2018; the labor productivity in 2018 reached 572 tons/person-year, an increase of 3.45 times compared to 1995. Besides, workers' lives have been improved continuously, such as the average salary of workers is now over 11.6 million VND/person-month, up 17.6 times compared to when it was established; miners' salary has reached about 18 million VND/person-month. In particular, the number of miners with an income of over 300 million VND/person-year is increasing significantly. In 2018, there were 792 miners with a high income of over 300 million VND and began to have many miners with over 400 million VND/person-year income. There are currently many dormitories for workers with 3,445 rooms equipped with air conditioners, water purifiers, washing machines, physical training areas, etc. Along with fulfilling the annual production and business plan, ensuring jobs, income and life for almost miners and their families, VINACOMIN and its subsidiaries always focus on implementing the service with localities, supporting difficulties, and building new rural areas, perform social security work in the area. Every year, VINACOMIN still pays a certain amount of money to carry out its social responsibilities, such as building schools, making roads, bringing electricity to the island, building houses for poor households and supporting to develop the local economy. In terms of environmental protection, VINACOMIN spent nearly 1,000 billion VND for environmental treatment. The group has planted greenery on 1,000 hectares of the landfill, equivalent to 30 % of the existing outside landfill area. It also installed 38 automatic environmental monitoring systems to monitor dust and emissions, investing in construction and putting into operation 45 mining wastewater treatment plants with a capacity of over 120 million m3/year, ensuring 100 % of wastewater has been treated following environmental standards. In addition, VINACOMIN has also invested trillions of VND in the construction of conveyor belts to replace transportation by trucks and railways. Thus, in order to achieve the goal of sustainable development, VINACOMIN should continue to invest in renovating exploitation technology, being environmentally friendly, constantly improving the physical and spiritual life of workers and enhancing welfare with society and the community.

4.2. Some disadvantages

Besides the strengths that need to be promoted, VINACOMIN also has several weaknesses. Because the management of CSR activities has not been paid much attention, leading to the exploitation of some minerals beyond the plan, causing big waste, unsafe labor and bad impacts on the environment. The application of ISO 26000 in VINACOMIN and its member companies has not been implemented specifically and has not brought high efficiency. The management staff are still weak in terms of foreign language skills; the level of business knowledge and international business law is low and unprofessional; the work settlement efficiency in some departments has not kept up with the requirements. There is a lack of high-quality skilled workers, especially in mining, metallurgy, mechanics and mineral processing industries. Generally, industrial behavior and self-protection sense of self and colleagues are still limited. The number of miners has a strong fluctuation and a large shortage due to unreasonable labor policies.

5. LESSONS ON CARRYING OUT CSR IN CHINA FOR VINACOMIN

- The government has to build an index system to measure and analyze CSR implementation at state-owned companies, including VINACOMIN.

- The implementation of the ISO 140001, the OHSAS 18001, the ISO 26000 series needs to be done more fully at VINACOMIN. This group should develop a system of guidance documents to carry out the set of standards to its member companies.

The government needs to engage in social responsibility in all companies' business strategy, including VINACOMIN. It is necessary to set a certain deduction rate based on all companies' profits in VINACOMIN to build a fund of CSR’s activities.

- Additionally, VINACOMIN needs to provide more incentives for the workers to attract them during the recruitment process. Regularly educating occupational skills and safety for workers to reduce the risks that may be encountered at work.

- Creating more efficient programs to improve the lives of the local community concerns about environment.

6. CONCLUSION

Social responsibility issues of coal mining companies in recent years have been more interested. This article gives some theories related to CSR, such as CSR concepts, the ISO 26000. Furthermore, the history of CSR activities in China was demonstrated, including three stages: before 1978, from 1978 to 2000, and after 2000. Stemming from the role and how to carry out CSR in Chinese SOEs combined with the reality of CSR activities in VINACOMIN, the article also provides some recommendations to enhance the CSR implementation in VINACOMIN.

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A REVIEW OF THE COAL POWER SECTOR IN VIETNAM

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Abstract: *According to data from the Vietnam Energy Association (VEA), Vietnam currently has 21 coal power plants that are in operation, with a total capacity of about 14,310 MW, accounting for nearly 50% of the national power structure. It is expected that by 2030, coal power will continue to play an important role in ensuring national energy security. However, besides the risk of coal shortage, the operation of coal power plants currently presents many threats to the environment, while the development of "clean" and environmentally friendly coal power requires a huge investment scale and faces many difficulties in mobilizing investment capital. Details of these issues will be clarified in the article.*

Keywords: *coal power, coal power plants.*

1. INTRODUCTION

According to experts, each country goes through 3 phases of power development. Specifically:

+ Phase 1: The period of not developing or developing at a very slow pace (usually 1-2 % per year), the total national power production and power per capita were very low. Vietnam was the same in 1961-1990: Average power per capita of Vietnam at that time was only about 100kWh/person.year while that of the world was over 1500kWh/person.year.

+ Phase 2: The development period was very fast; the annual growth rate was often more than 10 % per year. It was the period of European countries after World War 2 and of developing countries, including Vietnam from 1990 and expected to 2030.

+ Phase 3: The saturation period of power demand, the growth rate was low, only about 1-2 % per year, but the total national power production and power per capita were very high, like G7 countries today, for Vietnam, it is expected after 2030.

Table 1. Average power growth of some countries in the period 1995 - 2018

Country	Average power growth (%/year)
1. United States	1.35
2. Japan	0.96
3. Germany	0.96
4. France	0.62
5. India	6.57
6. China	10.25
7. South Korea	6.58
8. Taiwan	5.10
9. Indonesia	5.89
10. Thailand	8.11
11. Malaysia	12.78
12. Vietnam	13.69

(Source: Electricity Regulatory Authority - Ministry of Industry and Trade)

According to the data in Table 1, it shows that Vietnam and some countries in Southeast Asia are in phase 2.

China, South Korea, and Taiwan are at the end of phase 2 or about to enter phase 3. In phase 2, the power demand is very high; if it is not met, the economy cannot grow.

According to the power planning approved by the Government, it is forecasted that after 2030, Vietnam will gradually move into phase 3 like South Korea and Taiwan today.

In 2015, production from coal power only accounted for 30.4 % of the total national power production, but it is expected to increase to nearly 50 % in 2020 and it is expected to account for about 55 % in 2025.

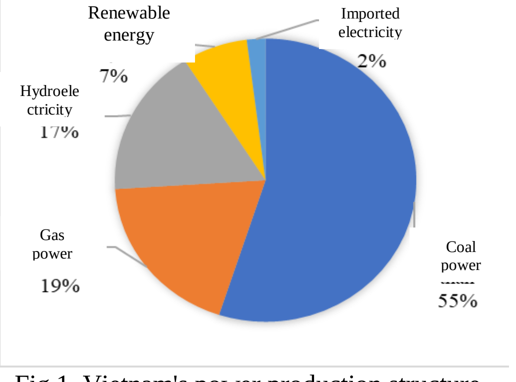

Fig 1. Vietnam's power production structure in 2025 according to the Power Planning VII

(Source: According to the Adjusted Power Planning VII)

However, according to the Report of the National Steering Committee for power development in February 2020: compared with the Power Planning VII (2016), it is expected that coal power capacity will decrease by 8,760 MW in 2025, only accounting for 43 % of the total power structure, decreasing by more than 11 % compared to the old planning.

There are many reasons for limiting the development of Vietnam's coal power in the past and in the future.

First, it is undeniable that with current technology, coal power plants' operation has an adverse impact on the environment and potentially causes many public health hazards. Therefore, authorities and people of many localities (such as Bac Lieu, Long An, Ha Tinh, Quang Ninh, etc.) have strongly opposed the implementation of new coal power plant projects in the locality. By 2020, there have been 14 projects that have faced fierce opposition from localities and are being asked to be reconsidered for discontinuation or expected to convert from coal power plants to gas or other types of clean energy such as Projects of Long An1, Long An2 Thermal Power Plants (Long An); Projects of Quang Ninh3, Cam Pha3 Thermal Power Plants (Quang Ninh), Projects of Tan Phuoc1, Tan Phuoc2 Thermal Power Plants (Tien Giang), etc.

Besides, there are many other causes such as coal shortage for thermal power plants; and lack of investment capital due to the huge demand for coal power projects. Especially in the context of the difficult economy due to the current Covid-19 epidemic, Vietnam will face difficulties in raising capital for new coal power projects and potential risks in the capital raised for the projects in the last period.

In the past time, there have been many studies on the development of Vietnam's coal power and the Adjusted Power planning VII that focused on assessing the impact of this power source on the environment and society. Therefore, this article focuses on clarifying two issues: coal source and investment capital for coal power plants in Vietnam.

2. A NUMBER OF EXISTING PROBLEMS IN VIETNAM'S COAL POWER TODAY

2.1. Shortage of fuel for coal power plants

Vietnam currently has 21 coal power plants in operation, including 07 plants that use circulating fluidized bed (CFB) boiler technology using low-quality domestic coal (powder coal 6), 14 plants that use pulverized coal (PC) injection technology using better domestic coal (powder coal 5) and imported coal with a total capacity of about 14,310MW.

According to the adjusted "Vietnam Coal Industry Development Planning to 2020, with prospects to 2030", the coal demand and commercial coal supply capacity of Vietnam's coal industry in the period 2020-2030 are forecasted in Table 2.

Table 2. Forecast of Vietnam's coal demand and commercial coal production in the period 2020-2030

Unit: Million tons

Forecast	2020	2025	2030
1. Coal demand for the whole economy	94.0	138.0	165.0
Where: Coal demand for power production	*66.8*	*107.8*	*135.3*
2. Commercial coal production	47-50	51-54	55-57

(Source: Vietnam Coal Industry Development Planning to 2020, with prospects to 2030)

Through the forecasting data, it can be seen that, in the period 2020 - 2030, domestic coal production is not enough to supply for coal power plants, there will be a serious shortage of coal, even by 2030, there will be a shortage of more than 80 million tons. Importing coal for thermal power plants is a mandatory solution.

On the other hand, most coal power plants in Vietnam were originally designed and operated with Anthracite coal standards, while Anthracite coal production only accounts for about 3 % in the world market, so the import is extremely difficult. If the quality of the coal source is changed, there may be problems in operating the units.

Meanwhile, domestic coal mining enterprises are facing many difficulties: Conditions of underground coal mining are increasingly difficult and complicated. Open-cast coal mining operations are increasingly deep, the investment in advanced technology for mining has encountered many difficulties, taxes and fees related to coal mining have increased, so the domestic coal mining cost has continuously increased. These difficulties have greatly affected the ability of domestic coal mining enterprises to increase coal production.

Therefore, the amount of imported coal used for thermal power has continuously increased over the years.

Table 3. Coal structure used for power production in 2019

Indicator	Production (million tons)	Proportion (%)
Total amount of coal used for power production	55.5	100
Amount of domestic coal used for power production	36.2	65.22
Amount of imported coal used for power production. Where:	19.3	34.78
Used for Northern thermal power plants	*8.7*	*15.7*
Used for Southern thermal power plants	*10.6*	*19.11*

(Source: Vietnam Energy Association)

In 2019 alone, the value of imported coal was about $ 4 billion, equivalent to nearly 20 million tons of imported coal, an increase of about 60 % compared to 2018.

However, thermal power plants said that the daily imported coal usually does not meet the registered requirements. Inventory volume was always very low, with many potential risks. For example: In 2019, the average coal reserves of Quang Ninh Thermal Power Joint Stock Company and Uong Bi Thermal Power Company were only sufficient for the units running from 2 to 6 days, while the set-out requirement is to have sufficient coal reserves for 12 consecutive days of operation.

Shortage of coal is a common concern of most coal power plants in Vietnam.

2.2. Actual situation of capital sources invested in Vietnam's coal power

Table 4. Financing sources for coal power (accumulated to 2017)

Unit: Billion USD

Financing sources	Amount
1. Domestic financing sources	7,210
- Reciprocal capital of investors	*4,694*
- Loans from domestic banks	*2,516*
2. International financing sources	20,859
- Reciprocal capital of foreign investors	*4,326*
- Loans from foreign banks	*16,533*
3. Unknown sources	13,498
Total financing resources invested	41,567

(Source: Green Innovation and Development Center - GreenID)

According to forecasts by 2030, the total investment for all coal power plants in Vietnam (including operated plants, projects that are and will be implemented) will be nearly $ 90 billion. Accumulated to 2017, the total investment for coal power was more than $ 41.5 billion, including investment capital of investors, bank loans and other sources, mainly from international financial sources.

Specifically: According to the Report on "*Development of coal power in Vietnam - Financial perspective*" of Green Innovation and Development Center - GreenID: Of the total investment capital for coal power that has been raised: Investment capital from abroad was $ 21 billion, accounting for about 50 % of the total financing sources raised to develop coal power in recent years, including investment capital of foreign project investors and loans from foreign financial institutions. The financing source raised domestically was $ 7.2 billion, accounting for about 15.3 % of domestic investors and domestic bank loans. The remaining 30 % of the raised capital cannot be identified due to difficulties in data collection and source identification. The specific situation of the investment capital sources is as follows:

+ Of the $ 7.2 billion from domestic financing resources invested in coal power, $ 4,694 billion was investors' capital and $ 2,516 billion was loans from 9 domestic banks, banks that have provided many loans for coal power projects include Vietnam Development Bank (VDB), Vietnam Joint Stock Commercial Bank for Industry and Trade (Vietinbank) and Joint Stock Commercial Bank For Investment And Development Of Vietnam (BIDV).

+ For foreign investment capital, if classified by the territory and country, the source of investment capital for coal power in Vietnam comes from 8 countries and 1 multilateral international organization (Asian Development Bank - ADB).

Table 5. Domestic financing sources invested in coal power (accumulated to 2017)

Unit: Billion USD

No.	Domestic investment	Amount
1	BaoViet Insurance	0.015
2	Maritime Bank	0.023
3	Agribank	0.025
4	Eximbank	0.056
5	LienVietPostBank	0.117
6	Vietcombank	0.126
7	BIDV	0.374
8	Vietinbank	0.705
9	VDB	1.075
10	Investor	4.694
Total domestic investment		7.210

(Source: Green Innovation and Development Center - GreenID)

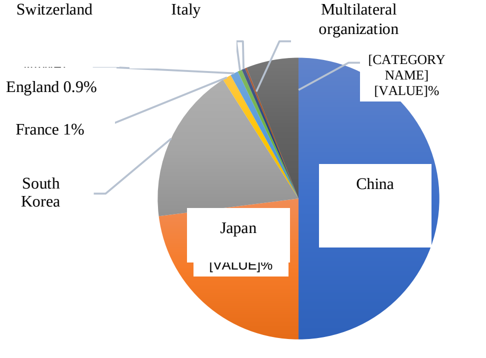

Fig 2. Proportion of foreign investment for Vietnam's coal power by country

In particular, China, Japan and South Korea are the three countries that lend the most money to Vietnam to develop coal power. China currently holds the No. 1 position, providing more than 50 % of investment capital with loans worth up to $ 8.3 billion. Japan ranked second, accounting for 23 % (equivalent to about $ 3.7 billion) and South Korea ranked third accounting for about 18 % (equivalent to an investment of more than $ 3 billion).

Besides the purpose of providing loans to enhance the economic and political position of the countries that provide loans to Vietnam. The first motive of China, Japan and South Korea in financing coal power projects abroad, including Vietnam, is to export-related Engineering, Procurement and Construction contracts.

This is especially important for China when its Government is taking tough measures to gradually reduce coal power such as stopping the construction of coal power plants in 15 provinces, suspending licensing and canceling projects under planning in 13 provinces, issuing plans to close old plants. The Chinese domestic market of coal power technology and equipment has become saturated and redundant due to the state policy, due to strong competition from renewable energy, etc. In other words, the China's banks such as the Export-Import Bank of China, China Development Bank, etc. will provide loans under the form of "buyer credit" to overseas coal power project owners to buy technology, equipment, supporting Chinese enterprises to produce coal power equipment to export their products (such as boilers, turbines, generators, etc.) to foreign countries. Therefore, often accompanied by loans from Chinese banks are engineering - procurement - construction (EPC) contracts executed by Chinese contractors. According to statistics of the Ministry of Industry and Trade, Dongfang Electric Corporation (Dofang), China People's Electric Power Group (Kaidi), Shanghai Electric Power Generation Group, Guangdong Electric Power Design Institute (GEDI), etc. are familiar contractors of EPC general contractors in coal power projects in Vietnam.

However, during the actual construction, China's EPC general contractors revealed a series of uncertainties. Vietnam Institute for Economic and Policy Research (VEPR) of Hanoi National University has just published a study on foreign direct investment inflows from China to Vietnam. Specifically, with thermal power, VEPR surveyed 40 thermal power plants that were operating and under construction. Although there were only 6 thermal power projects implemented under the general contractor, the value of China's EPC contract accounted for 69 % of the total capital for the construction of current coal power plants. Nearly 65 % of thermal power projects implemented by Chinese contractors were behind schedule. Meanwhile, only 40% of Japanese contractors were behind schedule and Korean contractors had no projects behind schedule.

2.3. The risk of lack of investment for coal power projects in the future

In the coming time, power from coal power will continue to play an important role in ensuring Vietnam's national energy security. Dozens of coal power projects that have been approved to deploy in the near future will face the risk of lack of investment due to the following causes:

Firstly, in the recent 2017 - 2019 period, the trend of divesting from coal power projects has been increasing in the world, especially in European countries. As of March 2020, 127 global financial institutions have announced policies to restrict investment and withdraw capital from coal power projects. In Vietnam, in December 2019, Standard Chartered Bank announced its withdrawal from loan financing for two projects Vung Ang 2 (1,200 MW) and Vinh Tan 3 (1,980 MW) and it is possible that more and more of Vietnam's coal power projects are rejected by financial institutions.

Secondly, the capital scale of coal power projects is very large and up to billions of dollars, so groups and corporations assigned by the State to implement thermal power projects are forced to borrow foreign capital or from domestic banks.

+ In case of foreign borrowing, a guarantee from the Government is required, while in order to control public debt, the Government has temporarily stopped guarantee for loans of state-owned enterprises because according to the Government's announcement in 2019, Vietnam's public debt was approaching the ceiling of 65 % of GDP according to the law. This means that in the coming period, Government direct loans or Government guaranteed loans that are included in the public debt limit will be very limited, including investment loans for coal power.

+ In case of borrowing capital raised domestically, according to the regulations, the bank's lending limit for power industry investment projects shall not exceed 25 % of the total investment while the capital demand for projects is up to billions of dollars, so it is difficult to find a financial institution that meets the demand.

Without change, the scale of thermal power investment loans would be difficult to increase with domestic financing sources.

3. CONCLUSION

Based on the study of the current status of Vietnam's coal power, it can be seen that similar to many other countries in the world, coal power in Vietnam has been occupying a large proportion of the total national power structure. In the medium term (next 10-15 years), coal power will still play an important role in the power system and to ensure sufficient power for the economy, Vietnam will still have to continue to choose coal power.

According to BloombergNEF, Vietnam is ranked fourth in the list of 10 countries with plans to develop coal power leading in the world.

However, as analyzed in the article, the next stage of Vietnam's coal power faces many difficulties such as lack of coal, many financial barriers, so it is difficult to raise investment capital, especially projects with clean and environmentally friendly technologies with a large total investment, etc. Therefore, coal power should have a system of uniform solutions of many related parties: Government, power and coal enterprises, domestic and foreign financial institutions, etc.

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DEVELOPING GREEN TRANSPORT PROGRAM IN VIETNAM TO COPE WITH GLOBAL CLIMATE CHANGE

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Abstract: *Road freight transportation substantially contributes to the economic development but creates adverse effects on the environment via greenhouse gas emissions, especially carbon dioxide. According to statistics in Europe for example, the period between 2000 and 2015 witnessed a 14% increase in the total road freight and the transport sector accounted for one-quarter of emissions simultaneously. With an increasing worldwide worry about the environmental aspects of carrying freight, a series of Acts and programs regarding green transportation have been issued. Recently, this concern has been mentioned in sustainable development goals introduced by the United Nations. In Vietnam, the development of Logistics and freight transportation have not coincided with adequate measures to alleviate harmful impacts on the environment. In this paper, we study green freight programs and the potential of their application for Vietnam.*

Keywords: *Green freight transport; Logistics; Climate change, CO_2, SDGs.*

1. INTRODUCTION

On 25th September 2015, all members of the United Nations agreed to introduce 17 sustainable development goals (SDGs) which will be expired in 2030. Ending poverty, hunger and combating climate change, etc. are inclusive.

Freight transport plays a cardinal role in the socio-economic national growth; however, it also gives rise to pollution (Facanha & Horvath, 2007; Kellner & Otto, 2012; Zhang et al., 2014). In particular, trucks which take responsibility for a significant percentage of goods emit a substantial amount of pollutants such as nitrogen oxides (N_2O), particulate matter (PM) and carbon dioxide (CO_2), which cause a wide array of health problems not to mention greenhouse effect and climate change (Tu & Tran, 2005; Wright & Fulton, 2005). Notably, greenhouse gases (GHGs), overwhelmed by CO_2 emissions from burning fossil fuels, were not categorized as a pollutant in the classical view; however, by 2009 they, according to the United States Environmental Protection Agency, pose threats to the human health (Demir et al., 2014; Tu, 2010). Thus it is necessary to launch campaigns to boost freight transport in the friendly environmentally and sustainable ways.

The Green freight transport program is the main content of the Green transport program which was established in 2004 in US, under the management and operation of US Environmental Protection Agency (USEPA). The program is designed to encourage goods freight transport enterprises to sparingly, responsibly and effectively use fuel with the aim of reducing the gas emissions causing the greenhouse effect - the main reason of the global climate change due to freight transport. By the support of the US Transport Association, over 600 well-known enterprises, companies and branches in the US such as Wal-Mart, Nike, ExxonMobil, CSX Transportation, Whole Food Market, FedEx, Schneider National, etc. have been taking part in the program up to now. The annual results are remarkable: reducing 33-66 million tons of CO_2 and 200,000 tons of NO_x emissions and a significant quantity of particulate matter (Particulate Matter - PM) per year. The Green Freight Transport Program has been established both widely and deeply all over the world.

The rest of this paper is structured as follows. Because greenhouse gases primarily come from the use of fuel by internal combustions trucks, Sections 2 reviews factors influencing fuel consumptions. Sections 3 analyses contents of Green Freight Transport Program and the potential of its application for Vietnam. The last section provides conclusions.

2. FACTORS INFLUENCING THE CONSUMPTION OF FUEL

According to the rigorous survey of Demir et al. (Demir et al., 2014), there are five factor categories determining how much fuel a vehicle consumes, that is, vehicle, environment, driver and operation. While measuring factors related to vehicle, traffic and environment would be easy and feasible, those with respect to drivers would be much more complex. Operational factors are frequently examined as externalities. Generally speaking, the magnitude of factors vary widely among studies (Marchet et al., 2014; Touratier-Muller et al., 2019). Several main factors are as follows:

2.1. Speed

It is widely accepted that speed is the most important factor. Undeniably, the longer distance always goes with the larger amount of fuel consumption; yet, estimating the emission per kilometer is not a good choice because the fuel consumption at different speed is dissimilar. In a comparative analysis, Demir et al. indicate that a decrease in speed from 100 km/h to 90 km/h witnesses a reduction in fuel consumption by about 0.02 liter per km (Demir et al., 2011). In fact, speed is affected by many other external conditions, such as traffic flows and speed limit (Tu, 2018; Tu & Tran, 2005).

2.2. Traffic congestion

The speed on congested road rarely reached the optimal speed, leading to the large(r) amount of emissions. For instance, travelling on 25 % of total distance in congested conditions leads to an approximately 15 % rise in fuel consumption.

2.3. Drivermm

Speed is determined by the driver based on the particular operational conditions, thus the driver is an important factor. In fact, drivers oversee almost all of the parameters of vehicles (e.g., acceleration, brake, tire, idle time). The difference in fuel consumption between the best and the worst driver is about 25 %. Nevertheless, how to define the quality of drivers' behaviors is relatively questionable.

2.4. Fleet size

Using a vehicle with higher capacity than the amount of good is clearly a waste. A smaller vehicle consumes less fuel than a bigger one because of having a smaller engine. However, at the same (total) capacity, two small vehicles may need more fuel than a larger one. Therefore, choosing the right type of vehicle is important to limit fuel consumed.

2.5. Empty kilometers

The situation at which a vehicle moves without freight is the waste and should be limited as much as possible. Reducing empty kilometers is very important to decrease the amount of fuel consumption. Unfortunately, in many cases it is necessary, for example the distance between the depot and the first customer's place or between the last customers' point and the depot. According to the statistics of the European Union, 23.9 % of total travel kilometers travelled are empty. Interestingly, the share of vehicle-distance in outbound transport is usually lower than the counterpart in inbound transport. Another drawback of empty kilometers is the (unnecessary) burden on both drivers and infrastructure.

2.6. Road conditions

The main characteristic of roads, which generates great impacts on fuel consumption, is the slope. Under the effect of the slope, the wheel horsepower need will go up considerably. To give an evidence, the fuel consumption on a 100 kilometer road may increase up to 6 liters in case the slope rises 1 % (Demir et al., 2011).

2.7. Environmental factors

The role of environmental factors in determining fuel consumption is undeniable. For instance, the consumption can rise by 5% and 10 % if the temperature reduces from 21°C to 10°C and 0°C, respectively. Environmental factors and road surface recently have been looked at in the concept of green corridors (Demir et al., 2014).

3. MAIN CONTENTS OF THE GREEN FREIGHT TRANSPORT PROGRAM AND THE POTENTIAL OF APPLICATION IN VIETNAM

3.1. Developing policies on fuel and exhaust gas management

Transport plays a vital role in the socio-economic national growth; however, it also gives rise to pollution. Especially it is responsibility for air pollution, greenhouse effect and climate change. Thus it is necessary to develop policies and regimes on fuel management; management of exhaust gas from vehicles.

3.1.1. Developing National Technical Regulation on Fuel

The development of National Technical Regulation on Fuel includes: gasoline, diesel fuel and biofuels in order to regulate limitations for technical criteria related to safety, health, environment and requirements for management of fuel quality.

Thereby, in Vietnam, the Regulation QCVN 1: 2009/BKHCN has been promulgated by Minister of Science and Technology on September 30th, 2009 - National technical regulation on gasoline, diesel fuel oils and biofuels (*'Chương Trình Môi Trường Trọng Điểm và Sáng Kiến Hành Lang Bảo Tồn Đa Dạng Sinh Học Tại Tiểu Vùng Sông Mekong (CEP) - Giai Đoạn 2' (Core Environment Program and Biodiversity Conservation Corridors Initiative in Greater Mekong Subregion (CEP) - the Second Phase)*, 2015).

3.1.2. Developing the Standard for control of automobile emissions

The route in application of the Standard for automobile emissions in Vietnam accords with the Standard for emissions in Europe. This is one of the most advanced standard systems, which is widely applied all over the world, including China and ASIAN countries.

The standard for emissions at level 3, level 4 and level 5 is in regard to test method and limitation of pollutants in emissions equivalent to the Euro III, Euro IV and Euro V which are regulated in the Technical Regulation on motor vehicle emissions of Economic Commission for Europe directly under the UN or in the directives of European Union which are applied to motor vehicles newly manufactured, assembled and imported.

The route in application of the Standard for emissions for automobiles which are newly manufactured, assembled and imported in Vietnam must be applied the standard for emissions at level 4 and level 5 as following:

+ The standard for emissions at level 4 from 01/01/2017.

+ The standard for emissions at level 5 from 01/01/2022.

Euro I, Euro II, Euro III, Euro IV, Euro V and Euro VI has been developed in 1991, 1996, 2000, 2005, 2009 and 2014, respectively. The limited concentration of automobile emissions in each new standard is lower than that in previous standard.

Emission pollutants are toxic compounds which directly affect human health and environment for the long time including carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons in general (HC) and Particulate Matter-PM. Typically, out of such emissions, carbon monoxide (CO) is generated caused by the incomplete combustion of carbon-containing compounds.

Methods for determination

In the materials regarding European Standards, the concentration of emissions may varies depending on each method of determination.

- The first method: determining the concentration of emissions under the route of the vehicle in "g/km".

- The second method: determining the concentration of emissions under energy generated by the engine, then the concentration of emissions has its unit of "g/kWh".

Besides a structure of an engine, emission volume significantly depends on factors such as time of itialization, load, velocity, stability of velocity and type of road.

To model the whole impacts of such factors, testers have established two methods including **ESC** (European Steady Cycle) and **ETC** (European Transient Cycle).

ESC is the method of determination which is implemented in a lot of stages. In each stages, both velocity and load of an automobile remain. When moving to another stage, two factors (velocity and load) are changed at random. During the process of implementation, emissions continuously pass through a concentration measuring equipment and the final value is the arithmetical mean of the entire of the stages. The ESC method is suitable to operation conditions in roads which cause little changes of velocity and load.

Unlike the ESC, the ETC method is based on the transient changes of velocity and load. Emissions are collected in a plastic air bag rather than passed through a concentration measuring equipment, then are analyzed after completion of the experiment. ETC is suitable to operation conditions within cities which cause transient changes of velocity and load.

Nevertheless, the route in application of the new standard for emissions only stipulates the emissions of automobiles which are newly manufactured, assembled and imported rather than used ones.

Selecting appropriate transport modes to save fuel

Each regional and national mode of transport in the agreed transport system has its own scope of operation with certain economic efficiency.

Thereby, a reasonable mode of transport not only satisfies the needs of customers, but also saves fuel consumption for transport and reduces emissions to the environment corresponding to the principle of increasing for pipeline transport, waterway transport, rail transport, automobile transport and air transport.

In a long-term planning, the organization of multimodal transport and selection of a reasonable mode of transport towards saving fuels as mentioned above are important solutions to the green transport program.

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3.2. Regarding structure of vehicles

3.2.1. Using aerodynamic shape to reduce air resistance and save fuels

Today, everyone knows that the lower the wind resistance index is, the smoother and more silent the operation is. However, in the early days of the automotive industry, aerodynamic design only played a minor role compared to the technical and economic issues.

The wind resistance index is used to assess the geometric resistance of an airflow to particles moving in it. This index does not depend on the speed of an object but depends on its shape.

Eduard Rumpler, the father of the German aviation industry, is the first man who launched an aerodynamic model of automobiles. His valuable experience gleaned from the automotive industry during World War I helped him convince the entire automotive industry to believe in the outstanding advantages of aerodynamics. In 1921, the first automobile designed by himself with a fallen teardrop shape that made the whole automobile exhibition in 1921 surprised at its wind resistance index of 0.27 while such average index of almost automobiles until 1984 was 0.4. Unfortunately, the difficulties in the development of engines has made the project never become a reality.

One year after the launching Rumpler’s automobile, Paul Jaray received a patent on “an automobile of the future" when he was 33 years old. The young Hungarian engineer has spent most of his time and energy on researching into air resistance, calculating aerodynamic components in order to design a chassis of an automobile that he believed that such automobile would be a design model in the future. The most significant differences of Jaray’s drawing are the design of the front end and the rear end. Regardless of the design of ‘port’ radiator grille of contemporary automobiles, Jaray’s the curved front end helped it smoothly get the opposite air flow causing less air resistance and saving fuels.

3.2.2. Using fuel-saving tires

Currently, many brands have used the technology of fuel-efficient tire production. According to calculation, this new tire type can save 4.0-4.5 % of fuels which contributes to reduce the greenhouse effect and reduce waste to the environment due to its higher durability.

Energy loss in tires is caused by heat generated in the operation. When the tire rolls, its surface is deformed to maintain the contact with the road surface. When leaving the road surface, its shape is gradually recovered. The continuous deformation under a rotary cycle generates heat making the tire hot which is partially dissipated into the environment causing the loss. The energy calculation required to deform the tire is called rolling resistance. Reducing the rolling resistance depends on not only tire surface but also many other factors. “Each element and material of a tire contribute to reduce rolling resistance”, Alessandra Ferraris, R&D Manager in Continental Tires said. If the elements are optimized, the temperature lag and deformation shall be minimum. Mr. Girvin from Michelin Tire brand explained the principle of working as following: “Robber is not a perfect elastic material; its temperature lag is worthy to take interest. If you hold two rubber balls and drop them in turn from overhead down, they shall bounce but shall be always lower than the drop location. This proves the lost energy. In other cases, the balls are nearly close to the ground, its mechanical power is absorbed and converted into heat.”

According to Mr. Berger from Bridgestone, the area of a tire which directly contacts with a road is the most important factor affecting the rolling resistance, making up about 40-50 %. The importance of tire wall and tire casing is about 20-30 %; remaining percentage is belonging to the importance of the rim.

The first generation of fuel-saving tires could be made from super-hard rubber rings. But there were some issues related to traction and vibration-absorbing. It creates pressure on manufacturers to produce new rubber compounds by adding natural and synthetic materials to limit the heat generation without losing the tire characteristics.

With major changes in technology, the current generations of fuel-saving tires have been improved in all of three main working criteria including high performance, high abrasion resistance and good traction (even on a wet road surface).

3.3. Improving the efficiency of exploitation to save fuels

3.3.1. Improving the coefficient of distance with load (β)

Among the criteria of exploitation-engineering of means, the criterion of the coefficient of distance with load (**ß**) and the criterion of the coefficient of load factor **(γ)** are considered as quality criteria, because when such these coefficients increase to the optimal limit (by 1.0), the cost of transport in general and cost of fuels in particular also increase but not significantly.

Thereby, improving the criterion of the coefficient of distance with load (**ß**) through combination of goods and optimization of a route to reduce the distance without goods is a feasible solution to increase the efficiency of means exploitation and to save fuels, contribute to successfully implement the green transport program.

3.3.2. Improving the coefficient of load factor (γ)

Selection of appropriate vehicles with goods; characteristics of the goods transport to enhance the coefficient of load factor within the allowable limitation (γ = 1.0) is to improve the efficiency of vehicle use and save fuels (Tu & Nguyen, 2013).

Distance with load and load factor are main variables in the well-known Vehicle Routing Problem in Logistics (Nguyen et al., 2016).

3.3.3. Reducing empty distance

As mentioned above, an empty distance is the distance that an automobile runs (without loads) from garage to the first place of loading on the route and after unloading (finishing the working shift) and driving back the garage. Reducing the empty distance by reasonable arranging the garage location and appropriate arranging the location of shift handover (in case of many automobiles).

3.3.4. Appropriate organization delivery and receipt of empty containers in ICD (Inland Container Depot)

ICD is a port located inland, without a harbor. Import or export goods (mainly are contained in containers) are unloaded from marine vessels - import goods; or assembled from the factory - export goods - and trans-shipped to ICD to make procedures for import and export. In term of the State management, ICD is a real port, is controlled by customs and customs clearance procedures are performed in the same way as those of other deports.

The organization of the delivery and receipt of container tires at the ICD rather than that in only one deport (commonly applied today) will significantly reduce the distance of transportation of empty containers, reduce cost of freight transport by containers and save fuels.

3.4. Eco-driving skills

Eco-driving skills relate to a method of fuel-saving and smart driving. The eco-driving skills can be applied to all engines of older vehicles. The eco-driving method is easily performed and achieve cost efficiency with the goal of reducing fuel consumption as well as environmental improvement.

Eco-driving benefits to society by reducing environmental pollution, traffic jams and traffic accidents. It also brings financial benefits to society by reducing fuel consumption and saving maintenance costs. Eco-driving is also a way to express the social responsibility of transport enterprises and can be used for the purposes of brand promotion.

Programs on eco-driving training have been held in Europe for about 20 years; in Japan since 2003; in Korea since 2010 and in many other countries.

In Vietnam, such programs shall be deployed at the end of 2015 and held by the Core Environment Program and Biodiversity Conservation Corridors Initiative in Greater Mekong Subregion (CEP) - the second phase.

The elementary content of eco-driving skills is following principles:

- Checking vehicle before driving including: check pressure of all tires in order to ensure pressure under the design (non-inflated tires shall fast become hot and tire explosion and fuel consumption of more than 2.0 %), check aerodynamics of the vehicle;

- Avoiding starting engine too long because newer vehicles do not need to preheat the engine and increase the rotation speed even when the outside temperature is low (it is cold);

- Speeding up (turn the gear) as fast as possible in order to suit to all use conditions;

- Maintaining a stable speed (economic speed); avoid changing speed or braking suddenly, use the highest possible gear to drive uphill and brake by engine and brake pedal to drive downhill.

4. CONCLUSIONS

The Green freight transport program is the main content of the Green transport program which has been established in 2004 in the US, and was designed to encourage goods freight transport enterprises to sparingly, responsibly and effectively use fuel with the aim of reducing the gas emissions causing the greenhouse effect - the main reason for the global climate change due to freight transport.

With global climate change, a high responsibility in front of the international community, freight transport enterprises based on both scientific and practical views affirm that they shall efficiently perform the Green freight transport program in Vietnam, contributing to comply with 17 sustainable development goals (SDGs) launched by the UN.

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RESEARCH TO DEVELOP A MONITORING, REPORTING AND VERIFICATION (MRV) FRAMEWORK FOR GHG EMISSIONS IN THE METALLURGICAL SECTOR

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Abstract: *Monitoring, Reporting and Verification (MRV) of greenhouse gas emissions in the metallurgical sector will support the development and implementation of greenhouse gas (GHG) emission reduction activities and mitigation targets in this sector. MRV implementation will consist of three processes: (i) Monitoring GHG emissions (M); (ii) Reporting the results of GHG emissions (R): and (iii) Verifying the results of GHG emissions (V). In particular, the development of the Monitoring process will include the development of monitoring indicators for GHG emissions from metallurgical activities. Developing a reporting process consists of developing tables and forms and identifying stakeholders involved in data collection and reporting of results. The establishment of the Verification process includes the identification of third parties and the procedure and method of re-examining reported GHG emissions from the metallurgical sector. The study has applied Delphi and MCDA methods to develop GHG emission monitoring indicators; and expert consultation methods for producing the table, report form, and Verification process. The research has created 16 GHG emission monitoring indicators with a bottom-up approach and detail by each metallurgical facility. Nine tables, reports on GHG emissions results, and diagrams describing the roles and responsibilities of stakeholders are recommended in the MRV framework of the metallurgical sector.*

Keywords: *MRV, Delphi method, metallurgical sector.*

1. INTRODUCTION

Climate change is one of the significant challenges in the 21st century. According to the Intergovernmental Panel on Climate Change (IPCC), the key driver of global climate change is the excessive GHG emissions from human socio-economic development activities (IPCC, 2007). Countries need to commit and reduce GHG emissions to stabilize the concentration of greenhouse gases (GHGs) in the atmosphere for human intervention in the climate system. Controlling GHGs has always been the main topic of negotiations at the United Nations Framework Convention on Climate Change (COP) Conference.

There are some requirements for nations to implement GHG emission reduction activities successfully. Countries need to have a detailed GHG emission inventory system and build a baseline GHG emission and develop a national strategy on Measurement, Reporting and Verification for mitigation activities (MONRE, 2015).

The metallurgical industry in Vietnam recently has been rapidly developing in both technology and production. The average energy consumption for steelmaking and metallurgical production in Vietnam is about 3 GJ/t, while the excellent practice is between 2.1 and 2.4 GJ/t worldwide. Therefore, the energy consumption of steel and metallurgical production in Vietnam is about one third higher than the scope of good practice in the world. However, about 50 % of factories in Vietnam are reaching that international good practice standards (Trinh Van Hoan, 2014). Recently, The Agence Française de Développement (AFD) report estimated the potential of improving energy efficiency in the metallurgical sector in Vietnam by 5 to 30%, bringing a significant emissions reduction potential of this sector.

This paper develops an MRV process, including the development of monitoring indicators for GHG emissions from metallurgy; the development of tables and forms and identifying stakeholders in data collection and reporting of results; and the identification of a third party, its procedures and methods for verifying GHG emissions from the metallurgical sector. The study has applied the Delphi method to develop GHG emission monitoring indicators, expert consultation methods for composing tables, report forms and verification process.

2. METHODOLOGY

2.1. Delphi methodology

The Delphi method is a consultation process to reach the consensus of experts on specific issues. The Delphi method is an iterative stakeholder consultation process. Besides, we also use qualitative research methods (which do not contain statistical parameters) to describe the level of consensus on some reports.

There are two ways to use Delphi: the traditional Delphi method and four-stage Delphi (Harold, 2002). The Delphi method is applied in many fields: economy, environment, sustainable development, land use, agriculture, transportation, tourism, climate change, etc. Bunting used the Delphi method to facilitate interactive engagement and reached a consensus in sustainable aquaculture development (Bunting, 2008). In the transport sector, a combination of the Delphi method and the Bayesian Network Model predicts highway accidents in developing countries (Anthony et al., 2016). Seyyed Ali Delbari uses the 2-stage Delphi method and the Analytic Hierarchy Process (AHP) to prioritize critical competitive indicators for aviation services (Seyyed et al., 2016). The future of 3D printing is also consulted with experts using the Delphi method. Eighteen forecasts have been developed to provide future scenarios for the 3D printing industry (Ruth J. et al., 2017). According to Thomas F. (2017), the Delphi method has been used in 1085 articles on nursing research, and 799 papers have been published in nursing journals.

In 2015, Nguyen An Thinh used the Delphi method combined with the DPSIR framework (Divers- Pressures-States-Impacts-Responses) to evaluate climate change adaptation measures of coastal communities. Questions were used to assess the level of consensus among members of the consultative group. The Kendall value calculated after the second round reached 0.681, showing the high level of agreement among the members. The study indicates that sustainable ecosystem development and new rural planning are considered as appropriate local adaptation measures in the study area (Nguyen An Thinh, 2017). Le Trinh Hai and the research team used the Delphi method to develop sustainable development indicators focusing on environmental and health fields, applied for Quang Tri province.

The paper applies the Delphi method with the analysis process divided into three stages: before, during, and after consultation. The consultation process is carried out in several rounds. In the first round, a series of open-ended questions appropriate to the problem is developed and sent to experts for answers to find criteria that can be used to prioritize measures. However, as this priority evaluation is widespread globally, the research will inherit these studies and synthesize general evaluation criteria. Moreover, assessment criteria that are specific and appropriate to national conditions will be consulted by experts on climate change mitigation. After evaluating the criteria, the questionnaire of their importance and suitability will be delivered to experts to assess further and achieve the consent index (Kendall index ≥0.5). The Delphi implementation process to identify specific evaluation criteria is as follows:

a) Before consultation:

Step 1. Selection of expert groups involving into Delphi process:

Ten experts working in climate change mitigation from the Department of Climate Change - Ministry of Natural Resources and Environment, Institute of Science Meteorology, Hydrology and Climate Change, Energy Institute, Energy and Environment Consulting Joint Stock Company, Institute of Agricultural Environment, Ministry of Transport, Ministry of Construction, Ministry of Industry and Trade, etc. were selected in the consultation process.

Step 2. Summary of GHG emission assessment criteria for metallurgical activities and consultation with national experts on some specific criteria of Vietnam. Indicators are divided into six groups:

Group of Emissions from burning fuels in metallurgical activities;

Group of Emissions from steel production processes (non-energy);

Group of GHG emissions from the production of ferroalloys;

Group of GHG emissions from aluminum production;

Group of GHG emissions from lead production; and

Group of GHG emissions from zinc production.

Step 3. Develop criteria table and evaluation criteria matrix according to the Delphi method.

b) During consultation:

Step 4. Application of the Delphi method for the first round:

Meetings and interviews with experts are organized to rank criteria from low to high with increasing importance. Table 1 shows an example of a matrix that evaluates the significance and appropriateness of criteria.

Table 1. Matrix of criteria evaluation according to the Delphi method

	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	...
Expert 1	1	3	4	5	2	6	
Expert 2	3	5	4	1	6	2	
Expert 3	5	4	6	3	1	2	
...	.	.	.	.	.	.	

Step 5. Data analysis for the first round:

After collecting data using Delphi Method, the Kendal coefficient was used to assess the suitability of the indicator. The level of consensus is scored according to the thresholds of 0.0-0.1; 0.1-0.3; 0.3-0.5; 0.5-0.7; 0.7-1.0 (representing very weak; weak; medium; strong; very strong level of consensus). The Kendall coefficient is calculated as follows:

When there are two signs x and y whose values correspond to a set of values of the other sign in the form of statistical distribution, the Kendall coefficient can be used to assess correlation and consensus. Here, experts are independent variables, and criteria are variables classified according to increasing importance.

The Kendall coefficient (W) is calculated by the following formula:

$$W = \frac{S^2}{1/12K^2(n^2 - n)} \tag{1}$$

n is the number of elements x (the number of experts); k is the number of y elements (number of criteria). W has a value in the range (0, 1).

$$S^2 = \sum_{j=1}^{K} (R_j - R) \tag{2}$$

$$R = \sum_{1}^{n} \frac{R_j}{n} \tag{3}$$

R is the sum of the terms for each element of y; R_j is the average of the sum of these terms.

Step 6. Application of the Delphi method for the second round:

In case the Kendall coefficient (W) is more than 0.5 in the first round, the evaluation process ends in step 5: The experts agreed with the proposed index group. In case the Kendall coefficient (W) is less than 0.5 in the first round, the evaluation results will be sent to experts together with more specific questions about the reason and basis of the evaluation in the first round to find out the disagreements between experts. The evaluation process will be repeated until the Kendall coefficient (W) is more than 0.5.

c) After consultation:

After finishing the data collection, the results are analyzed. The weighted value of the criteria will be determined based on the results of rankings evaluated by experts.

2.2. Data

After analyzing and consulting national experts on the six groups of criteria related to climate change mitigation mentioned above, the study synthesized 58 critical criteria divided into six groups and made a questionnaire to conduct a consultation with ten experts.

In the first round consultation, experts evaluated the importance of criteria according to the collected data, ranked from 0 to 5.

Table 2. The evaluation scale of the importance of the indicators

Level of importance	Very important/ Can be collected	Very important/ Hard to be collected	Important/ Can be collected	Important/ Hard to be collected	Less important/ Can be collected	Less important/ Hard to be collected
Scale	5	4	3	2	1	0

Table 3. List of criteria for consultation

Group of criteria on Emissions from burning fuels in metallurgical activities	Unit	Description
M1. Fuel consumption	ton	This criterion monitors and assesses fuel consumption for each type of metallurgy. Fuel consumption is a basic indicator to monitor GHG emissions from fuel combustion of metallurgical activities by Tier 1

Group of criteria on Emissions from burning fuels in metallurgical activities	**Unit**	**Description**
		calculation.
Group of criteria on Emissions from steel production processes (non-energy)	**Unit**	**Description**
M2. Amount of coke smelted for steel production	ton	This criterion is a primary indicator to monitor GHG emissions from coking for steel production by Tier 1 calculation.
M3. Amount of materials and fuels of different types, such as natural gas and fuel oil, are consumed and burned for coking at steel production facilities	ton	This criterion is a basic indicator to monitor GHG emissions from coking for steel production by the Tier 2 calculation method.
M4. The amount of blast furnace gas consumed in coke ovens	m^3 or ton, GJ	This criterion is an essential indicator to monitor GHG emissions from coking for steel production by the Tier 2 calculation method.
M5. Amount of Coke is produced at steel production facilities	ton	This criterion is a basic indicator to monitor GHG emissions from coking for steel production by the Tier 2 calculation method.
M6. The transferred amount of coke oven gas	m^3 or ton, GJ	This criterion is a basic indicator to monitor GHG emissions from coking for steel production by the Tier 2 calculation method.
M7. The volume of by-products from the coking process in steel manufacture is transferred to another facility or factory	ton	This criterion is a basic indicator to monitor GHG emissions from coking for steel production by the Tier 2 calculation method.
M8. The carbon content of input or output material	ton C/unit of material	This criterion is a basic indicator to monitor GHG emissions from coking for steel production by the Tier 2 calculation method.
M9. Crude steel manufactured by Basic Oxygen Furnace (BOF) technology	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 1 calculation method.
M10. Crude steel manufactured by Electric Arc Furnace (EAF) technology	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 1 calculation method.
M11. Crude steel manufactured by Open Hearth Furnace (OHF) technology	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 1 calculation method.
M12. Pig iron production (not used for steel production)	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 1 calculation method.
M13. Direct Reduced Iron production	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 1 calculation method.
M14. Sinter production	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 1

Group of criteria on Emissions from burning fuels in metallurgical activities	Unit	Description
		calculation method.
M15. Pellet production	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 1 calculation method.
M16. Quantity of coke consumed in iron and steel production (not including sinter production)	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M17. Quantity of onsite coke oven by-products consumed in the blast furnace	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M18. Quantity of coal directly injected into a blast furnace	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M19. Quantity of limestone consumed in iron and steel production	Ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M20. Quantity of dolomite consumed in iron and steel production	ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M21. Quantity of carbon electrodes consumed in EAFs	ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M22. Quantity of other carbonaceous and process materials consumed in iron and steel production, such as sinter or waste plastic	ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M23. Quantity of coke oven gas consumed in a blast furnace in iron and steel production	m^3 or ton, G	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M24. Quantity of iron production not converted to steel	ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M25. Quantity of blast furnace gas transferred offsite	m^3 or ton, GJ	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M26. The carbon content of material input or output	ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M27. Quantity of coke oven gas consumed in a blast furnace in sinter production	m^3 or ton, GJ	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M28. Quantity of blast furnace gas consumed in sinter production	m^3 or ton, GJ	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.

Group of criteria on Emissions from burning fuels in metallurgical activities	**Unit**	**Description**
M29. Quantity of other process material a, other than those listed as separate terms, such as natural gas, and fuel oil, consumed for coke and sinter production in integrated coke production and iron and steel production facilities	ton	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M30. Quantity of sinter off-gas transferred offsite either to iron and steel production facilities or other facilities	m^3 or ton, GJ	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M31. The carbon content of material input or output x	ton C/ton of material	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M32. Amount of natural gas used in direct reduced iron production	GJ	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M33. Amount of coke breeze used in direct reduced iron production	GJ	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
M34. Amount of metallurgical coke used in direct reduced iron production	GJ	This criterion is a basic indicator to monitor GHG emissions from steel (non-energy) production by Tier 2 calculation method.
Group of criteria on GHG emissions from the production of ferroalloys	**Unit**	**Description**
M35. Production of ferroalloy	ton	This criterion is a basic indicator to monitor GHG emissions of ferroalloy output by Tier 1 calculation method.
M36. Mass of reducing agent	ton	This criterion is a basic indicator to monitor GHG emissions from ferroalloy production by Tier 2 calculation method.
M37. Mass of ore	ton	This criterion is a basic indicator to monitor GHG emissions from ferroalloy production by Tier 2 calculation method.
M38. Carbon content in the ore	ton of C/ tons of ore	This criterion is a basic indicator to monitor GHG emissions from ferroalloy production by Tier 2 calculation method.
M39. Mass of product	ton	This criterion is a basic indicator to monitor GHG emissions from ferroalloy production by Tier 2 calculation method.
M40. Mass of non-product outgoing stream l	ton	This criterion is a basic indicator to monitor GHG emissions from ferroalloy production by Tier 2 calculation method.

Group of criteria on Emissions from burning fuels in metallurgical activities	**Unit**	**Description**
Group of criteria on GHG emissions from aluminum production	**Unit**	**Description**
M41. Metal production from the Prebake process	ton	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 1 calculation method.
M42. Metal production from the Søderberg process	ton	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 1 calculation method.
M43. Net prebaked anode consumption per ton of aluminum	ton C / ton of aluminum	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M44. Sulfur content in baked anodes	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M45. Ash content in baked anodes	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M46. Paste consumption	ton/ ton of aluminum	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M47. Emissions of cyclohexane soluble matter	kg/ton of aluminum	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M48. Binder content in the paste	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M49. Sulfur content in pitch	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M50. Ash content in pitch	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M51. Hydrogen content in pitch	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M52. Sulfur content in calcined coke	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M53. Ash content in calcined coke	%	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2 calculation method.
M54. Carbon in skimmed dust from Søderberg cells	ton C / ton of	This criterion is a basic indicator to monitor GHG emissions from aluminum production by Tier 2

Group of criteria on Emissions from burning fuels in metallurgical activities	**Unit**	**Description**
	aluminum	calculation method.
Group of criteria on GHG emissions from lead production	**Unit**	**Description**
M55. Quantity of lead produced by Direct Smelting	ton	This criterion is a basic indicator to monitor GHG emissions from lead production by Tier 1 calculation method.
M56. Quantity of lead produced from the Imperial Smelting Furnace	ton	This criterion is a basic indicator to monitor GHG emissions from lead production by Tier 1 calculation method.
M57. Quantity of lead produced from secondary materials	ton	This criterion is a basic indicator to monitor GHG emissions from lead production by Tier 1 calculation method.
Group of criteria on GHG emissions from zinc production	**Unit**	**Description**
M58. Quantity of zinc produced	ton	This criterion is a basic indicator to monitor GHG emissions from zinc production by Tier 1 calculation method.

Source: IPCC Guideline for National GHG inventory, 2016, and 1996 revised versions.

3. RESULTS AND DISCUSSIONS

3.1. List of simplified MRV criteria

The Kendall coefficient is 0.57 from the above-collected data. With the value of more than 0.5, the expert group has a high consensus with the proposed set of indicators, so there is no need to conduct Delphi second round. The shortened set of criteria includes 16 indicators, as shown in Table 4.

Table 4. List of simplified MRV criteria

Criteria on Emissions from burning fuels in metallurgical activities	**Unit**
M1. Fuel consumption	ton
Criteria on Emissions from steel production processes (non-energy)	**Unit**
M2. Amount of coke smelted for steel production	ton
M9. Crude steel manufactured by BOF technology	ton
M10. Crude steel manufactured by EAF technology	ton
M11. Crude steel manufactured by OHF technology	ton
M12. Pig iron production (not used for steel production)	ton
M13. Direct Reduced Iron production	ton
M14. Sinter production	ton
M15. Pellet production	ton
Criteria on GHG emissions from the production of ferroalloys	**Unit**
M35. Production of ferroalloy	ton
Criteria on GHG emissions from aluminum production	**Unit**
M41. Metal production from the Prebake process	ton
M42. Metal production from the Søderberg process	ton
Criteria on GHG emissions from lead production	**Unit**
M55. Quantity of lead produced by Direct Smelting	ton

M56. Quantity of lead produced from the Imperial Smelting Furnace	ton
M57. Quantity of lead produced from secondary materials	ton
Criteria on GHG emissions from zinc production	**Unit**
M58. Quantity of zinc produced	ton

Source: Synthesizing from interview results

3.2. Forms of data and reports on GHG emissions for the metallurgical sector

Information on group inventory and measurement of GHG emissions

Establishing a GHG measurement and inventory group is essential when implementing emission reduction programs and projects and implementing MRV. The members of the group may be officials of the enterprise, may have additional support from external experts, or maybe a third party. The size of the group depends on the size of the business. For large enterprises, the GHG measurement and inventory group should include representatives of the management board and other managerial departments. For smaller organizations, the team may consist only of the management representative and the manager of the production. Team members must hold regular meetings, have open and creative discussions, review and re-evaluate the current technology and management process, and be capable of applying mitigation ideas.

In steel and metallurgical plants, the members of the GHG emission measurement and inventory group should be considered, including managers, accountants, and engineers, etc. Inviting additional financial staff and non-business consultants is also an appropriate way to collect better objective ideas. The GHG emission measurement and inventory groups collect necessary production information of the enterprise for joint analysis with group members. The data collected may use the Reporting Form No.1.

The measurement and inventory of GHG emissions require background information based on several existing documents, records, and reports of the enterprise. The checklist in Reporting Form No.2 helps the team consider the availability of data.

Table 5. Reporting form No.1: Basic information

<table>
<tr><td colspan="6">Name and address of enterprise</td><td colspan="2">Number of working day per year:</td></tr>
<tr><td colspan="8">Information of greenhouse gas emissions measurement and inventory group</td></tr>
<tr><td colspan="4">Name</td><td colspan="2">Role - Department</td><td colspan="2">Role in group</td></tr>
<tr><td>1
2
3</td><td colspan="3"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="8">Basic production information of the business</td></tr>
<tr><td colspan="2">Main products</td><td colspan="2">Designed capacity (ton/year)</td><td colspan="4">Actual capacity (ton/year)</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="4"></td></tr>
<tr><td colspan="8">Raw materials used</td></tr>
<tr><td rowspan="2">Main materials</td><td rowspan="2">Scrap steel
Pig iron
FeMn
FeSi
Other (specify</td><td colspan="2" rowspan="2">ton/year</td><td rowspan="2">Auxiliary materials</td><td rowspan="2">Electrode
Slag substance
Furnace material
Golden sand
Grease
Other (specify)</td><td colspan="2">Quantity</td></tr>
<tr><td>kg/year
kg/year
kg/year
kg/year
kg/year
kg/year</td><td></td></tr>
<tr><td rowspan="2">Water and energy</td><td rowspan="2">Country
Charcoal
electricity
Gas
Oxi
Other (specify)</td><td colspan="2">Quantity</td><td rowspan="2">Equipment</td><td rowspan="2">Furnace
Refining furnace
Casting machine</td><td colspan="2">Capacity</td></tr>
<tr><td>m^3/year
m^3/year
tons/year
Kwh/year
kg/year
kg/year</td><td></td><td>tons/hour
tons/hour
tons/hour</td><td></td></tr>
</table>

Source: Developing from Guidelines for cleaner production for steel and metal casting sectors.

Table 6. Reporting form No.2: Availability of data

Data	Yes/No	Source and accessibility	Note
Floor plan			
Output records			
Profile consumption			

Data	Yes/No	Source and accessibility	Note
materials			
Profile consumption of water and energy			
Technological scheme			
Energy balance			
Equipment maintenance records			
Environmental status profile			
Technology information: - Process of operating electric arc furnace - Operating process of casting machine			

Source: Developing from Guidelines for cleaner production for steel and metal casting sectors.

Note that many enterprises do not have enough initial information, and the team members will discuss how to collect additional data. Only documents that reflect the current production status are of high value in assessing economic, technical, and environmental efficiency.

Analysis of stages and assessment of emissions

Once all essential information about enterprises, the GHG emission measurement and inventory group collected, it is recommended to describe the current production process in the common language by listing all steps in the process. The team needs to survey to identify the technology information and find obvious improvement opportunities, which are easy to do as a starting point for the evaluation. This is an opportunity to review the production process, identifying the flow of raw materials, determining emissions, and re-evaluating losses.

It is necessary to survey each factory in turn, according to the technological process and operation regulations, from the stage of data entry, material preparation, metallurgy, casting, warehouse to boilers review and electrical systems, etc.

During the survey, the team should record the following essential information:

- Inputs and outputs of each stage (see Reporting Form No.3). For the production, it is required to specify the type of emissions as Solid (S), Liquid (L), or Gas (G)
- Observations on the waste of materials at each stage (Reporting form No.4). These are initial observations, and the team will continue to explore opportunities for improvement. For steel production enterprises, the limitations of the management process and compliance with operation regulations are one of the leading causes of raw material losses
- Expenses for primary raw materials and materials (Report form No. 5), recording the prices of raw materials and the fuel used as the basis for calculations

Table 7. Reporting form No.3

Stage	**Input**		**Output**		
	Main material		Name and type of emissions		
	Material	Fuel	Solid (R)	Liquid (L)	Gas (K)
Stage 1					
...					

...	
Auxiliary equipment	
Processin g system	

Source: Developing from Guidelines for cleaner production for steel and metal casting sectors.

Once the group identifies the necessary input and output flow of the production process, it is recommended to name the technology step according to the nature of technology (such as "processing" or by equipment such as "electric arc furnaces"). At the next step, details of stages such as the transition process between stages, technology stages, and emissions, should be listed in detail.

Table 8. Reporting form No.4: Current situation of internal management

Area	Data
Resources	Arranging ground to receive materials
	Sorting and transporting materials
	The spilled material
Electric furnace	Layout plan
	Equipment maintenance
	Feed, control tempering temperature, remove liquid steel
	Heat loss / emissions
Refining furnace	Adjust chemical composition
	Temperature homogenization
	Eliminate impurities
Foundry	Loading materials, operating procedures, products
	Handling and storage of products
	Amount and nature of cooling water
Auxiliary	Overflowing water
	Water temperature after cooling
	Furnace

Source: Developing from Guidelines for cleaner production for steel and metal casting sectors.

The observations given are not critical (e.g., the cooling water has not been fully recovered) but needs to be observable (water overflow in the cooling tower). This will support mitigation measures.

After the observations, it is possible to come up with mitigation measures. These are exact display solutions that have not been previously considered for the operation. The participation of external experts in this step is incredibly effective.

Experienced operation control and site management in steel mills is often overlooked and is the most specific, most attractive part of starting the approach to reducing emissions. Moreover, many mitigation options have been identified as those that can be implemented for short periods of time, at low cost, requiring only minor device changes or improvements in maintenance. The application of these measures has been proven to be a good start for efforts to reduce plant GHG emissions, encouraging managers and officials to conduct mitigation assessment.

Table 9. Reporting form No.5: Cost of input materials

Names of raw materials and fuels used	**Unit**	**Cost VND/unit**	**Used quantity tons/year**	**Used quantity unit/ton of product**	**Cost VND/ton of product**
Scrap metal					
Pig iron					
FeMn					
FeSi					
Al					
....					
Electricity					
Water					
Gas					
....					

Electrode
Fluxes
Coal dust
Refractory materials

Source: Developing from Guidelines for cleaner production for steel and metal casting sectors.

The above table only covers costs for the main fuel. This is the basis for measuring program effectiveness, and partly shows the correlation rate between materials. The overall picture of overall production costs is complemented by the cost of human resources, energy, and the operation of an environmental treatment system.

Prepare production line diagram

The preparation of production line diagrams and technological process diagrams is an essential step in measuring and inventorying GHG emissions. The block diagram of a production line consists of production steps (not by device name) with input, output, waste, and emissions streams. Every used material should be included in this diagram because it will remain in the product or lose in the waste stream. Seldom used raw materials should also be named. Although the GHG measurement and inventory team is familiar with the technology line, it may be necessary to conduct a site visit a few times before reaching an agreement on the production line diagram used for measuring and inventorying GHG emissions.

With large scale production or pilot MRV implementation, a detailed production line will be built for the selected area for deployment. This must be the largest polluting area. Enterprises producing steel by electric arc furnaces have simple production lines. The application of MRV is usually carried out on the whole line, or with steel refining at electric arc furnaces.

The best technology scheme should achieve the following points:

- The production steps are described
- A list of input and output materials: The input materials are on the right, the output materials are on the left of the production description.
- Include material recovery and reuse
- Material balance

Material balance is a tool to record the materials used at each step of production quantitatively. Good material balance plays a vital role in measuring and inventorying GHG emissions because it can quantify unknown losses or emissions. A good fuel balance also supports the benefit-cost assessment of mitigation measures. The basic principle of material balance is that the material that goes into the production process will have to exit the products at some point, in some form. Materials can be balanced in one of the following two ways:

- o Overall balance: used for all types of raw materials and materials into the production line. The balance is carried out through each stage with the change of all components involved in the production line.
- o Component balance: only used for a valuable material or component. Track changes in this component on every stage.

Reporting Form No.6 can be used to record the material balance. There are two ways of recording the material and material balance: by table or by technological process diagram. When using technical process diagrams to record the proportion of raw materials and materials, the composition and concentration of each input and output material type must be clearly stated. Material balance can be based on daily, monthly, or annual measurements.

No balance is perfect. When combined data of each stage and the overall data of the whole step will appear errors due to the inaccuracy of the data because the sum of much small waste streams is not included, such as evaporation, spillage etc. The purpose of material balance is to find the most massive waste streams to focus on minimizing.

Table 10. Reporting form No.6: Material balance

Stage	Input		Output		Emissions		
	Type	Quantity	Type	Quantity	Liquid	Solid	Gas
Stage 1	Materials...		Product 1		Liquid	Solid	Gas
	Materials...				1.1	2.1	3.1
	Fuel...					Solid	
	Fuel...					2.2	
Stage 2	Product 1		Product 2		....	....	....
	Materials...						
	Fuel...						

Source: Developing from Guidelines for cleaner production for steel and metal casting sectors

Data used in material balancing can be collected from a bookkeeping or direct measurements. The used data should be converted to the same production unit. Particularly for the powder must be converted in absolute dry form to avoid moisture from different raw materials.

Ideally, the discharge data in the material balance should be accompanied by additional material parameters or a new modified form of materials lost according to the waste stream, to facilitate the determination of waste stream costs in the next step.

Each waste stream should be numbered (e.g. L1, L2, L3 for liquid waste, G for gas, and S for solid) to facilitate cost identification and subsequent cause analysis.

3.4. Verifying process

Verification is a process that verifies the authenticity of the data and description for a GHG inventory report and is closely related to the methods and content of inventory. The verification process can be done once or in different stages.

The verification process mainly includes reviewing documents and inventorying GHG emissions at the facility. The MRV system needs to specify or require a sampling plan for sampling businesses by region.

The verification process can be divided into three basic steps: preparation of verification, verification at the facility, preparation, evaluation, and submission verification reports.

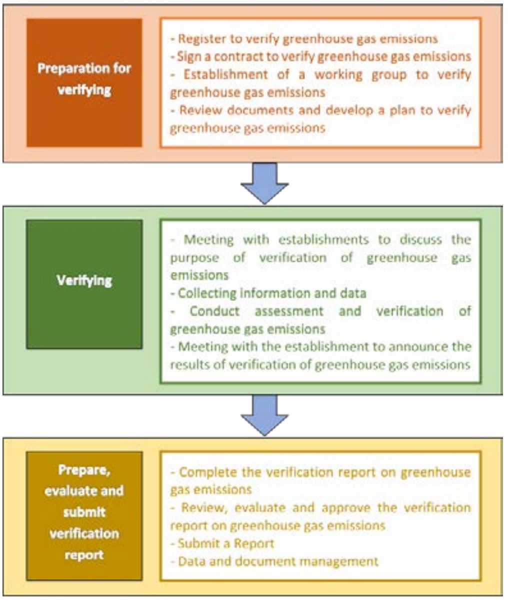

Fig 1. Verifying process for GHG emissions from the metallurgical industry

4. CONCLUSION

MRV is widely used in many cases for a variety of purposes. MRV is also a fundamental element of the governance system of actions developed throughout history, particularly in systems that tax production processes, such as agriculture, industry, and trade. The proposed national MRV framework is based on top-down or bottom-up approaches. In which the integrated MRV system includes multiple reporting categories for different levels (central and local). The central government is responsible for reporting and verifying activities, focusing on one or a specific group of policies, actions, or areas. Therefore, the development of an appropriate MRV system requires a detailed analysis of the approach in designing the institutional structure and guidelines for MRV.

The report has developed an MRV process for reducing GHG emissions in the metallurgical sector by analyzing the appropriateness of current measurement measures in various types of metallurgy and identifying a practical institutional framework including related entities and human resources. The necessary resources, the political system, regulations, and procedures are essential for developing an effective MRV system. The report has also designed data forms and reports on GHG emissions for six types of metallurgy and set up a process to appraise GHG emission inventory reports for six kinds of metallurgy. This will be an essential source for proposing a roadmap to reduce GHG emissions for the metallurgical industry.

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MISCELLANEOUS

A DISCUSSION ABOUT THE VALUATION METHODS FOR GLOBAL GEOLOGICAL PARK

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Abstract: *The global geological park definition has been introduced and developed by the UNESCO Geological Park Program for 20 years. By 2018, the geological park network involved about 200 parks. The glocal geological park not only bears the geological significances, but also carries the ecological, archeological, historical, and cultural values of the area. Furthermore, it contributes to the socio-economic and environmental development of the country. However, the global geological park is a special type of property. Hence, assessing it is necessary for the authority to identify and serve management purposes. The evaluation can be accomplished by using multiple methods, such as renewable/regenerating costs-approach (cost-based approach) and capitalizing method (income-based approach).*

Keywords: *Global geological park; evaluating/ measuring/ assessing method(s)*

1. BACKGROUND

A geological park is a unique natural area with clear boundaries and contains a collection of geological heritage that has multiple scientific values. The park is allocated within a certain geographic range and in harmony with the surrounding landscapes. It also has biological diversity, archeological values, historical values, and socio-cultural values. A geopark usually has a large area so that we can develop economic activities, such as tourism and other ancillary services. If a national geological park meets all requirements of UNESCO's program, it will be eligible for a global geological park title.

After about 20 years of implementing UNESCO's program, the global geological park network has grown significantly with about 200 parks by 2018. Examples of countries that have several global geological parks involve China, Italia, United Kingdom, Spain, and Japan, etc. In Vietnam, there are 2 global geological parks, which are: Dong Van stone plateau (Ha Giang), which was granted in 2010, and Non Nuoc Geological Park (Cao Bang), which was recognized in 2018; besides, there are many other potential areas to become global geological parks.

The geological park not only bears geological significances, but also has ecological, archeological, historical, and cultural values. Furthermore, it contributes to the socio-economic and environmental development of the locals. The potential benefits of the geological parks include: boosting tourism, creating new jobs, promoting the awareness of the geological environment, and protecting the local and national critical areas. For instance, the Dong Van stone plateau was granted the global geopark title by UNESCO in 2010 and re-admitted in 2014. From 2015 to 2018, the number of visitors, especially international tourists, at the geological park increased dramatically. In 2015, this geological park welcomed over 300,000 tourists; by 2018, the number of tourists increased to 1.13 million with approximately 300,000 foreign visitors, and total revenue from tourism was around 1,000 billion Vietnam Dong (Hoang M. Nguyen, 2008). Along with the development of tourism, local living quality has been improved significantly. Handicraft products and agricultural products, such as vegetables, fruits, cattle, pigs, and chicken, etc., have grown strongly. Notably, there is an increase in the connectivity between the local farmers' agricultural products and other markets through visitors' recommendations and businesses.

Thus, the benefits of the global geological park toward socio-economic development are shown through both direct and indirect quantitative indicators. However, how much weight, in particular, these values can be quantified? It is necessary to answer this question to serve well the management purposed, which include: dividing benefits to different localities (involving the landowners' interest in these countries that allow private-owned lands) that geographically have parts of the park, assigning management rights and duties, creating tax policies and fees on using natural resources, managing the environment, and using as a reference for further investment and developing plans on other global geoparks. However, the reference purpose has yet been fully aware by Vietnamese researchers. Thus, this matter should be taken in further considerations.

2. AN OVERVIEW ABOUT THE METHODS TO EVALUATE A REAL ESTATE

In the world, many authors are giving different concepts on this matter; for example W. Seabrooke at University of Portsmouth, United Kingdom, Fred Peter Marrone-Marketing Director at AVO (Association of Valuation), Australia, and Lim Lan Yuan at National University of Singapore, etc.. In general, real estate evaluation is a monetary task that requires the highest confidence level due to the benefits toward certain subjects at a given time.

The Law of Pricing, under the Constitution of the Social Republic of Vietnam-Chapter I, Article 4, stated 'Evaluation is a compulsory task that is executed by the Government agencies, production and trading organization or individuals to establish prices for goods and services,' and evaluation is a particular form of pricing, 'Pricing appraisal task belongs to the agencies or the organizations who have appraisal functions; the prices are determined through the monetary value of the assets in accordance to the Civil Law as at a certain range of market price, at a given time and venue, for a certain purposes.' (Wikipedia) . The properties include real estates and mobile properties.

Nevertheless, scientists have pointed out a few methods to evaluate the real estate based on different aspects:

2.1. Market-based approach

This approach requires the willingness of both suppliers and purchasers and the available information about similar real estate on the market. The value of the property should be appraised based on the recent trading transaction of other similar properties on the market. As a reference, the evidence of these transactions needs to be customized in order to serve the current scenario.

This approach involves either direct comparison method or similar-transaction value method and sometimes combines both direct comparison method and cost-based approach into a complex form, called deduction method.

The advantages of these methodologies involve (1) minimal technical difficulties as there is no fixed model or formula while only concludes the signals through past transactions on the market and (2) market responses-there is evidence that demonstrates the current practices at the real estate market. On the other hand, the limitations are: (1) The comparison method is inappropriate unless the similar real estates traded are in the same area. The fewer references are available; the less accurate the comparison is, and (2) The available information is considerable history; once the market fluctuates, this information quickly becomes obsolete; thus, the accuracy drops.

2.2. Cost-based approach

This approach is based on the amount of money spent to create a real estate in history or in the future. The value of the real estate is determined based on the costs of building a property with similar or identical functions and depreciation of the property that is required to evaluate.

This approach includes the cost-based method (renewable costs or replaced costs) and sometimes combines with the comparison method to create a more complex form, called deduction method.

The advantages of these methods are: (1) applicable even when the database about market responses is unavailable; thus, they are instrumental to evaluate those properties that barely change the owners or those that are in shortage of evidence to forecast future benefits, (2) applicable for a newly created property or for pricing a new building, and (3) available as the last resource when other methods are invalid. However, the limitations are: (1) Similar to the direct comparison method, cost-based method shows flaws if the market data is minimum, (2) costs are generally not equal to the property's value and naturally cannot create any values, and (3) The nature of discount is subjective and difficult to estimate.

2.3. Income-based approach

This approach is based on the current principle of the real estate value that is equal to the present value of the future income from that property. If the future income from the real estate is forecasted, the value of the real estate can be relative to the total converted values of future earnings to the present ones.

This approach includes various methods, such as the direct capitalization method, the discounted cash flow method, and the investment method.

These methods have the following advantages: (1) Theoretically, these methods have the most rigorous theoretical basis, since they directly approach the potential benefits that can be brought by the real estate, and (2) The future earnings can be predicted with highly accurate level. However, there are disadvantages: (1) Several factors that affect the future cashflow are required to be adjusted before make forecasts based on the similar scenarios, and (2) The evaluation result is highly sensitive to a single change at any parameters; thus, the result is subjective to forecasting.

3. APPLYING REAL ESTATE ASSESSMENT METHODS FOR ESTIMATING THE VALUES OF A GLOBAL GEOLOGICAL PARK

3.1. A management viewpoint

None of the mentioned methods are uniquely correct. In real-world situations, we conclude and apply the most appropriate method while the others are supplemental and used as a cross-check on the evaluation outcomes.

To select the most appropriate assessment method, we need to consider the following factors: (1) the characteristics of the property, (2) the reliability and usability of the actual materials, (3) the objectives and pricing principles, and (4) the pros and cons of each method.

By applying the viewpoint above to measure the global geological parks, we can conclude the following points:

+ The properties of real estate:

- The global geological park is an exclusive real estate indeed, which presents as a unique natural area, containing a collection of geological heritages that have scientific values, are harmonized with the local landscape, and contain biological diversity, archeological values, historical values, and socio-culture.

- Each geological park has exclusive characteristics. Currently, there are 8 types of geological park, which involve: (1) karst geological parks at karst island, (2) mountain and volcanic parks, (3) island, lagoon, downstream river, and ocean geological parks, (4) delta river parks and river systems, (5) tectonic and structural geological parks, (6) paleontological and mineral parks, (7) petrographic parks, and (8) semi-dry to dry geological parks.

- The global geological park has a large area and possibly includes several administrative units under state management.

- The global geological parks contribute to the development of the socio-economics and the environment of the locality through boosting tourism, creating new jobs, promoting people's awareness of the geological environment, and protecting the national significances.

- The global geological park can sustainably exist if we protect it, and it will bring us sustainable socio-economic and environmental benefits.

+ The actual materials:

- All countries and localities need to carry out a master project to synthesize and propose a combination system of science and legal to identify, classify, and evaluate the geological heritage, thus, establish the geological parks. In particular, the geological heritage can be identified into the following categories: the paleontology, the geomorphology and caves, the environmental stock, rocks, stratigraphy, minerals, the geological economy, the tectonics, the cosmic, and the continental and ocean geological cores. Each geological heritage will be assessed based on 6 criteria, including the scientific and educational values, the geological diversity, the value of the aesthetic landscape, the cultural, social, and historical values, threats, and conservations, and based on quantitative tests at international, national, and local levels.

- All countries and localities are required to apply and file documents for their geological parks prior to submit it to the UNESCO Committee to review, appraise, and recognize the parks as per administrative procedures. A title granted is valid for 4 years, and this title will be re-recognized by the expert if the filings meet the evaluation requirements.

- The UNESCO Geopark program has been introduced recently; many countries are currently working hard to implement such program. Therefore, the transferring and trading activities related to the geological parks have yet been regular on the market.

Based on the mentioned factors, in combination with the advantages and disadvantages of each evaluation method, it is possible to apply either the cost-based approach or the income-based approach to assessment a global geological park, thus, serve the management purposes.

3.2. Evaluate a global geological park by the cost-based approach

Evaluating a global geological park by using a cost-based method is to renew costs in real estate evaluation. Renewable costs are expenses that are reimbursed as at the time of property assessment to build a prototype.

For a geological heritage being recognized as a global geological park, it requires close collaboration between the central state and local authorities in every country and the scientists, research agencies to deliver multiple missions, including:

a) Executing scientific research activities on geological heritage conservation, development, and management. Particularly to:

- Conducting research and concluding domestic and international experiences in preserving and promoting the values of the geological heritage and the geological parks;

- Creating scientific criteria set and the procedures, measuring, classifying, and recognizing the geological heritages and the geological parks; establishing the scientific foundation to construct and adjust the overall plan for the geological park network development and the sustainable development plan for the global geological parks; identifying the appropriate scientific and technical solutions to rationale the usage of natural resources in general and the geological resources in particular;

- Researching to evaluate the geological heritages;

- Recording the identification, assessment, and classifications of geological heritages and the global geological parks.

b) Improving the institutions and policies on the conservation and rational usage of geological heritages and global geological park of the whole country.

- Building up the legal base for the conservation, the rational usage of geological heritage, the development, and the management over the global geological park network;

- Designing conservation and reasonable utilization plans over the geological parks in some regions and liaising with the local socio-economic development plans.

c) Promoting and emphasizing education about the global geological parks;

d) Strengthening international cooperation, taking advantage of the technology sponsored by other countries and international organizations to carry out the conservation of geological heritage and develop and improve the management over the global geological parks.

To execute the project, it requires huge funds from the government's fundings, investment/sponsors by the domestic and foreign organizations or individuals. These funds will be used to pay salaries for the experts and the workers who participate in the project, material costs, machinery and facilities, and management costs, etc., according to the project plan. Once the project is completed, the receiving funds will continue to be used to cover the documentary costs, assessment records, and other administrative procedures to accredit the global geological parks. Therefore, it is significant to convert these future costs into the current expenses through:

- For those works with cost components being estimated in detail, based on the volume of the works that have been completed or finalized the expenses, recalculating these costs according to the current rate of hiring experts and workers, leasing equipment and buying supplies.

- For some general management tasks and administrative procedures, the costs cannot be separated into components; thus, adjusting these costs to the current rate based on the national annual price index.

Total adjusted costs of all project work and administrative procedures are the values of the global geological park by using the regenerating costs method.

3.3. Evaluate a global geological park by the income-based approach

The nature of this approach is to turn the future income into that at present to define the value of the real estate. It is expressed through the following formula:

$$PV_0 = \sum_{t=1}^{n} \frac{I_t}{(1+i)^t} \qquad (1)$$

In particular:

PV_0: The present value of future income, also being known as the value of the real estate

I_t: Investor's future income from the real estate as at year t

i: The current rate

n: Duration to receive income (by year)

The income from real estate is very diverse; however, it can be categorized into two groups as the following:

- Direct capitalization method: applied in the case at which the income from real estate is relatively stable (remaining unchanged or changing within a certain proportion) throughout its useful life or at which the real estate is permanent

- Discounted cash flow method: applied when the income from real estate varies over different periods (unstable)

Given the characteristics of the aforementioned global geopark that useful life is permanent and that the annual income through tourism activities is relatively stable (predictable), the direct capitalization method will be more appropriate than the discounted cash flow method.

* In case of a stable future annual income:

$$PV_0 = \sum_{t=1}^{n} \frac{I_t}{(1+i)^t} = I.\sum_{t=1}^{n} \frac{1}{(1+i)^t}$$

When t → +∞, we have:

$$PV_0 = \frac{I}{1+i} . \frac{1 - \frac{1}{(1+i)^{+\infty}}}{1 - \frac{1}{1+i}} = \frac{I}{i} \quad (2)$$

* In case of a stable increase in annual income:

$$PV_0 = \frac{I_1}{i-k} \quad (3)$$

With: $I_1 = I_0(1 + k)$ (4)

In particular:

PV_0: Value of the global geopark

I: The stable annual income threshold generated by the geological park. I_0: The income as at the current year.

The annual income (I_0 or I) is determined as below:

$$I = TR - C1 - C2 \quad (5)$$

TR:The average differences in the annual revenue from tourism before and after the introduction of a global geological park (according to the local's actual statistics)

C1:The investment costs to complete the facility system at the tourist attractions in the global geological park area (according to the economical life of the project)

C2:The annual expenses to operate tourism (according to the actual statistics from traveling companies).

i: The capitalization rate, determined by one of the 3 following methods:

- *Compare the capitalization rate of various real estates on the market;*

- *Based on the average interest rate of the State treasury bonds at different periods;*

- *Analyze loan - capital equity: Based on the average weight of the capitalization rate for loan i_m and the capitalization rate for equity i_e, in which the average weight involves mobilizing capital from different sources to invest in the global geological parks.*

$$i = M \times i_m + (1-M) \times i_e \quad (6)$$

In particular:

i: The capitalization rate

M: The loan rate on total investment capital

(1-M): The ratio of equity to total investment

i_m*: The capitalization rate for loan*

$$i_m = \frac{\textit{Annual payment for both principal and interest amounts}}{\textit{Total principal loan}} \quad (7)$$

i_e*: The capitalization rate for equity:*

$$i_e = \frac{\textit{Annual return on equity}}{\textit{Total equity}} \quad (8)$$

k: Rate of increasing annual income (k<i)

4. CONCLUSION

Assessing the global geological park is necessary for several management purposes, such as the beneficial purposes at local levels (including the benefits of the landowners at these countries that allow individuals to own land privately) that have authority over the property areas belonging to the geological park, to grant and assign the management rights to companies/agencies, etc., and for reference purposes for further investment in other global geological parks. As a permanent real estate, the global geological park can be assessed by two methods, which are regenerating costs and capitalizing cash flow.

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BUSINESS COMMUNICATION AT VIETNAM OIL CORPORATION (PVOIL) - THE STATUS QUO AND SOLUTIONS

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Abstract: *In the course of production and business activities, PetroVietnam Oil Corporation always considers communication activity as an important tool to achieve the goal of becoming a leading brand in Vietnam in the field of import-export operation, processing and trading of petroleum products. The role of communication activities was further emphasized by PVOIL after the Decree 83/2014/NĐ-CP on the petroleum business was issued with new points to increase competitiveness in the market, threatening the position of PVOIL. In recent times, communication has been promoted and implemented synchronously in the whole Company in public communication, internal communication, and resolving communication crises. Many communication tools have been flexibly applied to achieve the highest efficiency, such as press, websites, fan page, point-of-sale communication or social propaganda activities. As a result, the position of PVOIL has increasingly enhanced; production and business activities have obtained many good results. Besides the achievements, the limitations of communication operation and their causes are indicated in this paper. Some proposals are also given to improve further the effects of this work at PVOIL in the future.*

Keywords*: PVOIL, corporate communications, communication reality, communication solutions*

1. INTRODUCTION

On September 3rd, 2004, the Gorvernment promulgated The 83/2014/NĐ-CP Decree on petroleum business with many new noticeable points, such as cutting down on business investable conditions, creating a level playing field between State enterprises and Private enterprises, expanding the involved elements in the petroleum business. As of 2014, our country has had 18 traders engaged in petroleum import and export, along with 29 traders who are eligible to participate in the segment of petroleum distribution. Obviously, the release of this Decree with wide-open provisions will facilitate many organizations to participate in the petroleum business, which will increase competitiveness in this market and put great pressure on Petrolimex, PV Oil. Mipecorp, etc.

Facing this situation, right after the 2nd Party Congress of Vietnam Oil and Gas Corporation, in the 2015-2020 term (on April 3rd, 2015), PVOil's Board of Directors agreed to promulgate a Resolution on the implementation of urgent solutions to stabilize the situation, ensure the growth and maintain the development. The Resolution emphasized that communication and corporate culture need to be strengthened in this new period and considered it an important tool in the Corporation's development strategy. Therefore, PVOil has set very specific goals in communication, for examples: creating awareness and attention of partners and customers; providing information to related parties about the products and services so as to consolidate and position PVOil brand in the petroleum trading market and also keep up the production and business activities, especially in developing new products and services.

After 5 years of putting this Resolution into practice, the Corporation and its member units have achieved some commendable successes and, at the same time, drawn many valuable lessons in corporate communication. However, the communication activities at PVOil still faces certain difficulties, so it needs to be more reinforced and strengthened in order to reach higher efficiency in the future.

2. THEORETICAL BASIS OF COMMUNICATION ACTIVITIES IN ENTERPRISES

Corporate communication is a collection of all propaganda and information transmission activities that come from businesses to different subjects, such as the public, potential customers, partners, competitors and even employees in the enterprise. Accordingly, communication activities within enterprises can be divided into two main parts with two different purposes: external communication (public communication) and internal communication.

External communication activities are used to promote the company's image, brand, products or services to the outside public by applying media such as television, newspapers, signs, websites, social networks, advertising videos, etc., to attract customers' attention. Besides, organizing or participating in seminars, charities, sponsors, events or social security programs for the community… are also effective ways to use public communication for enterprises.

Besides external media, *internal communication activities* also need to be focused because it helps build and maintain relationships between the company members. It also supports the leaders to convey their message to employees in the business so that they are aware of the importance of their contribution, which will help the company achieve its goals soon. Internal communication can be done via some popular media such as e-mail, website, internal radio publications, message boards, face-to-face meetings or speeches, soliciting opinions, frank exchange between leaders and employees, internal gameshow and rewarding or collective training sessions.

Social media crisis is also a big concern to all enterprises in communication activities because of its seriousness. When there is a crisis, enterprises need to handle it flexibly to avoid adverse effects on the enterprise's image and reputation. Many businesses apply the following ways to deal with media crisis: quick crisis-causing issue assessment and then responses to the relevant subjects' questions will be given; besides, a positive and honest attitude is needed; consulting experts about crisis settlement; and most importantly, a methodical plan to prevent the media crisis.

3. THE STATUS QUO OF BUSINESS COMMUNICATION ACTIVITIES AT PETRO VIETNAM OIL CORPORATION

While the level of competition in the petroleum business is increasing, the view of Petro Vietnam Oil Corporation towards the communication is becoming more necessary because it will give effective support to the production and business activities and the development goals of the Corporation in the future. In reorganizing and restructuring the operating apparatus, the Communication Department under the Office of the Corporation was established, which carries the task of advising and assisting the General Director on business communication. Communication activities at PVOil focus on three points: public communication, internal communication, and dealing with social media crises, which aim to provide complete, accurate, and timely information through the media. From there, the prestige, image and trademark of the enterprise can be protected and enhanced. Also, the untrue and negative information should be minimized to avoid a bad effect on the Corporaion and its affiliates's operations. By optimizing and concentrating the resources, creating a systematic connection, the enterprise can improve communication activities' quality and efficiency with the motto "Communication is one step ahead". Up to the moment, PVOil has been carrying out a variety of communication activities which is suitable for each stage and each situation to achieve the proposed target.

3.1. Public communication activities at Petro Vietnam Oil Corporation

In communication activities, PVOil always considers public relations as the most important promotion tool due to its goal, which can change the awareness and establish and exploit relationships with external organizations and individuals related to the activities of the Corporation and its member units. The Corporation has already determined that this is a difficult task because the external communication objects are diverse and plentiful. They could be any social organizations, the media, the financial community, the local public, intermediaries, distributors, customers, etc. Therefore, it is necessary to have different interaction methods towards each object to achieve the highest communication effect. In the past time, PVOil has implemented a lot of media activities to introduce, propagate and promote the image and the products of the Corporation to the public with many different tools and get some good results. Which may include:

a. *Communication through the press:* This type of communication has always been interested in the Corporation and has been considered as an essential tool to promote PVOil's images and information. The management committee continuously directs that effective coordination with the media is very important to proactively provide information about the productions, business activities and services of PVOil. Besides, regular and irregular press conferences have been usually held to contact and respond to the journalists' reports about those information that they are interested in. Thanks to these great efforts, positive information about PVOil often appears on the press (newspaper, online newspaper), television and radio (VTV, VOV, VnExpress, Dantri, Baomoi, Zing, Vietnamnet, Petrotimes, Investment Newspaper, CafeF, Business Times, Vietnam News Agency and some Government websites).

b. Communication via social networks: The fact that more than 66 % of Vietnamese population having access to the internet and 62 millions Vietnamese people know about social networking has really been a key communication tool for business in this current 4.0 technology era. So as to serve the media and advertising, PVOil advocates taking full advantage of social networks in the technology era by building and developing its private channels on social platforms such as PVOil Youtube, PVOil Fanpage, PVOil Youth Fanpage, etc. As a result, much information was posted quickly and continuously updated to attract a large number of followers and interactions.

c. Communication via PVOil website: The website is definitely the most basic platform in the online array of businesses. By looking at one business's website, customers can get information about that business and the products that they offer. Thus, PVOil always considers the website as a direct and useful communication channel. Right after transforming to operate as a joint stock company model (since August 1^{st}, 2018), PVOil has built and put into use a new website which is diversified and modern in both forms and content, and suitable with the nature and requirements of the public about informations. The amount of news posted on the website is increasing. The quality of news, articles and images is rising. Moreover, the content is closely following the Corporation's activities, the petroleum industry news, and even social issues. The result shows that the number of visitors to the website is increasing. On average, there are now hundreds of visitors to the main website of PVOil in a daily basis. The above result was due to the Corporation has done an excellent work of fostering and investing to the working equipment for the editor team (content management and technical management), thereby making sure that they are in the best condition to take care of the website thoroughly. Also both Vietnamese and English contents are updated regularly.

d. Communication at selling places: With more than 560 owned petrol stations, over 3000 petrol agents and 27 depots distributed throughout all the provinces and cities nationwide, PVOil is the second-largest market share in petroleum retail. Because of this reason, communication activities at selling places are the decisive channels of PVOil. Because customers cannot check the quality of gasoline by themselves when they come to gas stations, they can only observe and trust the product provider. Since 2016 Vietnam Oil Corporation has started implementing a project to improve the quality of services at the petroleum depot (Project 808) and a project to improve the quality of customer service at affiliated petrol stations (Project 1114). Accordingly, petrol stations were upgraded to be more spacious, cleaner with professional service style and committed to quality with the slogan “The real gasoline, the exact liters”, and also the sales process is publicized at the selling places in order to create confidence with purchasers when using the product. All business locations are used as a media and advertising for PVOil brand with specific content and activities.

e. Communication through brand name recognition and slogans: Brand is a useful tool in modern marketing. It is a sign to identify an individual and an organization's products and brands, then distinguish them from other competitors. Vietnam Oil and Gas Group (PVN) agreed to use a common brand image for all group members to create a strong and sustainable cohesion. Furthermore, short slogans that carry understandable messages have always been concerned and used by PVOil. For example, “Make the distance closer”, “Let miles be smile,” are some impressive, concise and easy slogans to remember and have deeply humane meaning. Besides, PVOil also focuses on brand recognition through the decoration of petrol stations, employees and mangers' uniforms to create a sense of confidence in customers.

f. Communication through product advertisements: PVOil has carried out many promotional activities with various methods, such as producing documentary films, guiding business operation videos or music videos, TVC’s advertising related to its business activities. Advertising activities are also conducted through many other means such as hanging large posters on national highways, advertising on transport vehicles, or via the sizeable electronic screen in some public places… These advertisements are always designed carefully and meticulously from the content to the form in order to ensure the uniqueness to attract customers.

g. *Communication through events:* Important events often attract many people’s attention, especially those who greatly influence many different fields. Determining that this is an indispensable link in business communication strategy, PVOil has worked with many prestigious groups and organizations to promote PVOil’s products and services through various significant occasions and events. Some examples include Surf with the 38 Team - Spirit of Race at the Blancpain GT Series Asia International Racing Championship, Media on Vietnam Offroad Cup from 2016 to 2019 as the main sponsor of the race; communication at the events of Forbes magazine and Vietnam Young Entrepreneurs Association. Some remarkable social events are also the focal points of PVOil's communication recently. On the occasion of the Vietnamese team's participation in the Final VFF CUP 2018, PVOil organized a cheering band for Vietnam Team before the match at the petrol stations. In addition, facing the situation of unfortunate traffic accidents caused by drinking alcohol is increasing, PVOil conducted a propaganda campaign at selling places with the slogan "For yourself, your family and society, please do not drive after drinking alcohol". This communication solution demonstrates both the humanity and the responsibility of a supplying petrol enterprise for transportation vehicles. Most recently, PVOil has organized a free mask distribution at petrol and oil retail strations to help prevent the spread of Covid-19 epidemic in the community.

h. *Communication through social security activities:* For 3 consecutive years from 2017 to 2019, PVOil has organized the program named "Coming home with PVOil to celebrate Tet", bringing thousands of disadvantaged students studying in Ho Chi Minh City and Hanoi to return to their home on Tet holiday. At the same time, the Corporation has also held free drinking water supply places for poor labourers and students at some petrol stations near populous areas and on high-traffic streets. Additionally, some volunteer programs to give gifts for poor students and difficult family circumstances and free health check-ups and visits for inhabitants were also organized. The Corporation has directly or indirectly participated in constructing social security works throughout the country, such as bridges, roads, schools and charitable homes for families under preferential treatment policy.

3.2. Internal communication activities at Petro Vietnam Oil Corporation

When it comes to communication activities, PVOil's leaders always affirm that how to match with its name is very important, which is to communicate thoroughly from top to bottom and from inside to outside. If a business only focuses on public relations and disregards the internal communication, it still doesn't know how to use communication activities in its best way. As a result, internal communication at PVOil has been promoted recently. The Corporation's main tools are organizing meetings to gather and exchange information between management levels between managers and employees. PVOil's website is the place where the Corporation conveys information about their operation and the orientations of operating in the future. Employees can exchange, discuss and contribute their ideas for collective activities through social platforms or chatting groups such as website, Facebook, Zalo, Viber, etc. Each department is equipped with a separate space for message boards, which updates that department's professional information and news from senior management. Electronic signs and boards attached to production zones, warehouses and retail stores are always up to date with the latest news on production and Corporation's plans, emulation and commendation work. Moreover, every year many cultural, sporty, fine art activities are organized to enhance the exchange between officials and employees in the company so that the internal solidarity in PVOil is enriched. For instance, some competitions were organized for all employees and their children to contribute content and ideas for communication and advertising activities of PVOil. In 2017, PVOild held a painting competition titled "PVOil's colors", the artworks of which was used for the company's 2018 calendar distributed to all employees. PVOil's advertising idea contest has also been launched every year. By organizing skill contests for employees, not only professional knowledge and skills were tested, but also the guidelines, policies and regulations of the Corporation were transmitted to the workers.

3.3. The handling of social media crisis

Communication is a very sensitive activity and can spead rapidly, particularly in this digital age. For this reason, the appearance of communication gaps is unavoidable for all businesses. Every enterprise needs to base on the severity of the media crisis to have timely treatment. For PVOil, whenever the social media crisis appears, the Corporation always controlled actively to capture relevant media information. The Corporation can handle any crisis soon by receiving feedback, being honest with the media, consulting experts about crisis settlement, face-to-face meetings with the press, or even legal intervention of the law to handle quickly, avoiding a media crisis taking control of the situation.

4. EVALUATION OF COMMUNICATION ACTIVITIES AT PETRO VIETNAM OIL CORPORATION

4.1. Achieved outcomes

Since the Communication Department's establishment, PVOil has developed and promulgated the regulations, processes, and forms for this work. For example, media plan briefs, instructions for how to relate to the press and work with them, guidelines for speech in communication, social networks, and media crisis handling. These documents are disseminated to all affiliates to ensure standard, scientific and effective communication.

Communication products with suitable contents and messages for the target and the subject groups such as publications, documents, news, articles, photos, videos, documentaries, etc. These products are always produced directly by PVOil or by cooperation with the press and professional communication units to guarantee the quality, especially for external communication.

The Corporation's web portal is regularly evaluated and adjusted in both Vietnamese and English contents, based on the media goals' analysis and the demand for information towards communication objects. The website plays a crucial role in both external and internal communications.

Social media channels, digital/ online media such as Facebook, Youtube, Zalo, Viber have been used very effectively because of their attractiveness and quick spread. However, PVOil has always managed strictly to avoid communications risks while using these channels.

Collective events, such as traditional festivals, Tet holiday, Vietnamese press day, social, cultural and sports events in the community, are always utilized to disseminate news, enhance the image and consolidate relationships related to the Corporation's communication.

In recent years, Petro Vietnam Oil Corporation (PVOil) is always aware of communication activities' particular importance. Under the direction of leaders at all levels, this work has been increasingly effective, contributing a huge impact on the image building and promotion of PVOil.

4.2. Limitations

From 2015 till now, many objective and subjective impacts have adversely affected the image, reputation and brand of Vietnam Oil and Gas Group, in general, and Petro Vietnam Oil Corporation, in particular. Compare with the achieved results, the communication work of PVOil and its member units still needs to be strengthened and consolidated. The drawbacks are: The coordination, exchange and provision of information by the relevant departments have not been timely; many subordinate units have not assigned cadres and departments to monitor the communication work. The leaders have not yet shown their role clearly. Financial regulations create some difficulties and have not been encouraging enough. Some communication tools, such as web portals, internal websites, etc., of the old information units have not been updated. The website has not worked (PVOil Nam Dinh, PVOil Phu Yen, PVOil Vung Ang); etc.

The reasons for these above weaknesses are due to the fact that some leaders have not paid much attention to it and their direction has not been drastic enough and lacks consistency. Besides, the initiative in providing news to the press has been overlooked. Internal communication has not been paid adequate attention. New trends in communication have not been caught up. Additionally, the budget for communication is limited; thus, the essential demands have not been met. The training and cultivation of human resources in the field of communication have not been paid proper attention.

5. SOLUTIONS FOR COMMUNICATION ACTIVITIES AT PETRO VIETNAM OIL CORPORATION

- *First: It is necessary to unify the direction of work from the Corporation to its member units.* In communication activities, the Corporation needs to supply concrete guidance for each department to build and unify the funding plan, then allocate and implement it appropriately for each specific activity. Monthly, every departments/units and unions throughout PVOil have to provide information on production and business activities, events for the Communications and Corporate Culture Department, so that all levels can rely on it then orient and organize the propaganda close to reality and in accordance with the requirements of each period.

- *Second: Completing and applying the implementation of regulations and processes in the communication work.* Internal regulations and status should continue to be perfected. In particular, the regulations on speech and information provision should be prioritized for improvement, followed by regulations on the web portal's management and operation and other related documents. By building a complete and detailed set of documents on communication at the Corporation level, the member units can use that as a foundation for reference and apply it consistently. Furthermore, building a praising and rewarding mechanism for outstanding collectives and individuals will encourage, motivate, create positive spillover effects, and scaling personal models, especially in communication activities.

- *Third: Using a variety of measures and tools to implement communication work effectively.* With traditional and orthodox press agencies that have ìnfluence on social public opinion, the Corporation needs to continue maintaining and expanding cooperation, penetrating deeply into social networks, periodically assessing the effectiveness to have a solution and implementation in the next time. Regular and irregular information should be proactively provided to relevant media agencies. The Corporation may cordinate with others to handle the issue if necessary and create a consensus of public opinion on the Corporation and its member units' activities. It is important to invest in the website and timely update news for each content and communication object. The Corporation needs to create diversified media products to promote PVOil's image and potential, standardize sponsorship/support and organize events, and marketing activities to promote the brand. It should also focus on oral communication measures and direct dialogue with laborers. Effectively exploiting and operating the Corporation and its units' traditional rooms is a way to approach a larger group of employees.

- *Fourth: Allocating resources and improving the quality of the communication staff at PVOil.* At each unit, leaders need to be responsible for directing, reviewing and assigning employees in charge of communication and corporate culture. It is essential for the Corporation to consolidate the management apparatus and pay proper attention to the settlement of policies, proposals and recommendations related to communication activities. Moreover, maintaining and organizing training conferences, exchanging information and experience in communication between units and individuals in this work.

6. CONCLUTION

Overall, the communication activities at PVOil have achieved many positive results, having a part in the timely and accurate transmission of information about the Corporation's activities. Besides, these work also helped create cohesion with social events and activities, build close relationships with the press agencies, timely handling many inaccurate news that has a negative effect on the operation of the Corporation and its affiliates. Besides, there are several subjective and objective impacts affecting the image and reputation of Vietnam Oil and Gas Group in general and the Petro Vietnam Oil Corporation in particular. Therefore, it is necessary to consolidate and strengthen communication activities in the coming time to affirm the prestige and brand of Vietnam Oil and Gas Group as well as Petro Vietnam Oil Corporation.

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KNOWLEDGE MANAGEMENT DEMAND IN ENTERPRISES UNDER VIETNAMESE COAL MINERAL INDUSTRY GROUP

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Abstract: *Knowledge management is important to create the competitiveness of businesses, especially mining enterprises of VINACOMIN. In Vietnam, the concept of knowledge and knowledge management (CG) has not been focused on research and development. Stemming from basic concepts, strategic transformation and growth models, promoting the trend of changing economic thinking and development. New forms of the economy have been formed, such as network economy, sharing economy, knowledge economy ... Accordingly, the mining enterprises of VINACOMIN must also renovate production and business management and corporate governance for consistent with the market economy integration period. In particular, in the era of knowledge and globalization, VINACOMIN mining enterprises also need to apply modern management models like CG to be able to survive and compete effectively with enterprises in the market. From that perspective, the article mentions the need to apply CG in mining enterprises of VINACOMIN in the context of the 4.0 revolution in order to contribute to promoting the training and development of human resources, meeting the requirements of "high competitiveness domestically and internationally" as mentioned in VINACOMIN Development Strategy to 2020, orientation to 2030.*

Keywords: *Knowledge; Knowledge management; Mining enterprises; VINACOMIN*

1. QUESTION

In the period of information, knowledge economy, knowledge becomes an asset and an important factor for an enterprise's success, especially for enterprises operating in technical fields, such as technology or mining industries. According to Susan Rosenbaum, Director of Knowledge Management at Schlumberger, the leading technology company in the oil and gas industry, affirmed: "In Schlumberger, knowledge is valued as the most important asset" [1]. Indeed, 80 – 90 % of the value of products in these professions is composed of intelligence. Therefore, knowledge as an asset and resources of an enterprise should be managed, stored, shared, expanded and promoted, creating value for the enterprise. If not recognized and well managed, knowledge will be lost, business activities will be ineffective when we have to rediscover existing knowledge, re-learn successful solutions, repeat mistakes and synergy is not promoted, businesses develop unsustainably [2].

From the 90s of the 20th century, developed economies began to shift to knowledge economy. In the knowledge economy, the creation, transmission, storage, development and use of knowledge dominate all economic activities. Science and technology are the direct production forces. The knowledge management theory has gradually replaced the theory of human management. The practice of knowledge management will help businesses and the economy to develop vigorously.

In the 21st century, knowledge is becoming increasingly important for the sustainable development of businesses, economies as well as the nation. Today, knowledge is considered one of the key success factors in modern organizations, and knowledge management becomes an effective competitive strategy. The whole world has currently entered an era of information and knowledge, where any organization or country that effectively manages and uses its knowledge resources will create advantages. Competition is to ensure the sustainable development of your organization or country. In addition to the development of society and the economy, normal production and business activities have been developing strongly into a sharing economy, a modern economy, etc. Minerals, in general, and mining enterprises, in particular, should also aim to and develop in a sharing and modern economy in the current context.

By 2030, Vietnam's coal demand is forecast to be equivalent to 80.4 million TOE (tons of standard oil), per capita of about 0.77 TOE/person (corresponding to the forecasted population of 104 million people).

According to the forecast in the JEEI Outlook 2018 Normal scenario (October 2017), by 2030 the world's average coal demand per capita (TOE/person) will be 0.5 while that of China is 1.48; Japan: 0.93; Korea: 1.74; Taiwan: 1.75; Malaysia: 0.86; Thailand: 0.35; USA: 0.78; Australia: 1.18. Therefore, compared with the world's per capita, Vietnam's coal demand until 2030 is higher, but compared to many countries still much lower, especially compared to Taiwan and Korea. China, China, Australia, Japan and some countries rich in coal resources.

Regarding the development orientation of domestic coal exploitation: According to the forecast in QH 403/2016, commercial coal output in the period to 2030 is expected to be (million tons): in 2020: 47-50; 2025: 51-54; in 2030: 55-57.

According to the document [8], based on the status of resources, the remaining explored coal reserves, the planned domestic production of coal has been updated as follows (million tons): years 2020: 44; 2025: 45; in 2030: 53 and in 2035: 55 million tons. Details are as follows (thousand tons):

In order to achieve the above-mentioned coal production level, according to QH403 / 2016 from 2016 to 2030, the coal industry needs a total investment capital of VND 269,006 billion, an average of VND 17,934 billion / year. With the situation of increasing coal prices and limited financial capacity of the enterprise, in the coming time, the coal industry will not only face the risk of loss, but the mobilization of capital to meet the needs of investment development. Development will be extremely difficult.

That said, the pressure to secure coal for thermal power plants, thereby ensuring the goal of "electricity one step ahead" is enormous. And this pressure is trusted by the Government to put "on the shoulder" of VINACOMIN.

2. KNOWLEDGE AND KNOWLEDGE MANAGEMENT

According to the Oxford English Dictionary, knowledge is facts, information, or skills acquired through experience or education; knowledge of an object's theory, or practice. In epistemology, the science of knowledge, knowledge is defined as justified true belief. In simple terms, knowledge is facts, information, or skills, which have been tested for practical correctness and gained user confidence.

The basic feature of knowledge is that it can be exchanged and transferred from one object to another, used many times and brought value added to enterprises.

The knowledge development tower model (Fig 1) of Bender and Fish represents the process of knowledge formation. In particular, data are only numbers, values and phenomena systematically collected. Data that adds value by adding meaning, understanding through human interpretation will become information. Information will turn into knowledge when reinforced by trust after use. Expertise is acquired when knowledge is enriched, refined, combined with other knowledge, through repeated experience, research, training ... The author Apurva also called this level of knowledge "wisdom" [3]. According to this tower model, the higher you go, the more valuable the knowledge is, but it is more difficult to share and transfer. , more transfer.

There are many classifications, but for ease of application for knowledge management in enterprises, knowledge is often divided into two categories:

- Explicit: can record, present in the form of text, audio, images, digital files, etc., and easily store, transfer and share on IT infrastructure or information. through the process of training, guidance, knowledge sharing activities;

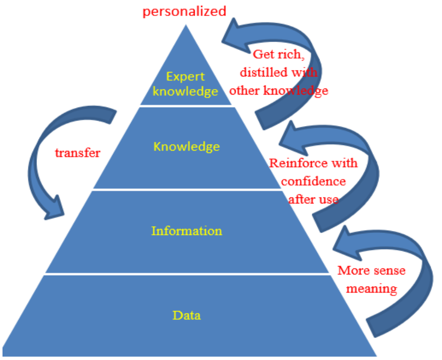

Fig 1. Knowledge development tower (Bender and Fish, 2000).

- Tacit: formed from practical experience, or through in-depth research and stored in a specific human brain (such as beliefs, experiences, know-how, etc.), which have not been recorded, expressed as explicit. Hidden knowledge can be forever hidden and lost with the departure of a particular person. But knowledge hidden in one individual can turn into knowledge hidden in another individual through exchange, cooperation, training. Hidden knowledge can also turn a part into reality if narrated, recorded in writing, video, audio, and then shared on the business's information infrastructure.

There are many definitions from different perspectives on the concept of knowledge management. According to Petrash (1996), knowledge management is bringing knowledge to the right people at the right time, helping them make the best decisions. Reid Smith, Schlumberger's Vice President of Knowledge, said that knowledge management is to create a working environment for knowledge and experience to be shared easily, and then applied by individuals to make optimal decisions in real-time [4]. Amin (2001) has a simpler definition, highlighting the purpose of knowledge management is to turn information within an enterprise into the ability to act effectively [5]. The most comprehensive view is that of Dalkir (2005), arguing that knowledge management is systematic, deliberate coordination of human, technological, process, and organizational factors to increase value by reusing and creating new knowledge. This coordination process includes creating, sharing, applying knowledge, and receiving feedback with lessons learned, good practices, memory enrichment, and sustaining the business's ongoing learning process.

Thus, knowledge management is the life cycle of knowledge management (Fig 2): creating/capturing knowledge; standardized for storage under an accessible, accessible scientific structure; share to enrich knowledge and enhance the capacity of individuals; creating conditions for individuals to use, creating added value for enterprises; at the same time, receive feedback in the process of using to validate knowledge or update/refresh to help knowledge enter new life cycle.

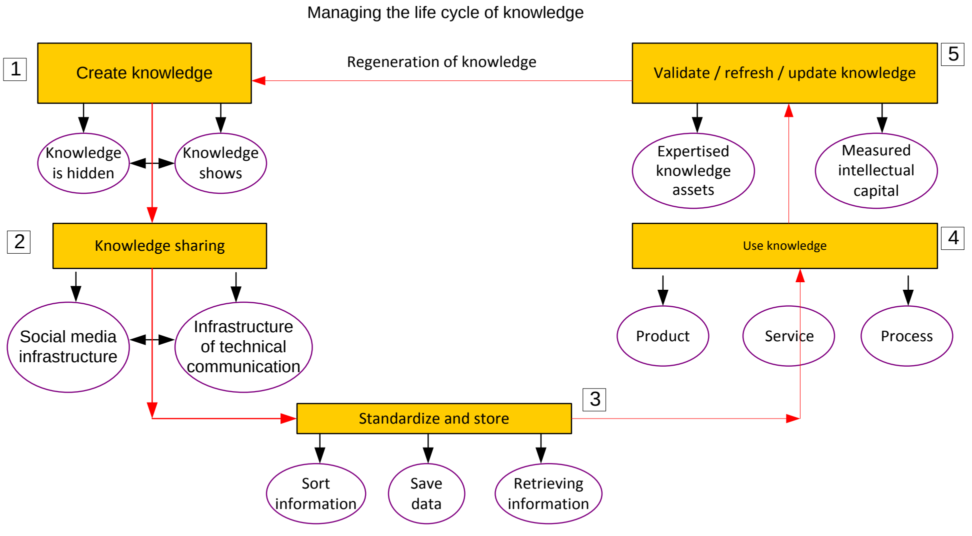

Fig 2. Life cycle of knowledge in knowledge management.

3. DEMAND FOR KNOWLEDGE MANAGEMENT IN VINACOMIN'S MINING ENTERPRISES

3.1. Knowledge management in enterprises of Vietnam Coal and Mineral Industry Group is an objective, practical need

In a knowledge society, mining businesses must then compete with other businesses based on their knowledge and the ability to turn that knowledge into value through products or services. In an era of knowledge and a globalized economy, mining businesses will have to adapt to new conditions to survive and thrive. Because the wave of knowledge age is coming and will affect all organizations and countries evenly, mining businesses cannot avoid that influence. Therefore, the CG will become important for mining enterprises in particular and the mining industry in general. This requires the mining enterprises to proactively apply the CG to cope effectively with those changes.

On the other hand, globalization also makes the world flatter and the knowledge-based competitive trend will quickly spread around the world. In countries around the

world, countries with developed industries, mining enterprises are also seen as sources of innovation and ensure sustainable development. Governments also enact policies to support the innovation of technology, products and services in these areas, thereby enabling these businesses to compete effectively in the knowledge economy. Therefore, to survive and develop, mining enterprises in a developing country like Vietnam are forced to apply CGs to compete with enterprises from developed countries based on the knowledge strength and innovating ability.

However, compared to other enterprises in the market, mining enterprises have specific characteristics, so investment in research, development, application of new technologies, or the CG system's implementation faces many difficulties. Therefore, it requires a great effort from the staff of the mining enterprises, the mining enterprises themselves and the government's support to turn mining enterprises into knowledge-driven businesses. It is important for mining businesses to know their current situation, improve IT maturity, and adopt an appropriate CG approach. Having so, new mining enterprises can enhance their competitiveness and innovation capabilities. Besides, the application of CG in enterprises of TKV also comes from and based on the following specific grounds:

** Derived from human resource needs*

From a human resource perspective, the need for increased exchange, sharing, and creativity in working groups of diverse fields of expertise is one of the main reasons for governance development. In addition, the need to increase the ability of employees to handle complex situations and retain knowledge when working groups disintegrate or re-establish also makes building a CG system necessary.

- *Firstly*, the need for promoting exchange, sharing and creativity in operational groups is getting bigger. The reason is that companies are tending to work together to increase competitiveness and increase resources for businesses. Therefore, employees in different companies often have to work together. Moreover, developing a product requires a combination of many different areas (design, engineering, information technology, security, internal marketing, etc.). In other words, members of a working group must come from different departments, which they usually only know about their area of expertise without the necessary knowledge of other areas. Cultural differences can also make it difficult to work in a team. Therefore, it is essential to increase teamwork's ability and efficiency, typically the team members' sharing and communication. Knowledge management can become the optimal solution to this problem because it fosters discussion and knowledge sharing in groups and organizations.

- *Second*, the workgroups were formed and dissolved. Currently, working groups are often formed to solve problems and projects in a short time. After completing the task, these groups are often dismissed, members return to their daily work or join other working groups, where their expertise is more valuable than the knowledge gained in other areas of the project. Importantly, such knowledge is not stored, becoming "personal property" of employees. When the employee is gone, the company's knowledge also loses, or when the group disintegrates, it also brings the group's knowledge away. Knowledge management can help a company solve this problem effectively because it involves a process of "capturing" hidden knowledge - through direct exchanges and the storage of hidden knowledge. as shown.

In addition, in the era of fierce economic competition, the demand for skills and ability to make employees' decisions is increasingly higher. Today, time is the key competitive factor for every company. You may face unexpected changes, creations from your competitors, and unstable market movements. Your company will most likely not be able to keep up with the advances of the external environment. Therefore, responding and making decisions before an employee's situation needs to be accurate and as fast as possible. This requires an employee's knowledge level to be higher and information to be provided more quickly and accurately. With good knowledge management, you can completely solve these problems.

** Stemming from economic needs*

The old economic theory suggested that all assets are vulnerable to depreciation, but this is not true of knowledge. The laws that govern knowledge are different from those that govern the physical world. For example:

- At the same computer, when person A uses it, the others cannot use it anymore.

- After the user A uses and transfers it to another person, the computer quality is considered to be worn and reduced in value.

But with knowledge, when one person is using, others can also use it. And the more knowledge is used, the more valuable it becomes. Economists call this the rule of increasing profit: the more you use it, the more it provides value - thereby creating a self-reinforcing cycle.

Knowledge management offers the unique opportunity to turn knowledge into a system that helps the company create a time advantage of keeping the competition constant, creating undeniable economic and market value.

** Technology and demand for a knowledge management system*

The strong development of information technology has completely changed the job. We can now collect and store large amounts of information easily, transmitting them quickly. The number of jobs being completed based on technology, especially computers, is increasing. The importance of technology is undeniable. However, technology does not create a competitive element for your company. You have just owned a completely new technology, helping your company to surpass its competitors. Later, when an adversary makes the same tool or buys the same technology, your competitiveness will be lost. In the current technological age, the time for such a technology race is getting shorter and shorter, so we cannot treat technology as a long-term competitive element.

Meanwhile, the technology with the two main benefits of storing and transmitting information allows us to build effective information storage and distribution system. Technology has become effective storage, distribution and exchange of knowledge. By effectively combining technology with knowledge management, the company can create new competitive elements and enhance its long-term competitiveness.

Besides, thanks to technology development, the processes and processes are completed more quickly and efficiently. The life cycle of the product, from research, production, to sale and after-sales services, is thus shortened. Products are also regularly upgraded and improved, and the market is constantly changing. As product time becomes a vital factor for the company, decisions must be made more quickly and accurately. So what makes the company do this? Technology can help us collect, store and transmit information exceptionally effectively, but in order to turn information into knowledge and decision making, people, knowledge and experience are needed.

Knowledge, not technology, directly helps employees who own it make decisions. With the help of technology, knowledge management can help employees of the company work more effectively, make more informed decisions on their own, reduce mistakes, and satisfy customer requirements.

** Organizational structure and demand for a knowledge management system*

Like technology, organizational structure changes too quickly. These organizational changes put us in the position of not having an effective knowledge management system.

Imagine that you are in charge of a large project and suddenly encounter a problem. After a while searching for solutions, a team member remembered that the same problem had arisen and was solved quite effectively in a previous project. You go through a pile of high-profile resumes trying to find a process or at least a hint, but all you find out is that the project team members work everywhere - branches of companies worldwide.

Today, companies work on project-oriented. Each member is picked up from different functional departments to create a unique team. Teams, after finishing a project, often move to a higher project or scatter to other projects. The knowledge, experience, skills acquired during product and service development are not transferred to the project teams in charge of developing the following versions during the evolution of that product service. Besides, with the team and project organizational structure, the skills developed during the collaboration process will often be lost when the team disintegrates and the process knowledge acquired by the team will not be available for future reuse. In this case, a knowledge management system will help your company capture project knowledge, allowing you to reuse it in the future.

Globalization creates a flat playing field, more competitive than ever. Twenty years ago, neither you nor I would have thought India could become America's backyard with a series of call centers scattered across the country, providing services to customers worldwide, Especially customers from Europe and America. Today, Microsoft does not necessarily have to be involved in all stages of creating software. They can move the "less gray" outsourcing to other countries for wages that are only half the price paid to a programmer at Redmond. At the same time, to produce a laptop, Dell has a collection of more than 40 suppliers - companies, workshops, factories around the world specializing in manufacturing assembly components. Globalization with esoteric formulas, business strategies, designs, etc. That's why we need knowledge management.

Besides globalization, competition is becoming more fierce as countries are gradually lifting regulations, leaving the market to adjust itself according to its inherent rules. Suppose you have a price advantage over your competitors because your supplier in Korea and the Korean government have removed the regulatory barriers that make your input cheaper. Meanwhile, in India - where tariff barriers still exist, your opponents struggle to buy inputs at a higher price. Suddenly, India decided to remove all tariff barriers. What happens next? Both you and your competitors now start from the same point. You lose your competitive advantage. The only thing you can do is cut costs. You start fiddling with a layoff, leaving a little bit here and firing a bit there. You forget that when you push someone out of the company, you also push away the hidden knowledge he has in mind. Meanwhile, your competitors choose a different approach, build a knowledge management system and skills to avoid reinventing what you already have, achieving the goal of reducing costs and long-term competitive advantage.

In such a competitive environment, you cannot say “Do I have a good product? So why should I care about marketing?” Developing a new product or service requires a perfect combination of many different fields, from marketing, research, design, manufacturing to finance, etc. When there are too many people from these fields, different expertise involved in a project is very likely to cause misunderstandings and disagreements about benefits. Knowledge management answers questions about knowledge assets, ownership, beliefs before and after work.

3.2. Actual status of knowledge management in enterprises of Vietnam National Coal - Minerals Group

Along with the country's renovation and economic development, mining enterprises in Vietnam, in general, and VINACOMIN, in particular, also have strong development in mining technology, techniques. However, according to the survey of the author and recent studies, despite the development and innovation in technology and technology, are still very weak in many aspects, such as lack of cohesion with enterprises in and abroad, weak competitiveness, little innovation, unstable personnel, and not ready for integration. In addition, the mining enterprises in general and the mining enterprises of Vincomin in particular also receive the government's attention and support as some support policies for the sustainable development of mining enterprises. With that support, the application of CG in mining enterprises will be gradually promoted and deployed more. However, at present, mining enterprises of VINACOMIN are conducting information management in spontaneous and small specific ways such as: managing the existing knowledge in documents, documents ... of which department That manages and stores; of which Company it manages ...;. Information management activities are organized by organizations based on seminar activities, visits, sharing and learning experiences, exchange activities, etc., without a system to store current knowledge and not yet having an IT application program to do Information Management. Therefore, the effectiveness of CGM operations is still low. The application of CGs in mining enterprises is still very few, even not implemented. The number of successful cases of implementing CGs in practice has not been recorded.

Currently, with the rapid development of information technology applications in enterprises, such as SCM, CRM, ERP, social networks, etc., the deployment of the CG system at the present time is appropriate. The sooner the deployment of CG solutions, the sooner the mining enterprises will create competitive advantages and ensure their sustainable development. However, the successful implementation of a CG system is a difficult problem for mining businesses in many aspects, such as awareness, resources, technology, implementation process, etc. It takes determination. The right strategy from the business side and the encouragement and support from the government can overcome the difficulties and successfully apply CG.

5. REFERENCES CONCLUSIONS AND ECOMMEDATIONS

Knowledge management plays an important role in creating the competitiveness of enterprises. Knowledge has become an important asset of mining enterprises, in general, and VINACOMIN's mining enterprises, in particular, because this is a high-tech industry, the complexity, interdisciplinary of technical activities, the area spreads. The effective knowledge management system has contributed to the success of companies that directly explore, exploit and consume.

VINACOMIN needs to build a system of CG to enhance operational efficiency, enhance competitiveness, towards sustainable development. To achieve that, VINACOMIN can gradually build a system of CG in the following schedule:

- Phase 1: Awareness raising, training experts on knowledge management and pilot implementation. VINACOMIN invites knowledge management experts from Vietnam and worldwide to teach and share experiences, send potential staff to attend training courses, or recruit, have a team of qualified experts, and practical experience in knowledge management. It is possible to select 2 units (a research and training unit; a production and business unit in the upstream domain) to conduct a test of knowledge management; disseminating experience in deploying knowledge management through annual workshops. In this phase, VINACOMIN assigned the Strategy Board to initially deploy the knowledge management information system, supporting practical activities at the units. The system may initially include online modules and tests for career development-oriented content, initial intensive training and management and basic skills training.

- Phase 2: Replicating an effective knowledge management model throughout the Group; focus on building knowledge management habits into the core culture of the business through maximizing support for communities of knowledge management practices. The Board of Strategy was assigned to continue strengthening the construction of central database and knowledge bases for the whole Group.

- Phase 3: Promote knowledge creation, promote added value from knowledge management. Connecting database, knowledge base, building an InTouch-style centralized knowledge management system, focusing on sharing support for the implementation of domestic and foreign projects, promoting deployment and application, applying new technologies, training experts, training highly qualified human resources.

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IMPROVING THE SYSTEM OF INDICATORS AND Statistical forms IN MINING ENTERPRISES

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Abstract: *It is impossible to run any business activities without management information. Management information is a product of management information systems in an enterprise. Management information is aggregated from data generated in the enterprise's business activities and gathered in statistical tables. Now, the application of modern information technology is a mandatory requirement to handle the large amount of data generated in mining enterprises. However, the indicators and statistical forms in the current information systems at mining enterprises are still inadequate. These restrictions make it difficult for the deployment of information technology applications in the information system. The article analyzes and points out the limitations of the system of indicators and the current forms in the mining business. From there, the author proposes principles, points of view and directions to build an appropriate system of indicators and statistical forms***.**

Keywords: *Statistic; Database; Information; Information system*

1. INTRODUCTION

Economic statistics for businesses, especially enterprises in the market economy, increasingly occupy an important management activity position. Economic statistics in enterprises include a lot of content and related aspects. However, this article addressed a problem, that has not been paid enough attention and incompleted for many reasons. The problem relates to statistical forms and indicators in mining enterprises today.

It is said that statistical indicators are the final results of statistical activities. The system of statistical indicators creates a general picture that fully reflects the enterprise's production and business operations. This is the basis for the business's next management activities, such as business economics analysis, business strategy formulation and business planning, operational management, and production management, etc. That system covers all aspects of management activities and must be built to ensure the highest requirements of science and practice.

Statistical forms are aggregated tools that allow the presentation of statistical indicators in the form of tables built according to strict rules for the most concise and systematic presentation and synthesizing and rendering information for management. The indicators system will be very limited in the application if they are not scientifically gathered in the form.

Although awaring the significance and importance of indicators and forms, there are still inadequacies and limitations in the statistical work in mining enterprises today that need to be addressed to improve purpose.

The state-controlled market economy in our country now orders even higher requirements on the standardization and completion of the statistical work in enterprises in general and the indicators and statistical forms in particular.

Simultaneously, with the integration of the world economy both in content and form, there are new issues of statistical indicators and forms that need to be supplemented and solved. Thanks to that, the enterprises' statistical work will be integrated into content and form with the world economy.

Finally, the development of science and technology in this day, especially information technology, creates new advantages and raises new problems and requires the system of indicators and statistical forms to meet the integration process in terms of criteria, methods of synthesis ...

For our country's coal industry, the economic statistics function is performed by the statistics department at all levels (the Statistics Department of Vietnam Coal and Mineral Industry Group and the statistical departments at member enterprises). For many years, the Group and its member companies have paid great attention to developing and improving economic statistics, reflected in the promulgation and implementation of relevant policies and regulations that mention rules of statistical form for units within the Group and many of detailed criteria. However, business management practice shows that the indicator system's scientific and practical requirements and the forms that the article will mention here are the sources of issues that need to be completed.

2. CHARACTERISTICS OF PRODUCTION AND BUSINESS OPERATIONS IN MINING ENTERPRISES RELATED TO STATISTICS WORK FROM THE PERSPECTIVE OF INDICATORS AND STATISTICAL FORMS

In addition to general scientific requirements, a system of indicators and statistical forms needs to be built in accordance with the specific conditions of business and production of statistical objects. For coal mining enterprises, it is:

- *Complicacy of production conditions and technologies*. Mining enterprises often own complex production technology and systems and many unusual factors from mining to processing and consumption of products compared to other industry businesses. Whether underground mining or open-pit mining, the production line includes many stages. Each stage needs its specific indicators and statistics. This feature requires a system of indicators and statistical forms fully reflect production and business operations according to technological properties. It also increases the complexity and difficulties for statistics in the business.
- *The unsynchronized production technology leads to synchronization in the system of indicators and statistical forms*. Compared with many manufacturing industries, due to adapting to minerals' natural conditions, mining enterprises' production technology lines have been more unsynchronized. That makes it difficult to automate technology lines and the control process and leads to difficulty in synchronizing the system of indicators and statistical forms.
- *The continually changing in production conditions is raising new statistical issues.* Mining activities depend heavily on natural conditions and constantly changing locations, accompanied by technical parameters. This leads to changing the content, forms and indicators of statistics in the same business, a manufacturing unit, or a production stage. The most typical example is when changing mine from open-pit mining to underground mining, or changing in the method of exploitation, holding technology, digging, screening and so on. That change leads to the need for updating and linking the statistical system before and after changes. It takes a lot of time and labor costs, etc.
- *Distinctive characteristics*: The difference in business production in all aspects from

other production and business sectors makes the statistical work in general and the model indicator system have difficulty in meeting the dual requirements: the unity with the national system, the reality of enterprises, the popularity and the separate.

- *Differences in management mechanism*: At present, the coal industry is operating under the mechanism of the parent-subsidiary business model, aiming to operate under the market mechanism and ensure national energy security. The process of mechanism change will also require changes in statistical management methods, related to the system of indicators and forms.

3. SITUATION AND CAUSES

3.1. Situation

From the studies of coal mining enterprises in the TKV Group currently, it is possible to make some comments on the status of the indicator system and statistical form as follows:

- *Lack of systematic*: At present, the request for primary data collection, secondary information collection is implemented according to the specific functions of each management department. Management departments tend to build their own forms and specific criteria to meet their management information requirements. This type of organization creates a difference in names, statistical forms and statistical indicators of different functional departments. It does not follow a certain standard or guarentee uniformity throughout the enterprise and the organization. The inconsistency manifests itself in conceptual aspects, names and indicators, and also statistical forms. There is also inconsistency in the method of calculating and constructing indicators and statistical forms in different functional areas. This makes it especially difficult to share data resources and statistical reports among functional departments throughout the enterprise.

- *Lack of comprehensiveness:* The system of indicators and statistical forms, such as indicators and statistical forms of business conditions for communication and development strategy and so on do not fully cover all aspects and activities of the enterprise. Further, the number of indicators in the statistical form and the number of functional departments' statistical forms are not consistent in the whole enterprise, particularly in the entire industry.

- *Lack of vertical and horizontal connectivity*: Considering the whole enterprise, the current indicators and statistical forms have not guaranteed vertical connectivity (from the highest management level to the lowest) and horizontally (between functional parts). Because each functional department collects primary data and aggregates secondary data according to its criteria, targets and forms, there is no consistency throughout the enterprise. Accordingly, data cannot be shared. Each department and individual keep their own data. This leads to inconsistency and takes a lot of effort and time to repeat, collate, correct and repeat statistics repeatedly for different departments with the same Figs.

- *Lack of "extension":* The statistical forms lose count of expanding and the type of information supplement ability according to new requirements. And when you need to expand, the extension is difficult to add in the system. In particular, the current statistical forms are difficult to meet information requests for different subjects because it has to integrate information systems according to functions and share a database and information for many management functions.

- *Lack of connection and consistency between statistical indicators and forms with the system of indicators and plan forms*. Data, targets and statistical forms are not consistent with the work plan report and periodical reports. Besides, our country's mining enterprises' current economic statistics indicators have not been proven to be compatible with the world's widely used indicators.

- The current indicators and statistical forms have not created favorable conditions for the application of modern information technology. Each functional department uses its own software application, which has led to unreliable statistical data and a disunited system. As a result, the sharing of the same data between functional departments is not possible. A department that needs information from another usually has to copy the data file or re-entry manually. However, in order to integrate information systems with shared databases for the whole enterprise and share data and information for all management functions, the target system and statistical forms must be standardized and unified throughout the enterprise and country, and gradually progressed to standardization with international standards.

- The statistical indicators are not conducive to the production of statistical reports and do not serve well to analyze and plan strategies and plans. This is because there has been separated clearly between the primary data (initial data not yet aggregated calculations) and secondary data (information extracted from the original data, shown in statistical reporting tables). Most of the statistical indicators, either unencrypted or encrypted, have not chosen the standard coded string of data following encryption principles or are not uniform across the enterprise. The whole enterprise has not built a shared database with a unified data structure for all functional departments. This is why it is very difficult to export information into statistical reports and apply information technology in data processing and information rendering.

- *Decentralization in statistical indicators management is not clear*. In mining enterprises, the statistics, storage and use of data are carried out at workshop, member enterprise and corporation levels. There is not really a clear decentralization in the management of statistical information, indicators and forms.

3.2. The cause of the limitations and existence

The reason why the system of indicators and statistical forms of mining enterprises still have the above limitations is:

- *Historical existence*: Although the mining industry in Vietnam has been established for a long time, the mining technology is still outdated, the exploitation is still fragmented and the management is not systematic. The authors' actual research shows that almost no mining enterprises have built their own system of standard, scientific, and unified statistical indicators for the whole enterprise. The indicators and statistical forms used are "hereditary" - the previous generation instructs the next generation to use the criteria, form, and statistics. Sometimes, the statistician at the workshop creates a new target, a new code of supplies, etc. when they need;

- *There is no proper awareness about the urgency to complete*: Many managers and employees, despite facing the inadequacies of the current statistics work (take time and effort for comparison, adjusting data, picking up reports, etc.), they are not yet feeling the urgency to complete or improve it and still accepting the existence of work;

- *Limitations on managers' qualifications*: At present, in Vietnam, only a few universities specialise in statistical training such as the National Economics University. In particular, the training program is toward national statistics rather than in-depth training on enterprise statistics. With specialization in other universities' business administration, economic statistics is only one subject in the training program. Moreover, this subject's research content is the statistics of production and business operations of the enterprise. The development of statistical indicators and forms is not mentioned as a concerned content of the training program;
- *Restrictions on means of management*: Limited tools - hardware and software for statistical work- are also why standardization of statistical indicators and forms have not been considered an urgent problem in mining enterprises. In fact, the software used in statistics at the workshop and enterprise-level is mainly Excel electronic spreadsheets installed on computers with different configuration strengths. In addition, the level of use of this software by statisticians, especially in workshops, is still quite limited. Most of this software is used mainly to create tables to store, filter and search data. Other utilities, which even are useful for software statistics, have not been fully and effectively exploited. Therefore, statisticians in workshops and enterprises have not realized the need to standardize statistical indicators and forms.
- *The use of statistical results has not been really effective, so it has not received appropriate attention*: This is also the next consequence of statistical inadequacies. Once they have not seen the great advantages of the statistics in general, the indicators and statistical forms in particular, they are still not urgent to improve and take appropriate care.

4. COMPLETED RECOMMENDATIONS

4.1. For state statistics management

In order to synthesize statistics for the industry, the whole country and in line with international standards, the General Statistics Office of Vietnam needs to develop a program to perfect the national statistical system. In particular, it should be given a specific roadmap, including completing planning, analysing situations, studying the feasible report and completing the system of indicators and statistical forms from the national to the industry and locality.

It is especially important to develop or improve a set of national statistical and industry standards, in which the international standards are used most. The standards of name, content, calculation method, symbol of the index is created and coded to create the best conditions for information technology application in statistical work.

Once the national standards for the statistical system and forms have been set up, the system of indicators and the design of standard forms should be developed and the organization of the statistical system needs to be completed, from the General Department of Statistics to local departments and branches.

4.2. For mining businesses

The article does not mention the complete content because it is determined from the impact on the shortcomings discussed above. The author proposes a process of completing the system of indicators and statistical forms at the mining enterprises as follows:

Step 1: *Develop a program* to complete the system of indicators and statistical forms for businesses. The program must be designed as a finished plan to complete indicators and statistical forms, including goals, content, time, resources, assigning responsibilities and tasks, etc.

Step 2: *Develop revised principles*, based on frameworks and requirements for statistical indicators, are applied consistently across the enterprise and toward consistency with the framework and requirements of the national statistics work.

Step 3: *Review the entire system of indicators and current statistical forms* to evaluate the advantages, disadvantages and contradictions of each criterion according to: consistency, universality, convenience for statisticians and users, ease of applying IT, comprehensiveness, reporting and rendering. Evaluation results must be recorded in statistical reports, explaining which criteria need to be changed, how to change and which criteria to be keeped, etc.

Step 4: *Determine the order of priority to amend and complete indicators and forms*. The reason is that the number of indicators and statistical forms in mining enterprises is very large, serves many different management functions and needs to be consistent throughout the system. So, it may not be possible to complete all indicators and forms immediately. The order of priority is based on answering questions: Which important indicators and forms involving multiple functional units that use the same information (common indicators and forms), can be done in advance; Which indicators only used within a set of functions or a workshop (specific indicators and forms), can be completed later.

Step 5: Amendment/completion in the first time needs to be compared with the norm / the original order. The contents to be completed are:

- For statistical indicators: Add/remove, complete and correct names, calculation methods, calculation units, collection methods ...

- For forms: Add/remove forms, complete the structure, content, form ...

Step 6: Summary of the system of indicators and forms completed in step 5. This is an intermediate result step to indicate new shortcomings arising due to the process itself. Then the complete results should be compared and analyzed. The problems need to be further improved.

Step 7: Continue to perfect (complete the second time) to meet the final goal requirements set out in the Program.

Step 8: Simultaneously apply the completed and the old system of indicators and forms simultaneously. The goal is to test the newly completed system carefully before officially applying it.

Step 9: *Formal application and replacement of the old system*. When replacing the old system of indicators and forms with new indicators and forms, it is necessary to ensure the transfer not to interrupt production and business management.

5. CONCLUSION

Economic statistics is one of the essential tools in the management of the Nation, the industry, and mining industry enterprises. In order to collect statistical data, create reports, provide accurate, timely, comprehensive information and apply modern information technology, the system of statistical indicators and forms must be standardized and ensure consistency. However, at present, the system of statistical indicators and forms of mining enterprises is not systematic, incomprehensive and does not ensure the vertical connectivity of management levels and horizontal connectivity among management functions of the business. Forms are not yet "expanding" to integrate new indicators as needed. In particular, the current indicators and forms have not facilitated the application of modern information technology for information storage, processing and rendering. These limitations are because of history, partly of the level and perception of the statistical managers. The article also proposes a process to improve the system of statistical indicators and forms to overcome these limitations.

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ANALYSIS ON TUNNEL STABILITY AND SUPPORT PRESSURE AT UPPER KENG TAWNG HYDROPOWER PROJECT, MYANMAR

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Abstract: *Utility networks for underground space in Myanmar have tremendously increased not only in underground mining but also in hydropower projects and transportation at the present time. As a result, underground projects have brought into being constructed in variety of different circumstances along with excavation processes and procedures and also in various shapes and dimension of tunnels. Although the total length of the Upper Keng Tawng waterway tunnel is 516 m, this study focuses to analyze the stability of the study area starting from 108 m to 118 m of the tunnel inlet This paper provides the determination of the required support pressure for the tunnel stability with respect to the ground response curve within the maximum allowable ground movement of tunnel, which is one of the most important key factors for stability analysis and permanent lining design of waterway tunnel. In order to design the tunnel, geological, engineering geological and geotechnical data are analyzed with the relevant various theories. This study also presents the classification of rock mass and geotechnical analysis required for the design calculation. The stability of the entire tunnel depends on the behavior of the rock mass before and after the excavation. Although there are several methods to analyze the surrounding rock mass, the stability analysis and the support pressure are calculated based on the Hoek and Brown criterion in this research. It is conducted with the principles of tunnel stabilization and the permanent lining design of the waterway tunnel with the safety factor of the tunnel lining.*

Keywords: *Tunnel stability, Support pressure, Ground Response Curve, Hoek and Brown criterion, Waterway tunnel*

1. INTRODUCTION

Multipurpose dam projects have been constructing these days in Myanmar to meet the communities' need. Upper Keng Tawng hydropower project is located at the near middle of the Nam Teng Chaung, one of the tributaries of the Than Lwin River which is approximately 22.5 km away from the southeast of Keng Tawng in Southern Shan State. The excavation and construction of a waterway tunnel is included in this project, that is operated by Department of Hydropower Implementation (DHPI), Ministry of Electric Power No.1, Myanmar. The total length of waterway tunnel is 516 m long and diameter of 8m and it also includes 36 m deep of surge tank. Upper Keng Tawng project has been planned to produce the total electricity of 51 Mega Watt for regional development which are generated by three units of turbines, each of which produces 17 Mega Watt of electricity.

The tunnel is excavated by using drill and blast operation and the method of tunnel advancing is the top- heading and bench method. When a tunnel is excavated, the strength and stress deformation are inevitably occurred during and after the excavation of the tunnel. The stability of the tunnel is influenced by the stress conditions of the surrounding ground. Unlikely to the urban tunnel, the waterway tunnel or the pressure tunnel is more stable due to the balance created by the water pressure and the rock pressure acting on the tunnel.

The analysis of the stability of the tunnel is determined first by estimating whether the tunnel is stable or unstable and then to predict the required support pressure aligning with the radial displacement of the tunnel by describing with the ground and support reaction curves. It also includes the estimation of the capacity of concrete lining as the final support system for the tunnel after the preliminary support system.

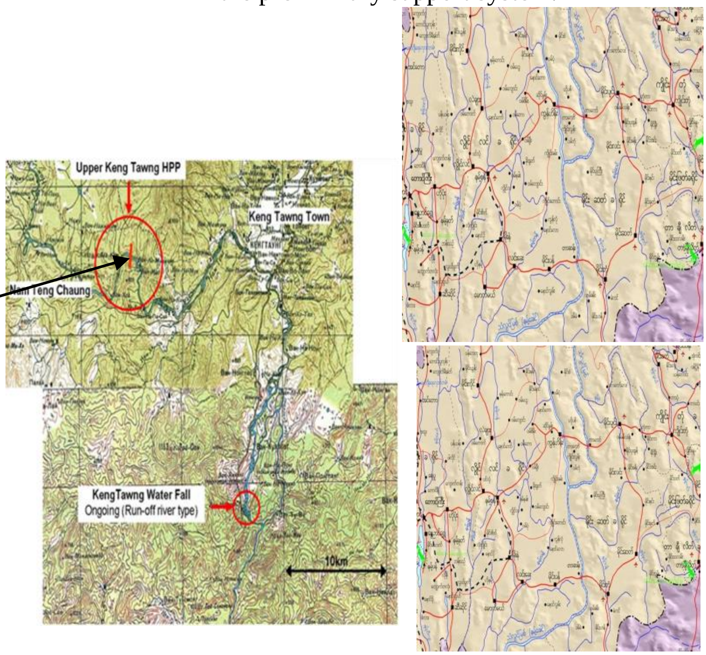


Fig 1. Location of Upper Keng Tawng Hydropower Project

Source: Nation online project, Geological Report of Upper Keng Tawng Hydropower project

2. BASIC CONCEPTS OF TUNNEL STABILITY

Stability analysis for tunnels is different from that of conventional structures such as building or bridges. In rock mechanics, complex rock masses and specific material properties can be encountered for the design requirements. A number of possible failure modes can exist in a rock structure so that the determination of the material properties is a major problem.

Stability of the tunnel is to maintain the tunnel in equilibrium under various conditions of exposure. The tunnel is excavated through the rock medium and for rock structures initial stress prior to excavation is subjected to the stability of the rock mass around the tunnel excavation. As soon as the tunnel is excavated, the initial stress makes strained all the surrounding rock mass around the tunnel and all the points around the tunnel are consequently displaced radially into the tunnel. Slow deformation is initiated at the constant stress and the stability of the tunnel is dependent upon the current strength of the rock mass. Even the tunnel is stable at some stage, there will be the respective loads and the radial displacements called inward displacement and these displacements are controlled by the support systems.

High rock pressure and large inward displacement will be resulted from the rock mass having the low strength and high rock stress conditions. Depending on the rock stress conditions, the different support systems such as flexible support system and rigid support system can be used to control the displacement of the tunnel. In order to know the deformation behavior and the timing for installation of the primary support or lining, rock mass strengths and correlations to the rock mass classification are the key parameters to identify.

The stability of the tunnel depends on many different factors but the most influencing factors are described as follows:

i. Earth stress field or stress prior to excavation of tunnel.
ii. Strength and deformation of rock mass around tunnel.
iii. Characteristics of rock support.
iv. Ground water condition.
v. Shape and size of tunnel.
vi. Method and sequence of tunnel excavation.
vii. Location of excavation face.
viii. Time rate effect.

a. Rock mass strength parameters.

The basic parameters for stability design calculation generally include geological (rock and soil conditions) conditions which characterize the rock mass in the in-situ state. The hydrogeological conditions establish the quantity and pressure of water that must be controlled. Along with the estimates and associated uncertainties for these parameters, the performance of the rock mass can be estimated and the stability design of a tunnel can proceed. The geologic stratigraphy and structure form the framework for exploring and classifying the rock mass for design and construction purposes.

This geologic framework subdivides the rock mass into rock types of varying characteristics, delineates geologic boundaries, and provides clues as to geologic or hydrogeological hazards which have high influence on tunnel stability analysis. For each type of rock, intact rock properties affect stress-induced modes of behavior, durability and the excavation progress of the tunnel. Rock mass properties greatly affected by discontinuities and weathering affect opening stability during and after construction of the tunnel.

Rock masses are heterogeneous and discontinuities containing cracks, fissures, joints, faults and bedding planes with varying degrees of strength along these planes of weakness. The planes of weakness present in a rock mass control its strength and deformation behavior.

Apart from the frequency of joints, the orientation of joints with respect to the loading direction assumes greater significance from the point of view of stability. The strength along these joints is another important consideration in controlling stability. Reliable strength estimation of a jointed rock mass is necessary to evolve safe and economical designs of tunnels, slopes, dam foundations and underground chambers.

When the stresses or loads applied to a rock are gradually increased, it breaks. The strength of the rock is determined by the magnitude of the stresses at which it breaks. The critical values of breaking stresses depend not only on the properties of the rock but also on the nature of the stresses themselves.

The behavior of the materials beyond the elastic range is termed inelastic. Thus the theory of elasticity can be used to make the first approximation of the stresses, strains, and deformations in a rock structure under a given loading condition, and that various inelastic theory can be used to estimate the behavior that may occur and the ultimate loads that a given structure can support before excessive deformation, fracture, or disintegration occurs.

Uniaxial compressive strength (σ_c) is the ultimate strength of rock specimen failure under the axial load condition which is very important for rock failure analysis and the tunnel stability (The International Society for Rock Mechanics (ISRM) standard terminology). Physical characteristics, such as sample preparation, size, saturation, and mineral content influence the uniaxial compressive strength of rock specimens. These factors can considerably reduce the strength of rock materials.

Strength of rock under triaxial stress is an important criterion to be determined. The angle of internal friction and cohesion are obtained by using Mohr's Coulomb failure theory: (Hoek and Brown, 1980)

$$\sigma_1 = \frac{2c\cos\Phi}{1-\sin\Phi} + \sigma_3\frac{1+\sin\Phi}{1-\sin\Phi} \qquad (1)$$

When there is no confining pressure,

$$\sigma_c = \sigma_1 = \frac{2c\cos\Phi}{1-\sin\Phi} \qquad (2)$$

c = Cohesion

σ_1 = major principal stress (MPa)

σ_3 = minor principal stress (MPa)

Φ = Angle of internal friction

σ_c = uniaxial compressive stress of intact rock (MPa)

Hoek and Brown (1980) proposed an empirical criterion applicable both to intact rock and rock mass, the following form is tested in asymmetrical conditions in the previous form:

$$\sigma_1 = \sigma_3 + \sqrt{m_i\sigma_{ci}\sigma_3 + s_i\sigma_{ci}^2} \qquad (3)$$

Bieniawski proposed to calculate "m_j" and "s_j" for anisotropic rock mass, they made use of the geomechanics classification, rock mass rating (RMR) system. Priest and Brown proposed to estimate "m_j" and "s_j" using RMR as the following expression:

$$m_j = m_i \exp\left[{(RMR-100)}/{13.4}\right] \qquad (4)$$

$$s_j = \exp\left[{(RMR-100)}/{6.3}\right] \qquad (5)$$

m_i = empirical parameters of the intact rock

m_j ,s_j = empirical parameters of the jointed rock mass

RMR = rock mass rating

The parameter 'm' is a finite positive value and ranges from 0.001 for highly broken rock masses to about 25 for hard intact rocks. The value 's_j' ranges from zero for highly broken rock masses to 1.0 for intact rocks.

b. Rock mass classifications

Rock mass classification is the process of placing a rock mass into groups or classes on defined relationships (Bieniawski, 1989). It provides a valuable systematic design aid on many engineering projects especially on underground constructions, tunneling and mining projects (Hoek, 2007). Rock mass classification system consists of descriptive terms of the geometrical and mechanical properties of a rock mass and it is a basis for estimating deformation and strength properties. The characteristics which control rock mass deformability and strength were similar to the characteristics adopted in Q and RMR.

The complexity of geology over the length of a tunnel drive means that even the best geologic surveys of the site for a proposed tunnel are unable to provide a complete understanding of the underground conditions. The objective is to obtain a perspective on the use of the general classification schemes for characterizing the rock mass and in particular, on estimates of the ground support pressure.

There are different rock mass classification systems for the use of analysis of stability of any excavation. But for the analysis of tunnel stability, the following rock mass classification systems are mostly used:

- Rock quality designation (RQD)
- Rock mass rating (RMR)
- NGI tunneling quality index (Q system)
- Geological Strength Index (GSI)

3. ANALYTICAL METHOD OF TUNNEL STABILITY

The most important requirement for obtaining the realistic results is the failure criterion for rock material. According to the linear Mohr-Coulomb criterion, the strength of the rock mass increases with confining pressure. The behavior of the rock mass in practical is non-linear Mohr envelope.

Hoek and Brown (1982) described an empirical non-linear strength criterion applicable to both isotropic and anisotropic rock masses.

$$\sigma_1 = \sigma_3 + \sqrt{m_j \sigma_c \sigma_3 + s_j \sigma_c^2} \qquad (6)$$

Where, m_j and s_j are constants that vary with the rock type and the rock mass quality.

In the analysis of the rock mass behavior around the tunnel, the upper equation is used for the initial rock mass strength. It is assumed that in the broken or plastic zone, the parameters m_j and s_j will be reduced m_{jr} and s_{jr} with the residual strength of the plastic zone around tunnel.

$$\sigma_1 = \sigma_3 + \sqrt{m_{jr} \sigma_c \sigma_3 + s_{jr} \sigma_c^2} \qquad (7)$$

The reduction of m_j and s_j to m_{jr} and s_{jr} are dependent upon the earth stress field, excavation method and fracture orientation of discontinuities.

a. Earth stress or vertical stress of the tunnel

The vertical compressive stress is developed by the weight of the overlying rock and soil of the tunnel. This earth stress or vertical compressive stress increases approximately in proportion to the depth below the surface or the overburden to the center of the tunnel and in proportion to the density of the overburden material.

$$\sigma_v = \sigma_z = \gamma Z \qquad (8)$$

γ = unit weight of the overburden material

Z = depth of the overburden (m)

σ_v = σ_z = vertical stress (MPa)

b. Horizontal stress of the tunnel

Material which possesses cohesion after shearing may be said to be in the plastic state of stress when the applied stress is equal the value of its shear resistance. The additional resistance furnished by cohesion reduces the magnitude of the lateral stresses, σ_x *and* σ_y induced by σ_z and thus;

$$\sigma_x = \sigma_y = i\sigma_z - 2ic\frac{\cos\emptyset}{1-\sin\emptyset} \qquad (9)$$

Φ = Angle of internal friction

c = Cohesion

σ_h = horizontal stress (MPa)

σ_v = vertical stress (MPa)

σ_z = vertical stress (MPa)

$i = 1/j = \frac{1-\sin\emptyset}{1+\sin\emptyset}$

c. *Elastic state or elastic boundary*

If the tangential stress at the boundary does not exceed the compressive strength of the material, then the material is said to be in the elastic state. This means that this material stands without support.

The elastic boundary may exist in fragmented or granular cohesionless material as well as in cohesive material. In this state, the minor principal stresses should be large enough to prevent shearing due to the major principal stress.

Therefore, the location of the elastic boundary is determined by the ratio of the radial stresses and the tangential stresses, and these depend on the shape of the opening, the magnitude of the natural earth pressure, the cohesion and the internal friction of the rock.

The tangential stresses around the circular tunnel can be described as follows:

$$\sigma_{th} = 3\sigma_h - \sigma_v \quad (10)$$

$$\sigma_{tv} = 3\sigma_v - \sigma_h \quad (11)$$

σ_h= horizontal stress (MPa)

σ_v= vertical stress (MPa)

σ_{th}= horizontal component of tangential stress (MPa)

σ_{tv} = vertical component of tangential stress (MPa)

d. *Required support pressure for waterway tunnel*

In the determination of the required support pressure for the waterway tunnel, there are mainly two types of support pressure which are critical parameters for the analysis of the tunnel stability. These are:

- Vertical support pressure (for roof of the tunnel)
- Horizontal support pressure (for wall of the tunnel)

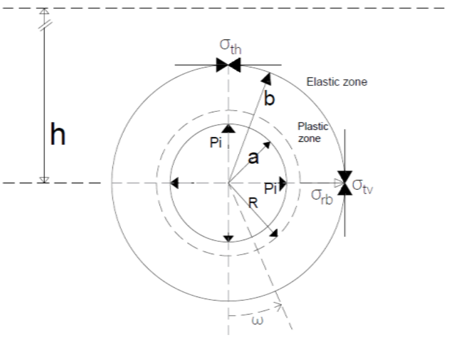


Fig 2. Support pressures and equilibrium conditions around circular opening

Source: Brown et al, (1993)

i. Vertical support pressure

The vertical support pressure is partially due to the radial pressure required to inhibit further extension of the clastic zone and partially due to the weight of sheared material in the clastic zone. The vertical support pressure is the maximum required support pressure for the stability of the crown of the tunnel.

$$\sigma_{rb} = \frac{1}{2}\sigma_{tx}\,(1 - \sin\emptyset) \quad (12)$$

$$P_{iA,V} = \sigma_{rb,vert}\,(\frac{a}{h})^{j-1} \quad (13)$$

$$P_{iB,V} = \frac{3}{2}\frac{\gamma.a}{(j-2)}\left[1 - (\frac{a}{b})^{j-2}\right]\cos\omega \quad (14)$$

The total vertical support pressure at the center of the arch is:

$$P_{i,V} = P_{iA,V} + P_{iB,V} \quad (15)$$

P_i = Support pressure (MPa)

σ_{rb} = radial stress around the tunnel (MPa)

σ_{tx} = horizontal component of tangential stress around the tunnel (MPa)

$\emptyset$ = angle of internal friction

ω = polar coordinate (90°,180°)

γ = unit weight of the overburden material

a = final radius of the tunnel (m)

b = radius of the plastic zone (m)

ii. Horizontal support pressure

The minimum required support pressure for wall of the tunnel is the horizontal support pressure which is required to stabilize the tunnel.

$$\sigma_{rb} = \frac{1}{2}\sigma_{tz}\,(1 - \sin\emptyset) \qquad (16)$$

$$P_{iA,H} = \sigma_{rb,hori}\,\left(\frac{a}{b}\right)^{j-1} \qquad (17)$$

$$P_{iB,H} = \frac{3}{2}\frac{\gamma.a}{(j-2)}\left[1 - \left(\frac{a}{b}\right)^{j-2}\right]\cos\omega \qquad (18)$$

P_i= Support pressure (MPa)

σ_{rb}= radial stress around the tunnel (MPa)

σ_{tz}= vertical component of tangential stress (MPa)

e. Inward displacement or decrease of opening diameter

When tunnel is excavated in unstable rock, the rock mass around the tunnel is displaced into tunnel as the time dependent deformation behavior. Deformation rate is governed by the ratio of the rock mass strength to earth stress. Extensive inward displacement may cause the many hazards, which are heavy support pressure on lining. Moreover, it would require the larger tunnel cross section to obtain to fulfill the required cross section of lining later. It should be considered in economy way.

In most cases where the internal boundary of an opening is stressed beyond its elastic limit, shearing will have extended some distance from the boundary before the support can be installed. If fracturing is extensive, support must be installed soon after excavation in order to prevent the opening from filling with fragment. In cohesionless material, support must obviously be installed simultaneously with the excavation.

The equation for decrease in radius of the tunnel in the clastic zone is described as follow:

$$a^2 = b^2 - k(b^2 - R^2) \qquad (19)$$

a = final radius of the tunnel (m)

b = radius of the plastic zone (m)

k = constant for the volume increase of the material

= 1.12 to 1.5 (book value of Labasse)

(R-a) = inward displacement (m)

f. Development of ground response curve

The Pi equations are used to calculate the support pressure. The curve between support pressure and tunnel displacement is plotted. This curve is called ground response curve. The support pressure decreases with the increase of the displacement.

The need for allowing the significant displacement is to reduce the cost of support system. This is the secret of success in tunneling through the weak rock.

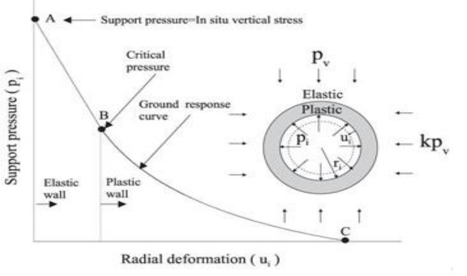


Fig 3. Ground response curve of a circular tunnel

Source: Brown et al, (1993)

g. Reinforced concrete lining for the tunnel

Reinforced concrete linings are used as an elastic support and reinforced layer in linings with a single layer should be placed close to the inside face of the lining to resist temperature stresses and shrinkage. This lining will remain basically undamaged for distortions up to 0.5 percent, measured as diameter and can remain functional for greater distortions. Multiple layers of reinforcement may be required due to large internal pressure or squeezing or swelling ground to resist potential ground displacements with a minimum of distortion. It is also used where other circumstancs would produce non uniform loads in rocks with cavaties.

h. Load considerations for waterway tunnel

In tunnel design, it is important to estimate the magnitude and distrubution of loads applied to the support pressure and the lining to carry the loads. The most important material for the stability of the tunnel is the rock mass, which accepts most or all of the distress caused by the excavation of the tunnel opening by redistributing the stress around the tunnel opening. The rock support and lining contribute mostly by providing a measure of confinement.

The loads may be greater than anticipated because of

- the variability of the environmental loading
- unforseen circumstances which may be lead to an increase in the general level of loading, errors in analysis and errors in during construction, etc.

A lining placed that has reached stability will experience no stress except due to self-weight. The actual stresses and displacements will depend on the modulus of the rock mass and that of the tunnel lining material. As the lining material pushes against the rock, the rock load increases.

i. Design consideration of reinforced concrete lining for pressure tunnel

A wide variety of support systems are available and the lining design will depend on the choice of construction method, including the nature of any temporary support.

Concrete linings require for tunnels must be designed to meet functional criteria for water tightness, hydraulic smoothness, durability, strength, appearance, and internal loads. The lining must also be designed for interaction with the surrounding rock mass and the hydrologic regime in the rock and consider constructability and economy.

Although the design of tunnel concrete linings is primarily dictated by structural requirements, constructability and practicability issues also influence the layout of the cross section. Depending on the computed section forces as well as the overall design concept of the tunnel, the linings can be carried out as a reinforced or an unreinforced cross section.

The structural layout of the tunnel concrete linings is dictated by various factors; geology and hydrological conditions, overburden depth, size and shape of the tunnel and the method of excavation and support to name the most influential ones. Varying tunnel lining thicknesses and loading conditions imposed by the above factors require multiple computation cross sections to represent typical and critical conditions relevant for the structural designs. The computations typically carried out by the empirical, analytical and numerical techniques produce a vast number of section forces for which the linings have to be designed.

In contrast to concrete designs for regular building construction where the reinforcement of concrete is adjusted segmentally along the length of a structural member according to the computed section forces, it is common practice in tunnel designs to base the reinforcement on the most favorable loading condition and use constant reinforcement along the perimeter and constant length of equal lining thickness. This is mainly due to constructability reasons.

Essential parameters are the strength of the concrete and steel, the thickness of the concrete lining and the amount of reinforcement. Some combinations of these parameters are limited by the building code or often dictated by the design.

j. Characteristics and design values of reinforced concrete for the waterway tunnel

When the initial ground support components do not fulfill the long-term functional requirements for the tunnel, the final lining is installed. Most of the tunnels in rocks are furnished with a final lining, which includes unreinforced concrete, reinforced concrete, segments of concrete and steel backfilled with concrete or grout.

Characteristics of the tunnel lining are as follows:

- Tunnel lining is not an independent structure acted upon by well-defined loads but by ill defined.
- Its behavior is governed by the surrounding ground.
- It is based on the interaction between support system and surrounding ground.
- The performance of the lining is effective when the support system and the ground is both uniform and continuous.
- It is a subsequence proceed working after rock stabilization work such as ground pre-treatment, grouting process and rock bolting.
- Tunnel lining is designed to resist an axial thrust based on the overburden and the groundwater pressure plus bending stresses resulting from the arbitrary percentage distortion of the diameter of the ring.

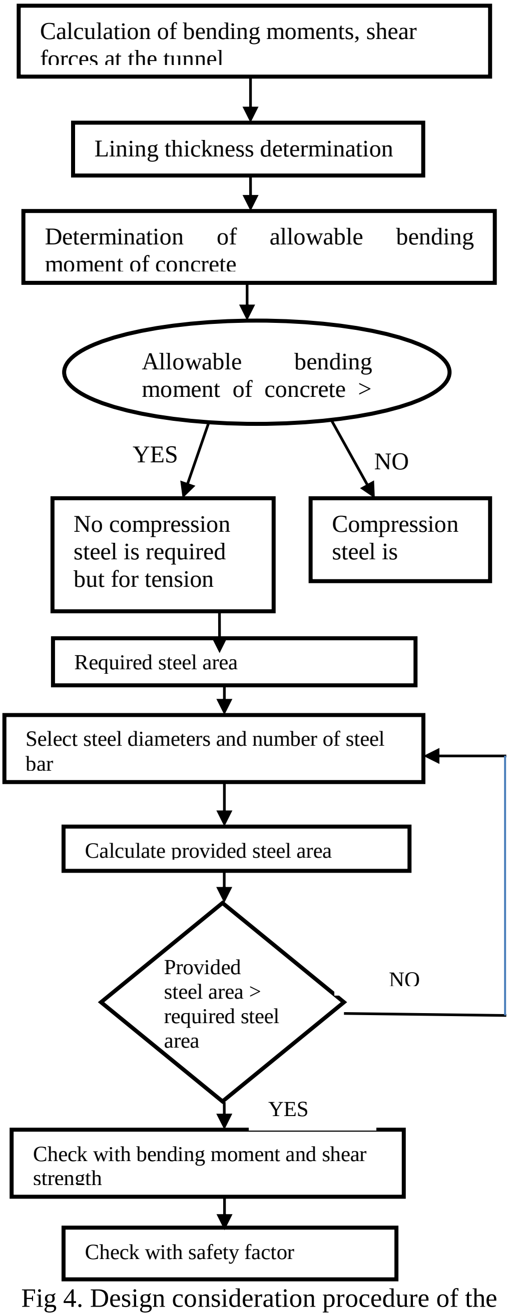


Fig 4. Design consideration procedure of the reinforced concrete lining

Concrete linings of pressurized water tunnels are always expose to cracks.

The cracks in the concrete linings cause to the water penetrates the surrounding of rock mass or soil, depending on the internal pressure drop of a certain water pressure on the exterior surface of the applied shields.

For reinforced concrete design of the tunnel, the maximum value of bending and shear are usually used to design the lining design of the waterway tunnel.

The design is checked for the remaining limit states such as deflection and cracking. In the waterway tunnel, cracking is more critical to the stability rather than deflection of the concrete.

4. ENGINEERING GEOLOGICAL CONDITION OF THE WATERWAY TUNNEL

Along the water way tunnel, 20 numbers of drill-hole were carried out for investigation (Drill-hole: ADD15, N11, ADD22, N8, N3, N2, N15, N7, N17, N5, N1, N9, ADD4, N10, ADD8). Mostly, the major rock type of water way tunnel is the sandstone, conglomerate and silty-stone. Different lithological conditions, buff to reddish brown colored silty, gritty sand residual soil of 7 to 27 m thick are observed. Reddish brown sandstone, conglomerate and siltstone are inter-bedded and intercalated underneath the soil layer. According to drill-hole investigation along the tunnel, six fault zones have been shown and some other buried fault may be occurred. The geological conditions and rock mass properties due to lithological changes and weathering effects will be considered in excavation design processes to eliminate or to reduce the related risks of tunnel construction during and after excavation.

According to the drilling investigation, the tunnel is mainly passed through the rock layers of mudstone, siltstone, sandstone and sandstone inter bedded conglomerate. The thickness of the overburden residual soil layer varies with the depth of 9-27 m along the tunnel. The maximum overburden depth of tunnel is about 70 m along the tunnel.

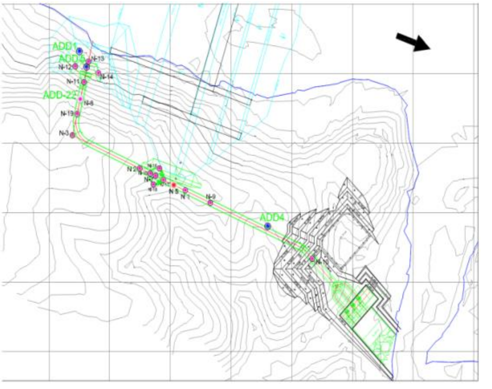


Fig 5. Drill hole location along Waterway Tunnel

Source: Geology report of Upper Keng Tawng Waterway Tunnel

According to the results of rock investigation along water way tunnel, the rock mass has been classified by the CRIEPI system (The Central Research Institute of Electrical Power Industry) and have shown with the relative RMR system. As mentioned in specification of water way tunnel project, it is necessary to classify by the Q system. Therefore, contractor will use the Q system, RMR and GSI for classification of rock mass quality and will present to responsible engineer or designer during excavation.

Based on the investigation, the groundwater level is estimated with the level of 706 m to be almost the same as the tunnel level. The range of tunnel invert level is from 706.0 m of intake to 686.36 m of outlet. Therefore, the effect of ground water pressure on tunnel is not critical during excavation. Proper drainage system will be required during excavation.

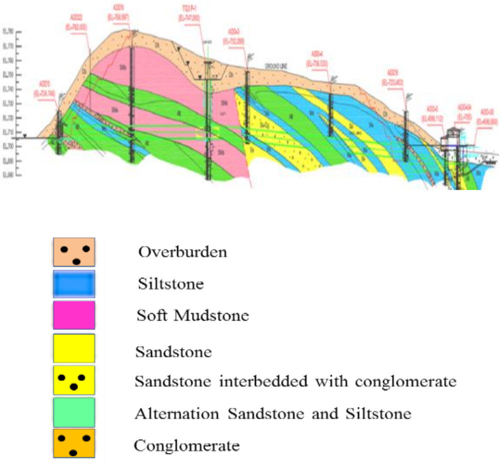


Fig 6. Rock types along the tunnel

Source: Geology report of Upper Keng Tawng Hydropower Project

Table 1. CRIEPI System of rock mass quality along the tunnel

Rock Type	CRIEPI System	RMR89
I	B	81-100
II	CH	61-80
III	CM	41-60
IV	CL	21-40
V	D	0-20

Source: Preliminary design report of Upper Keng Tawng Hydropower Project

a. Rock mass classification for study area

According to the preliminary design report, the rock mass has been classified by CRIEPI. For usual practice for rock mass classification, designer will modify using GSI and RMR methods with related strength of rock mass.

For the stability analysis of the waterway tunnel, the study area (from waterway inlet 108 m to 118 m) is close to the drill hole number N3. So, the rock parameters, geological conditions, rock mass quality and conditions are assumed nearly the same as the properties of the drill hole number N 3.

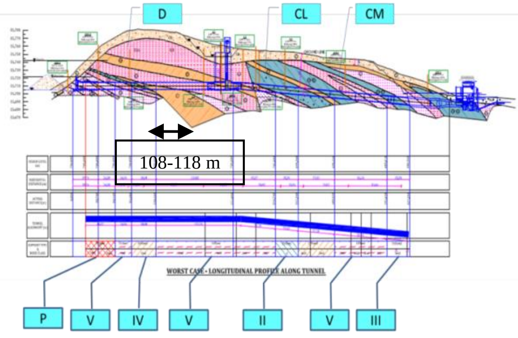


Fig 7. Rock class along the tunnel

Source: Final Feasibility Report of Upper Keng Tawng Hydropower Project

But the tunnel is assumed as it is in In-situ stress field which is hydrostatic that is, equal stress in all directions. Rock mass is isotropic and homogeneous. Failure is not controlled by major structural discontinuities. Support response is elastic-perfectly plastic. Support is modeled as an equivalent uniform internal pressure around the entire circumference of the circular tunnel.

Drill core quality is rated according to the rock quality designation (RQD) introduced by Deere (1963). RQD is an empirical index and it provides the quantitative index of fracturing within a rock mass based on the recovery of drill core. Although the RQD is widely used as a sole parameter for classification of rock quality, it is preferably to combine it with other parameters.

This quality index is a modified core recovery percentage which incorporates only those pieces of core that are 100 mm or greater in length. It should be noted that the RQD disregards the influence of discontinuity tightness, orientation, continuity and gauge (infilling) materials.

$$\mathrm{RQD} = 100 \times \frac{\text{Length of core pieces} \geq 100\ \text{mm}}{\text{Length of borehole}} \quad (20)$$

The RQD index is derived from standard sized core at least 50 mm in diameter over length of borehole of at least 1.5 m in length.

Firstly, the RQD value of the Upper Keng Tawng waterway tunnel is recorded from the drill hole results of the site investigation as an empirical value. But for more accuracy, the RQD values are determined again after blasting operation with 2 m interval.

The following values are recorded when the excavation is done by advancing with 2 m interval.

Table 2. Rock Quality Designation result for the study areas

Reduced distance from inlet (m)	RQD value (%)	Rock quality
108	45-50	Poor
110	45-50	Poor
112	40-55	Poor
114	40-50	Poor
116	40-50	Poor
118	40-50	Poor

i. Rock mass rating result of the waterway tunnel

Rock mass rating system (RMR) is based on the summation of rating for the following six rock mass parameters, all of which are measurable in the field and also be obtained from borehole data. Some of the data are denoted at the site during the excavation process of the tunnel but some are determined by testing the sample from the bore hole in the laboratory.

- Uniaxial compressive strength of intact rock material
- Rock quality designation
- Spacing of discontinuities
- Condition of discontinuities
- Groundwater conditions
- Orientation of discontinuities

Table 3. RMR result of the study area

distance from inlet(m)	RMR value	Rock class	Rock quality
108	35	IV	Poor
110	35	IV	Poor
112	35	IV	Poor
114	35	IV	Poor
116	35	IV	Poor
118	35	IV	Poor

ii. Q system result of the waterway tunnel

The rock class and rock quality of the waterway tunnel are also determined by using the rock quality system, Q system which was developed and used for determining the tunnel quality. The Q value of this waterway tunnel is calculated by the following formula:

$$Q = \left(\frac{RQD}{Jn}\right) x \left(\frac{Jr}{Ja}\right) x \left(\frac{Jw}{SRF}\right) \quad (21)$$

RQD=Rock quality designation

J_n = Number of joint sets

J_r = Roughness of the most unfavorable joint sets

J_a = Degree of alteration of filling of the most unfavorable joint set

J_w = Degree of joint seepage or joint water reduction factor

SRF = Stress reduction factor

Table 4. Q Value result of the waterway tunnel

Distance (m)	Q value	Rock class	Rock quality
108	3.4	D	Poor
110	3.3	D	Poor
112	3.4	D	Poor
114	3.4	D	Poor
116	3.4	D	Poor
118	3.4	D	Poor

iii. Geological strength index (GSI) of the waterway tunnel

The geological strength index GSI is based upon the visual impression on rock mass structure and rock weathering assessment, but the rock structures weathering assessment values quantization process is too rough, preventing accurate GSI values to be obtained.

After the classification of rock mass by using RMR, Q and GSI systems, the rock mass strength parameters which are critical for the analysis of stability of waterway tunnel and the determination of required support pressure and inward displacement of the tunnel.

Table 5. GSI results of the waterway tunnel

Distance from inlet (m)	GSI value	Rock type description	Rock quality
108	25	Disturbed	Poor
110	25	Disturbed	Poor
112	25	Disturbed	Poor
114	25	Disturbed	Poor
116	25	Disturbed	Poor
118	25	Disturbed	Poor

By the different classification of rock mass strength, the results show the rock mass strength of the study area of the tunnel is poor.

Table 6. Rock mass strength parameters related to rock mass quality (Siltstone)

CRIEPI rock class	B	CH	CM	CL	D
RMR	I	II	III	IV	V
UCS (intact rock)	26.11	26.11	26.11	26.11	26.11
RMR value	90	70	50	30	10
GSI	85	65	45	25	5
Damage Factor	0	0	0	0	0
m_i	7	7	7	7	7
m_j	4.097	2.006	0.982	0.481	0.235
s_j	0.1889	0.0205	0.0022	0.0002	0.00003
a	0.5	0.502	0.508	0.531	0.619
Φ, degree	36.74	31.76	26.11	20.35	13.45
c	2.819	1.556	1.071	0.718	0.321
UCS of rock mass	11.244	5.585	3.435	2.065	0.813
E of rock mass	6653.17	4535.9	1605.86	429.78	191.66
υ	0.25	0.3	0.3	0.35	0.35

Table 7. Rock mass strength parameters related to rock mass quality (Sandstone)

CRIEPI rock class	B	CH	CM	CL	D
RMR	I	II	III	IV	V
UCS of intact rock	65.92	65.92	65.92	65.92	65.92
RMR value	90	70	50	30	10
GSI	85	65	45	25	5
Damage Factor	0	0	0	0	0
mi	17	17	17	17	17
mj	9.95	4.871	2.384	1.167	0.571
sj	0.1889	0.0205	0.0022	0.0002	0.00003

CRIEPI rock class	B	CH	CM	CL	D
a	0.5	0.502	0.508	0.531	0.619
Φ, degree	45.14	39.57	33.57	27.44	20.14
c	7.188	4.8008	3.584	2.526	1.24
UCS of rock mass	34.828	20.422	13.359	8.314	3.551
E of rock mass	16797.28	11451.81	4054.33	1085.06	483.89
υ	0.25	0.3	0.3	0.35	0.35

The rock strength of study area of the waterway tunnel from the inlet of the tunnel (108 m to 118 m) has the uniaxial compressive strength of the intact rock which is the average value of drill hole N 3A, N 3B and N 3C and then the value is equal to 25.11 MPa and the rock is found as in siltstone having the unit weight of 0.003 MN/m^3.

b. Support pressure calculation for the study area of the waterway tunnel

Table 8. Input parameters for support pressure calculation

σ_{ci}(MPa)	25.11
ϒ(MN/m^3)	0.026
Φ (degree)	20.35
m_j	0.4810
s_j	0.0002
a (m)	4
h (m)	70

Table 9. Results for the determination of rock mass strength parameters

Strength of Rock mass (σ_{cj})	0.3551 MPa
Earth Stress Field (σ_v)	1.82 MPa
$\sigma_v > \sigma_{cj}$	The rock mass is defined as a plastic material.
Horizontal stress (σ_h)	0.7089 MPa
Tangential Horizontal Stress (σ_{th})	0.3068 MPa
Tangential Vertical Stress (σ_{tv})	4.7511 MPa
$\sigma_{tv} > \sigma_{cj}$	The tunnel is unstable without support.

c. Determination of required support pressure

Since the allowable displacement for this waterway tunnel (R-a) is 200 mm, the required support pressures for the roof and wall of the tunnel is determined as follow:

Radius to the final elastic zone, b	5.834 m
Vertical support pressure(for roof, ω=180°), $P_{i,V}$	0.2072 MPa
Maximum horizontal support pressure (for wall, ω=90°), $P_{i,H}$	0.6846 MPa

For the study area of the waterway tunnel of Upper Keng Tawng Hydropower project, the required minimum support pressure for roof is 0.2072 MPa and the required maximum support pressure for wall is 0.6846 MPa which are determined within the allowable inward displacement of 200 mm for wall. It has been also presented with the ground response curves and can also be identify to provide the required minimum support pressure with respect to the displacement.

The ground response curve for the roof the tunnel shows when the inward displacement of the tunnel reaches to its final limitation of 200 mm, the tunnel is more likely to happen failure. Therefore, before reaching to the allowable displacement, the support must be installed complying with the required support pressure to stabilize the tunnel.

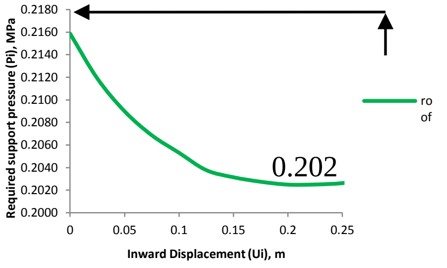


Fig 8. Ground response curve for tunnel roof

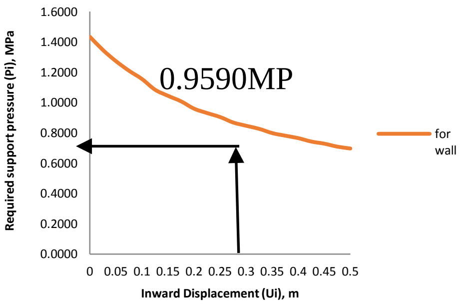


Fig 9. Ground response curve for tunnel wall

The stability of the wall of this waterway tunnel is possible until the minimum support pressure of 0.9590 MPa is provided with the allowable inward displacement.

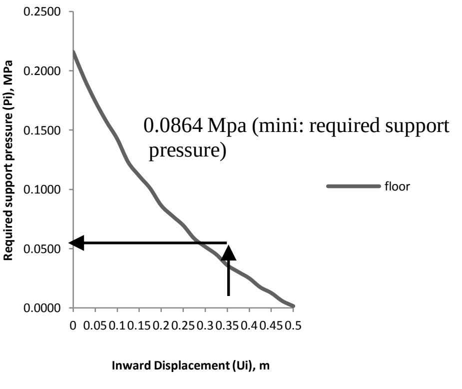


Fig 10. Ground response curve for tunnel floor

According to the following Fig, the floor requires the least amount of support compared to that of the roof and wall required. Even though the floor is stable, it is necessary to monitor the inward displacement of the whole tunnel including the floor.

d. Characteristics and design values of reinforced concrete for waterway tunnels

The main purpose of the tunnel lining is to remain stable soon after excavation is completed by creating a suitable structure in corporation with the surrounding rock mass. Moreover, tunnel lining helps to give the final shape to the tunnel cross-section and to give strength to the sides and roof to prevent them from collapsing.

Design and construction of the final concrete lining comes about through the interplay of tunnel cross-section, geological and hydrological conditions, construction method and structural consideration. For this waterway tunnel, the factors are considered as follow:

- Rock ground and concrete is uniform elastic body
- There is no space between surrounding rocks and lining concrete
- Rock has sufficient tensile strength because there is no looseness area due to grouting effect.

The strength of the concrete and steel members may be less than intended value because of:

- its variable composition
- the variability of manufacturing conditions during construction ans other effects such as corrosion.

Concrete strength design is based on the ultimate concrete strength, reduced by the strength reduction factor, ϕ, which is similar to LRFD (load and resistance factor design) used in building.

The design must be capable of withstanding the loads acting upon the waterway tunnel.

Design strength > design load (22)

If the compression steel is not required, the concrete has enough strength to endure the compression loads acting upon the lining. Although the strength of the concrete is tolerable to the compression stress, the steel bars are needed to install as main bars and distribution bars for tension.

The following equations are used for determination of the design:

segment of concrete and steel backfilled with concrete or

grout. Where the internal pressure exceeds the external ground and groundwater pressure, a steel

lining is usually required to prevent hydro-jacking of the rock. Adequate confinement refers to the

ability of a rock mass to withstand the internal pressure in unlined tunnel. If the confinement is

inadequate, hydraulic jacking may occur when hydraulic pressure wit

Balance steel ratio,

$$\rho_b = 0.85\beta_1(f_c'/f_y) \times (6120/(6120+f_y) \quad (23)$$

Maximum steel ratio is 75% of balanced reinforcing.

$$\rho_{max} = 0.75\ \rho_b \quad (24)$$

Allowable bending moment of concrete,

$$M_c = \phi\ \rho_{max} bd^2 f_y\ (1-0.59\rho_{max} f_y/f_c') \quad (25)$$

The load factor specified in ACI code must be applied to calculate dead loads specified in the appropriate codes or standards. The dead load must be multiply with the load factor 1.4.

Design moment, $M_{design} = 1.4\ M_{max}$ (26)

$$\rho = 1/m\ (1-(1-2m^*R/f_{ee})^{0.5} \quad (27)$$

where, $R = D_{esign} / (\phi\ bd^2)$

$m = f_y / (\beta_1 f_c')$

Minimum steel ratio, $\rho_{min} = 14/f_y$ (28)

Required steel ratio, $A_s = \rho bd$ (29)

Provided area of steel,

$A_{s,\ prov:}$ = Area of steel x No of steel (30)

Checking with the bending moment,

Moment for design,

$$M_b = \phi\ Rbd^2 \quad (31)$$

Where, $R = \rho f_y\ (1-0.59^*\rho f_y/f_c')$

$\rho = A_{s,prov:} /bd$

Checking with the shear force,

$$\emptyset V_n = \emptyset \times 2 \times \sqrt{f_c'} \times \mathrm{b} \times \mathrm{d} \quad (32)$$

d= effective depth (m)

b = width (m)

f_c =concrete compressive strength (MPa)

A_s= cross sectional area of steel (m^2)

f_y = ultimate yield strength of steel (MPa)

ρ = percentage of reinforcement

M_{design} = bending moment considered to design the concrete reinforcement (kNm)

M_{max} = maximum bending moment to be considered (k Nm)

M_c = allowable bending moment of concrete (k Nm)

ϕ = Strength Reduction factor for moment

β_1 = Strength Reduction factor for shear

Design calculation of permanent lining of Upper Keng Tawng Waterway Tunnel

For the loads determination acting upon the waterway tunnel lining, it can be considered as:

- Internal pressure
- External rock pressure
- Grouting pressure

In this paper, the external rock pressure is more critical and directly affected to the concrete lining than internal water pressure and grouting pressure. Therefore, only external rock pressures are considered as loads upon the concrete lining of the waterway tunnel.

The tunnel has a circular cross-section and it is assumed as the surrounding rock of the tunnel having the same type of rock class and similar properties and same strength.

For the bending moment and shear force, it is assumed as the tunnel is symmetrical and therefore, bending moment and shear forces at only the right portion of the tunnel are calculated.

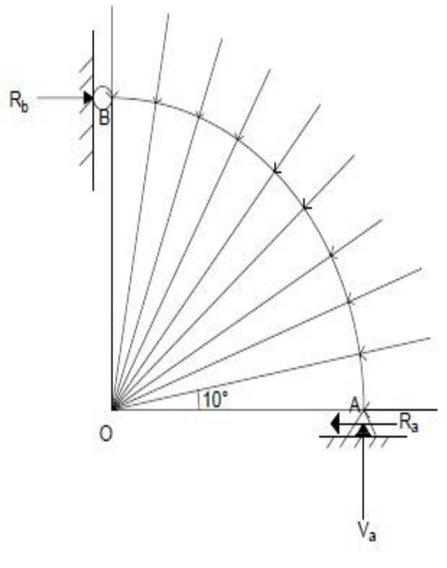


Fig 11. Right portion of the tunnel

From this calculation, the maximum bending moment and maximum shear force are determined.

M_{max} = 108 k Nm

V_{max} = 752 k Nm

According to the design procedure, the concrete lining thickness is determined.

For this study area of the tunnel, the lining thickness is determined as 500 mm (Main Report of Upper Keng Tawng Hydropower Project).

Table 10. Required dimensions and assumptions of lining

Thickness	30 cm
Cover	5 cm
Effective depth, d	20 cm
Width, b	100 cm

Table 11. Material properties according to ACI (American Concrete Institute) code of practice

Compressive strength of concrete, f_c'	30 MPa
Yield strength of steel, f_y	414 MPa
Strength Reduction factor for moment, ϕ	0.9
Strength Reduction factor for shear, β_1	0.85

Table 12. Results of calculation for allowable bending moment

Balance steel ratio, ρ_b	0.0310
Maximum steel ratio, ρ_{max} (75% of balanced reinforcing)	0.0232
Allowable bending moment of concrete, M_c	1449.87 kNm

The load factor specified in ACI (American Concrete Institute) code must be applied to calculate dead loads specified in the codes or standards. Since the tunnel is pressure tunnel, the dead load must be multiplied with the live load factor of 1.4. Then the design moment is 1.4 times of the maximum bending moment and therefore, the required design moment is 151.2 kNm per meter.

Since the design bending moment, M_{design} is less than the allowable bending moment of the concrete, M_c, compression steel is not required to install in this tunnel. The concrete itself has the strength to the compression of the load upon the lining structure.

The steel ratio provided is less than the minimum steel ratio. Therefore, in calculating the required steel ratio, ρ_{min} of 0.00332 should be used. Then the required steel ratio, A_s is 14.92 cm^2.

Assume 25 mm Diameter of Steel bar and number of steels is 8 per meter, the provided steel area, $A_{s,prov:}$ is 39.29 cm^2. Therefore, the bending moment created by installing these reinforcing bars is 406 kNm per meter which is greater than the required bending moment of 151.2 kNm.

Checking the safety factor with bending moment,

$$SF = \frac{M_{design}}{M_u} = 2.69$$

This reinforced concrete design is acceptable for this waterway tunnel since the provided design has safety factor of 2.69. Therefore, the tunnel is stable by installing the reinforced concrete with the thickness of 500 mm and the total number of 8 reinforcing bar of 25 mm diameter per meter of the tunnel cross section.

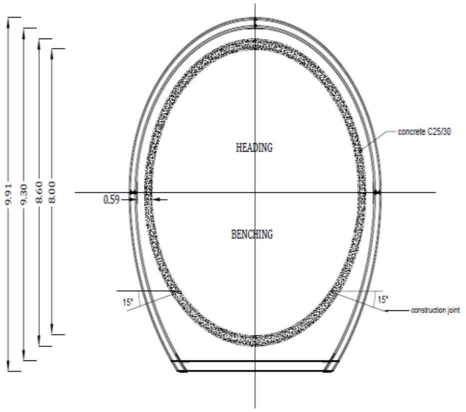
Allowable shearing strength of the lining concrete,

$$\emptyset V_n = \emptyset \times 2 \times \sqrt{f_c'} \times b \times d$$

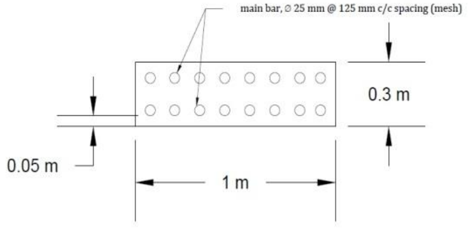
$$= 1397 \text{ kN per m}$$

The excavation method used in this tunnel is heading and benching method, but when the author visits the tunnel, it is in the heading stage of the construction. The final shape of the tunnel is circle, the concrete lining installation will be started after both heading and benching of the tunnel construction. But according to the safety measure, the concrete lining design and steel structure installation has been calculated and checked. The concrete type is C25/30 which is available in Myanmar. The steel used for main bar is 25 mm diameter and spacing of 125 mm (center to center), which provides the safety factor of 2.69. Therefore, this reinforced concrete design is acceptable for the tension.

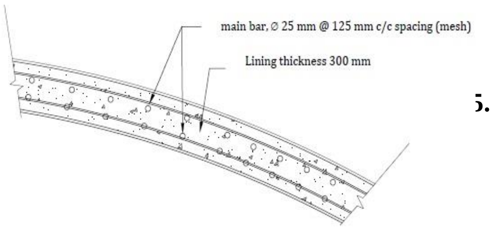
Since the allowable shear strength of the lining concrete is greater than the maximum shear stress created by the tunnel, the tunnel is stable by installing the main bar of steel to withstand maximum the bending moment.



(a) Tunnel profile with permanent lining



(b) Section for the final lining of the tunnel



(c)Tunnel lining thickness

Fig 12. Detail drawing of reinforced concrete for tunnel lining

If initial supports are installed early and correctly, it can be showed, that they will not deteriorate within the design life of the structure, and if the opening is stable, then a structural final lining is not required.

If initial supports are installed early and correctly, the opening is stable (with no continuing loosening), but it cannot be demonstrated that the initial supports will remain completely effective for the design life of the structure, then the loads on the final lining may be essentially equal to those of the initial support.

If initial supports are providing a seemingly stable opening but it is known that additional support is required for long term stability then that support must be provided by the final lining.

The initial supports should be designed to install after excavation to support the opening safely As the final support is to make sure the structure safe and stable in the long term usage of the tunnel, all the parameters such as grouting pressure and internal water pressure that could be the problem in stabilization of the tunnel should be considered when the final support design is implemented.

The calculation of the safety factor for the tunnel lining design is mainly related with the maximum bending moment and normal forces that induces in the lining material. The condition for this solution is mainly dependent on the properties of the rock mass media and the lining material and their coefficients.

5. CONCLUSION

One of the most important considerations in tunnel construction is the stability. When the tunnel has been excavated, stability is an important factor for the long-term usage of the tunnel and cost minimization especially as if the study segment of the tunnel which is 108 m to 118 m reduced distance from the tunnel inlet has poor rock class. The stability of the tunnel largely depends on the strength and deformation parameters of the surrounding rocks. In order to obtain the reliable data of these parameters, the geological and geotechnical data from the boreholes are properly collected. The quality of the rock mass is classified by the rock mass classification systems which have significant effects over the stable design consideration of the tunnel. In this study, RMR, Q and GSI systems have been used to classify the rock mass condition of the waterway tunnel. The analysis of tunnel stability for this study has been done by using only the Hoek and Brown’s criterion and the parameters of this criterion were determined from these rock mass classification systems.

According to different rock mass classification systems, the rock mass at the study area of the waterway tunnel (108-118 m) is in poor rock class. Within the allowable inward displacement of 0.2 m, maximum required support pressure for wall and tunnel crown has been determined as 0.6846 MPa and 0.2072 MPa respectively. When it is compared to the wall and floor of the tunnel, it is found that the crown can collapse when it reaches to the maximum allowable displacement of 0.2 m unless required support is provided. Therefore, before the tunnel displacement reaches to the maximum allowable displacement of 200 mm, the permanent support system which is the reinforced concrete having the thickness of 300 mm and the reinforced steel bar of diameter 25 mm with the spacing of 125 mm per meter of the tunnel length should be installed.

The displacement occurred to the tunnel crown is more critical than the wall and floor displacement in this tunnel. This happens because the tunnel depth has more influence in the crown displacement than in the wall displacement. The displacement of the wall and floor are always more influenced by the initial stress ratio in the rock mass than by the height of the rock mass above the crown of the tunnel.

The design of the permanent tunnel support has been implemented by considering only rock pressure as the load acting on the tunnel. But there are internal water pressure and grouting pressure that should be taken account into consideration when it comes to stability of waterway tunnel. In this paper, the surrounding rock condition is considered as homogeneous in the study area of cross-section. However, rocks are heterogeneous and anisotropic; numerical analysis should be used as it is based on non-linear analysis to get precise and accurate analysis of the tunnel stability.

It has been also presented with the ground and support reaction curves and can also be identify to provide the required support pressure with respect to the displacement of the tunnel. Finally, the displacement of the tunnel wall, crown and floor in isotropic conditions can be determined with the analytical approach, but further research is necessary in order to estimate displacements more accurately.

Ensuring the stability of the tunnel is one of the most important aspects to accomplish the project successfully during the planned completion date. The Upper Keng Tawng Hydropower Project, the 51-megawatt (MW) hydropower project currently being implemented by the Ministry of Electricity and Energy aims to contribute to electrification of about eight million households by 2025-2026. The project is expected to generate 267 million kWh of annual electric energy to the national grid and supply electricity to more than 800,000 residents in nationwide. It will improve the living conditions of local people, expand opportunities for economic activity, and improve health and the access to basic social services. This project is also executed according to the Myanmar Sustainable Development Alignment such as promoting equitable and conflict-sensitive socio-economic development throughout all States and Regions, enhancing the efficiency and competitiveness of State Economic Enterprises, building a priority infrastructure base that facilitates sustainable growth and economic diversification, providing affordable and reliable energy to populations and industries via an appropriate energy generation mix. It is not only providing job opportunities for the locals during the project but also planning to contribute the low-cost energy to electric power grids after the project completion. In order to implement the project sustainably, and to fulfill the requirements for compensation and mitigation, local benefit sharing ensures to facilitate the development of the local communities. It also helps to provide equitable development, sustainable and smooth project implementation and to avoid the conflicts from the local and other stakeholders and to create synergies maximizing the local development opportunities.

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INTERNATIONAL EXPERIENCE IN STATE MANAGEMENT FOR INDUSTRIAL ZONES AND LEARNING EXPERIENCE FOR VIETNAM

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Abstract: *An industrial zone is an area specialized in the production of goods and provision of services for industrial production, with a specified location and boundary, established according to the conditions, order, and procedures prescribed by the State. Managing and improving industrial zones' efficiency is an urgent issue to promote the role and essential contribution of industrial zones (IZs) to the national economic development, ensuring stable advancement in Vietnam at present. To do so, researching preceding countries' experiences to draw lessons for Vietnam is an issue that has profound practical meaning.*

Keywords: *industrial zone, industrial, state management.*

1. INTERNATIONAL EXPERIENCE IN STATE MANAGEMENT FOR INDUSTRIAL ZONES

1.1. Thailand experience

Thailand has developed the model of IZs and manufacturing zones (MZs) since 1970. The model of IZs and MZs of Thai is a model of integrated industrial zones, including IZs, MZs, and service zones.

Thai IZs can be owned by the State or privately or through a State-owned corporation, the Industrial Estates Authority of Thailand (IEAT) or the Board of Investment of Thailand (BOI); or a member of Thailand Industrial Estates Association (TIEA); either under the Ministry of Industry of Thailand or in a joint venture with IEAT. Therefore, the methods of investing in construction and trading in infrastructure are also diverse. Secondary investors buy lands for specific terms or lease properties in IZs with developed infrastructure.

The State management policy of IZs is consistent with decentralization to regions and localities. Different preferential policies for each area implement the IZ planning options. When investing in Thai IZs, investors enjoy preferential taxes, fees, prices, and a one-stop management mechanism. Financial incentives are determined according to investment preference regions. Thailand's industrial zones are divided into three areas: zone I include Bangkok and five neighbouring provinces; Region II covers the next 12 provinces, and Region III consists of the remaining 58 provinces. Financial incentives are most concentrated in Region III. Region III is the most preferential area. At the same time, Thailand also plans the industries according to investment incentives. Many industries are not allowed to invest in Region I, but only to invest in Region II or Region III. For example, the manufacturing of rubber products, ceramic, porcelain, glass, and tool making, etc., must be located in Region II or Region III; animal feed production, vegetable oil; Coke drinking water, table sugar, general garment products, fishing nets, ... must be located in Region III. In general, industries require much simple labour, likely to pollute, and need to use agricultural materials planned far from Bangkok and five neighbouring provinces.

Thailand was interested from the outset in providing adequate necessary infrastructure in favour of IZs, especially in new cities; redistribution of income along with other physical conditions. Environmental pollution in IZs is handled systematically and synchronously, limiting the establishment of industrial zones in tourist centers. Workers working in industrial zones are trained progressively and increasingly improve their skills; technologies being concentrated in several IZs is a condition for science and technology transfer among industrialists. In particular, Thailand has synchronized planning from industrial zones, comprehensive planning of industrial zones, spatial planning of industrial zones. The development of IZs always has a closed social infrastructure system to ensure the accommodation and living state of industrial workers. Management procedures are convenient and straightforward for investors. They have an asynchronous development program promotion mechanism between central and local state agencies. They prioritize investment in the construction of technical bases to form industrial centers.

1.2. Chinese experience

The process of forming and developing the IZ model is associated with China's reform and opening-up policy. The model that China chooses to develop is SEZs. Shenzhen City is one of five cities selected to be built and developed according to the "special economic zone" model in the early stages of development. Up to now, Shenzhen has become a modern special economic zone. It plays a vital role in supporting underdeveloped inland regions, serving as a bridge for joint ventures between domestic and foreign enterprises.

After more than 30 years of establishment, Shenzhen has attracted more than 50 billion USD of FDI capital with more than 29,000 enterprises. Many transnational corporations have also participated in investing here. Shenzhen has become one of the fastest-growing and most influential cities in China, home to high-tech products such as new materials, biotechnology, electronic components and microchips, the base of the creation, trading, and research and development of transnational corporations.

The development experience of Shenzhen, China focuses on the following principal contents:

Firstly, in planning construction and implementation:

- Develop planning according to a strict process, making full use of planning experts' opinions to ensure a long-term, high scientific vision. Therefore, the approved planning is of high legal nature, limiting the planning adjustment in the implementation process.

- Planning management is done based on accurate planning information and data, with negativity restrictions. The planning manager has high professional qualifications to operate the planning management apparatus. Besides, the plan harmoniously addresses the interests of investors and the State. Thus, the science of the project is ensured. The sense of responsibility of the people and enterprises is also adequately aware of the importance of the planning.

Secondly, on compensation and site clearance: the State does not compensate the people for land acquisition all at once but is divided into many times to facilitate long-term life through subsidies contributing to business capital, creating jobs, providing appropriate vocational training, etc.

Third, having preferential policies for investors according to regulations and oriented investment areas right from the start. Tax and capital mobilization policies have been applied more and more entirely and flexibly.

1.3. Malaysian experience

Since the 70s of the 20th century, IZs in Malaysia have been operating up. Up till now, most of the IZs are located in important centers. Free trade zones are built and located close to major cities with good infrastructure, abundant labour supply, and a favorable business environment. Based on each region's geographical location and advantages, the Government has appropriately allocated IZs such as hi-tech parks in Kedah, Penang and Johor, wood processing IZs in Selangor, and IZs specializing in electricity and electronics production in Malacca and petrochemicals in Terengganu. IZs in Malaysia have created socio-economic impacts of each region; some of the positive effects are as follows:

- The IZs have brought many jobs and incomes for the people in the area, including direct labour in the IZs who is participating in the construction and expansion of the IZs, roads, and indirect job creation for local enterprises while participating in supporting businesses inside the IZs (supplying raw materials, accessories and other services). Local residents can also meet the needs of workers in the industrial zone, such as providing essential services such as housing, supermarkets, food shops, etc. Thus, the industrial zones have contributed to the development of local businesses and increase income for people in the region.

- The Malaysian Government is interested in building IZs in underdeveloped regions to invest in programs such as expanding roads, building health centers, education, housing, etc. This work is associated with the planning of IZs and the planning of the region's socio-economic development. Accordingly, people in the area are the ones who will benefit from the above programs after the projects are completed and put into use.

- During the construction and investment process, the Malaysian Government is interested in architectural design and standard drawings applicable to industrial zones' construction. Each enterprise in the IZs has a green garden, brick road and sewer system, parking area, security room. Outside the fence of the IZs, building roads, closed sewers, and traffic lights to ensure safety for workers and people in the area. Therefore, people in the region also benefit from investments in industrial zones.

In addition to the positive impacts, industrial parks in Malaysia also bring the following adverse effects:

(i) Construction of housing to provide low-income workers and migrant workers. Infrastructure developers pay little attention to building houses for workers, and the shortage of workers frequently occurs.

(ii) Investing in IZs and MZs causes land prices to go up, workers do not have the opportunity to buy their own houses, leading to illegal land encroachment, prone to conflicts between related parties. The land fund to invest in recreational spaces and green parks is significantly reduced, reducing the chances of local people and workers participating in healthy recreational activities.

(iii) Large-scale IZs can restructure the local economy in a way that affects the interests of the poor. The land fund used for agricultural production is recovered for the construction of the industrial park, people can participate in projects in the IZs, but with low skills and poor workmanship, without proper training, they fall into unemployment when there is no productive land and no stable jobs.

2. LESSONS ON STATE MANAGEMENT OF IZS IN VIETNAM

From the study of successful and unsuccessful experiences in State management of IZs in some countries, the following lessons can be drawn for Vietnam:

Firstly, early planning and creating conditions for the development of IZs is a suitable way for industrialization and modernization of the country's economy.

The experience of countries and localities shows that to promote industrial zones' development, the state and local authorities need to improve the effectiveness and efficiency of management, primarily through the planning of IP development strategies, land policy, finance, and credit policy support for administrative procedures. IZ planning must be combined with territorial industry planning based on comprehensive planning associated with regional planning, linking industrial zones with urban areas and services.

In any locality with a dynamic government, the industrial park there not only develops rapidly but also operates effectively. To facilitate the development of IZs, provincial governments often focus on supporting land, capital, administrative procedures, and investment promotion. The experience of many provinces shows that the friendly state managers, the public, clear and stable planning, the cooperation of workers, and the guaranteed socio-economic infrastructure are decisive factors for the successful development of IZs in the locality.

Secondly, the experience of other countries shows Vietnam that, in organizing the management of IZs, it is necessary to focus on the following main issues:

- Ensuring consistency in management by clearly defining the functions, tasks, and powers of the management board of IZs at all levels. The state management system must be compact and practical.

- It is necessary to have long-term and stable policies for investors to feel secure in investing in IZs.

- Publicize administrative procedures, quickly and adequately handle investors' requests according to state regulations

- It is necessary to have strict sanctions for enterprises that violate the law.

- Have concern and friendliness from all authorities, departments, and branches in the province towards investors in the IZs. Ensure consistency in management by defining the functions, duties, and powers of the management board of IZs at all levels. The state management system must be compact and practical.

- There must be a contingent of wholehearted and qualified civil officers capable of performing state management tasks in IZs.

Thirdly, proactively formulate and implement appropriate investment promotion programs, coordinate smoothly with infrastructure investors to strengthen domestic and foreign investment promotion such as

1. Setting up targets for industries, fields, and projects that need investment promotion;

2. Select suitable investment promotion sites;

3. Organize domestic and foreign seminars with contents related to investment promotion.

Fourthly, the process of state management of IZs is complex and diversified. Each locality has a different direction and way of going. However, they all have the same thing, which is the effort to promote comparative advantage, boldly entering critical economic sectors, critical economic regions, and implementing the open doors in the direction of promoting exports, at the same time paying attention to the domestic market. The preferential policy for investors to IZs cannot go beyond the general regulations of the Government. Still, it can be flexibly applied to increase the attractiveness to attract strategic investors following the right industries, businesses that the planning requires.

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VIETNAM'S INTEGRATION INTO THE WORLD ECONOMY: A REVIEW AFTER 30 YEARS OF ECONOMIC REFORM

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Abstract: *This article aims to review Vietnam's integration into the world economy over the past three decades. After 30 years of economic reforms, the country has moved from a developing country to a middle-income economy. This success has resulted from important reforms, transformed from a centrally planned economy towards market mechanisms, and integration into the global economy. Thanks to trade liberalization, imports and exports of Vietnam have grown remarkably, having positive impacts on socio-economic development. However, there are still many challenges for Vietnam, such as trade and non-tariff barriers created by foreign markets and low competitiveness of domestic Vietnamese enterprises. At the same time, low value-added export products and services, along with high dependence in some markets, have emerged as key challenges to maintaining Vietnam's momentum in global trade expansion. As a consequence of the global economic recession, FDI inflows have declined in recent years but still play an important role in providing capital for Vietnam, while ODA is one of the essential investment sources for the socio-economic development of Vietnam. Our paper suggests that to attract and use both of these capital sources effectively, Vietnam needs to improve its institutions and public investment management.*

Keywords: *Economic integration; trade liberalization; economic reform, Vietnam*

1. INTRODUCTION

During the postwar period in Vietnam, as a result of the restrictive policies, there was an agricultural production crisis, no foreign investment, and insufficient domestic financial resources for economic development and job creation. By the time the Vietnamese economy was dysfunctional: it had no heavy industry, and bureaucracy blocked all market forces (Anh-Tuan D., Thi C., 2015). A desperate measure to improve the situation was adopted formally at the Sixth Communist Party Congress in 1986.

This movement is known as "Doi Moi" (or "reform" in English). After the political and economic reforms were launched, the country transformed from one of the poorest in the world, with per capita income less than the US $100, to lower-middle-income status within a quarter of a century with per capita income of around US$2,100 by the end of 2015 (CIEM, 2013).

Behind Vietnam's transformative growth are 30 years of major policy and institutional reforms that shifted the economy from central planning and towards market mechanisms and sought to integrate the country into the global economy. These reforms can be summarized as four processes of internal and external economic liberalization as i) the liberalization of prices and internal trade began in the mid-1980s to tackle severe supply shortages in most goods and services; ii) Agricultural liberalization began with a view to overcoming stagnant production, identified then as a significant bottleneck to economic growth; iii) the liberalization of the non-agricultural sector accelerated in the 1990s with a view to boosting the private sector; and iv) the external liberalization gained steam at all levels-unilateral, bilateral, regional and multilateral.

For the external liberalization, major changes have taken place at borders, such as reductions in import tariffs and removal of non-tariff barriers to trade; beyond borders, through greater access to overseas markets and to the WTO's dispute settlement mechanism; and behind borders through the opening of service sectors and distribution systems, and changes in legal and regulatory frameworks.

2. ANALYSIS OF VIETNAM'S INTEGRATION INTO THE WORLD ECONOMY

Vietnam has increasingly integrated into the global economy, resulting in rising flows of external trade and foreign investment associated with technology and higher-skilled labor. This process has not only boosted exports and facilitated restructuring in the domestic economy but also become a key driver of institutional reforms, including legal and judicial structures to become more consistent with international practices.

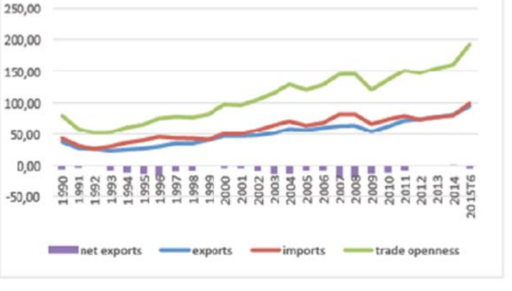

Fig 1. Development of foreign trade in Vietnam in percent of GDP

Source: *Calculated based on the General Office of Vietnam. Trade openness is defined as exports plus imports.*

From very low levels of imports and exports as a percent of GDP, trade increased sharply whereas imports were usually higher than exports. In 2015 the sum of exports and imports in percent of GDP reached around 200 % (Fig 1). This is exceptionally high compared with a value in the same year of 23 % of the USA or China 42 % (Hansjong H., E. Schweisshelm, T-M. Vu, 2016). This percentage is in international comparison, especially for a country with a population of over 90 million inhabitants as Vietnam very high and makes Vietnam more dependent on world market developments than other countries.

In most of the years, the current account balance in Vietnam showed negative values. However, the last year was more or less balanced (see Fig 2). In some of the years, the current account deficit was very high, with values of more than 5 % or even 10 % of GDP. Of course, net capital inflows allow the import of capital goods, which can increase productivity. However, much-needed imports of machines, etc. are also compatible with a balanced current account or even a surplus.

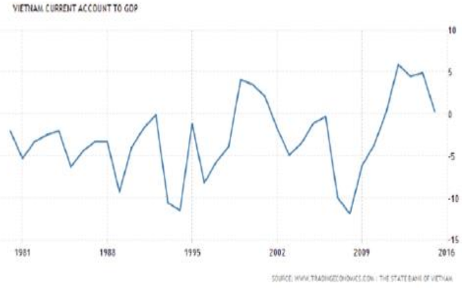

Fig 2: Current account balance of Vietnam in percent of GDP

Source: Trading Economics

After 2005, Vietnam's foreign debt sharply increased; however, it decreased after 2012 somewhat (Fig 3). With an actual foreign debt level of 45.2 % of GDP in early 2016, Vietnamese foreign debt is high (IMF, 2016). In the case of strong depreciation of the VND (dong), foreign debt can become a high burden. Most of the debt is public debt. Public debt to GDP in 2015 was 58.3 % with an increasing trend; at the end of 2014, public debt in foreign currency was 39.9 % of GDP (Ohno, K, 2015). While official loans to Vietnam are shrinking, Vietnam might gradually seek ways to get more risky commercial loans with floating interest rates. Therefore, the risk of changing interest rates and exchange rates might substantially increase.

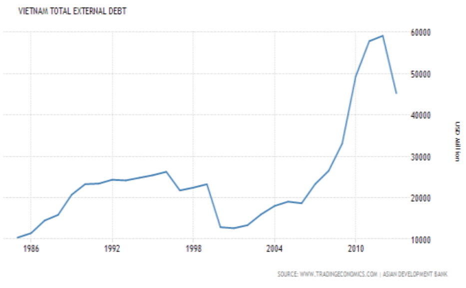

Fig 3. Gross foreign debt in Vietnam in percent of GDP

Source: Trading Economics.

Current account deficits are only possible if a country can realize net capital inflows or reduces official foreign reserves. For Vietnam, FDI inflows play a significant role and financed part of the current account deficit. However, FDI inflows which do not create foreign debt were not big enough to avoid the accumulation of foreign debt in Vietnam.

Since the Foreign Investment Law took effect in 1987, Vietnam has achieved substantial FDI inflows. Measured in percent of GDP, Vietnam reached its peak of attracting FDI in 1996. In 2008, thanks to joining WTO, Vietnam has again successfully attracted large volumes of FDI projects. After 2008 due to the negative impact of the global financial crisis and Vietnam's unstable macroeconomic development, FDI inflows remained relatively low but still reached levels of 5 % of GDP or more (see Fig 4).

Fig 4. FDI net inflows in Vietnam in percent of GDP

Source: World Bank.

2.1. Structure of exports and imports in Vietnam

Vietnam's main export items at present come from raw products, including mineral resources and agriculture, forestry, and fishery products. In 2014 this group of products accounted for approximately 50% of exports. Processed products like footwear, textiles, or gaiters accounted for about 30% of total exports. The industrial sector's share of Vietnamese trade has been continually increasing during the last ten years, whereas the period has seen a significant decline in the relative importance of agriculture exports. In general, the main export merchandise of Vietnam comprises of raw materials or pre-processed outsourced manufacturing based on labor-intensive and low value-added productions. Vietnam mostly imports machinery, intermediate products for manufacturing consumer goods, and other products that are not yet made domestically like cars, motorbikes, and refrigerators.

Crude oil accounts for approximately 20 % of total exports. But also, the mining sector is vital for exports and characteristics of the export structure. The number of enterprises in mining has increased rapidly, from 427 enterprises in 2000 to nearly 2000 enterprises in 2014. Among these, small and medium scale enterprises make up 60 %.

Vietnam's growth model is heavily reliant on trade in natural resources on the basis of three reasons: (i) The government focus on natural resource exploitation as one of the main development strategies, (ii) as a result of this strategy, huge capital investment and investment in advanced technology takes place in the exploitation and post-processing of natural resources, with only limited success, (iii) at the same time, there are many private companies exporting natural resources on a low technological level. As a result of this development, depletion and exhaustion of resources are accelerated, environmental degradation is expedited, and environmental costs became higher.

The proportion of exported services in relation to total exports went down from 11.6 % in 2005 to 7.6 % in 2012 and 7.6 % in 2014. More importantly, Vietnam's service trade balance has been constantly negative. Only tourism achieved surpluses, while other crucial services such as transportation, telecommunication, finance, insurances, etc. all suffered from deficits (Social Republic of Vienam, 2015).

For international trade, FDI inflows are of most importance for Vietnam. FDI projects mainly focused on the industrial sector contributing significantly to the process of economic restructuring towards industrialization. With around 30 %, the stock of FDI in the real estate sector is relatively high in Vietnam. FDI in this area, added to the real estate bubble in Vietnam, was not very helpful in industrial upgrading.

2.2. International Trade Relations and FTA Effects

Over the last two decades, Vietnam had constantly made efforts to foster its bilateral and multilateral relationships with other countries, beginning in 1995 when Vietnam entered the ASEAN and officially normalized its relationship with the United States. Trade and economic integration have provided momentum for economic development while at the same time, drove an overhaul and restructuring of the economy as well as governance, to cope with the potential challenges of economic integration.

Table 1. Vietnam's Participation in FTAs

Year	FTAs
	Signed
1995	ASEAN (AFTA)
2001	Vietnam - US Bilateral Trade Agreements
2004	ASEAN - People Republic of China FTA (ACFTA)
2006	ASEAN - Korea FTA (AKFTA)
2007	Vietnam joining the WTO
2008	Vietnam/ASEAN - Japan FTA (VAJPA)
2009	ASEAN - Austalia/New Zealand (AANZFTA)
	ASEAN - India (AIFTA)
2012	Vietnam - Chile FTA (VCFTA)
2014	Vietnam - Customs Union of Russia - Belarus - Kazakstan
2015	Vietnam - Korea FTA (VKFTA)
	Vietnam - Eurasian Economic Union FTA
	Trans-Pacific Partnership (TPP)
	Vietnam - EU FTA (VEFTA)
	In negotiation
	ASEAN - EU
	Regional Comprehensive Economic Partnership Agreement (RCEP/ASEAN+6)

The benefits of joining these FTAs include lower or zero tariff barriers for a number of exported products and services. To conform to the rules and regulations of the WTO, since January 1, 2007, Vietnam has been proactively reducing all import tariffs in line with its commitments (including 10,689 tariff lines) to an average of 13.4 percent (from 17.4 percent) over a 5 to 7 years time frame. Therefore, exporters in Vietnam have enjoyed a broader export market and favorable conditions to enter foreign markets than ever before. Yet, at the same time, local firms also face fierce competition from foreign goods and services due to the reciprocal character of the FTAs applied by participating parties. With the newly signed FTA with EAEU, Vietnam has advantageous access to a market of 175 million people with an estimated GDP of USD 1,500 billion. Following this, bilateral trade is forecasted to increase by 18-20 % per year, reaching USD 10-12 billion by 2020 compared to the USD 4 billion in 2014.

Overall, FTAs have brought about positive impacts on Vietnam's economic development, including a surge in the amount of trade (both import and export) and inflows of FDI. By advocating economic integration, trade reforms have gradually removed import tariff barriers, progressive deregulation of trade regimes, and the relaxation of restrictions on entry to trading activities. The average weighted tariff rate dropped from 20 % in the early 1990s to around 15 % in the early 2000s prior to accession to the WTO. In turn, with WTO accession, Vietnam has had to reduce its tariffs on industrial products by 13 % on average, on agricultural products by 21 % over 3 to 5 years.

Exports have created strongly positive dynamics for the country's economic development. However, the further Vietnam integrates into the global economy, the more it will be exposed to global risks such as regional/international financial crisis. Furthermore, when Vietnam reaches its deadline for relaxing all tariff lines, foreign imports and investment are likely to have an edge in the domestic market, posing intense competition to already struggling local firms. These threats will be heightened, with a higher degree of integration, and notably, the Vietnam - EU FTA and TPP will, over time, altogether remove all tariff lines. Most Vietnamese firms have not and will not be fully ready to take advantage of these trade agreements. Meanwhile, foreign businesses are global enterprises with strong capacities, high technology, and will be ready to grasp the potential Vietnamese market fully.

2.3. Features of Vietnam Economic Integration

Vietnam's economic integration process has exhibited several features. First, the process closely followed the gradualism approach. The scope of trade liberalization was expanded over time as Vietnam built-up structural preparedness and capacity to manage trade liberalization. The country began by increasing trading rights for all economic entities and phasing out tariff and non-tariff barriers (NTBs) (from late the 1980s to early 2000s), to liberalizing services (since the mid-2000s) and making commitments in "new areas" such as trade facilitation, intellectual property rights, and so on. Vietnam also began to establish bilateral trade agreements, proceeding subsequently to regional trade agreements under the ASEAN framework, and ultimately signing on to multilateral agreements under the WTO.

Second, both trade liberalization and integration have been viewed as institutional changes in Vietnam. Both processes require the adoption of trade-related rules, an incentive structure, and enforcement mechanism as well as the liberalization of trading rights, the implementation of domestic reforms. Together with the expansion of the scope of liberalization, efforts were also made to improve the business environment for attracting FDI and taking advantage of other opportunities from integration. In turn, the improved business environment necessitated access to foreign markets, and additional capital and technological resources, all of which drove attempts towards further economic integration.

Third, the country's international economic integration can be seen as a process that is based on three pillars. The first is WTO membership, which lays down the foundation for effective integration via commitments and provisions at the multilateral level while minimizing opportunities for administrative intervention into the domestic economy. Therefore, Vietnam can improve efficiency and reduce "distortions" to trade and investment through multilateral commitments. The second - a key feature of East Asian economic integration - is the FTAs between ASEAN and major regional partners. These incorporate provisions for development cooperation between more advanced members (i.e., Japan, Korea, and ASEAN-5) and developing ones such as Cambodia, Laos, Myanmar, and Vietnam (CLMV). The third is bilateral cooperation with major/strategic partners that goes beyond economic, trade, and investment arrangements.

Finally, Vietnam's economic integration and reforms tell a story of both successes and mistakes. The achievements are rather impressive: the country rapidly transformed itself from a low-income economy to a low-middle-income one, with a higher level of industrialization and trade openness. Nevertheless, the outcomes remain far from outstanding. The country still suffers from low-quality growth, an inefficient SOE sector, and public investment, high business transaction costs, distorted markets for production factors, and a limited spillover impact from FDI. Moreover, notwithstanding high trade openness, Vietnam still finds itself in a weak position in global and regional value chains. Most importantly, the momentum for reforms has been somewhat undermined by over-optimism surrounding post-WTO growth prospects. These sentiments cast doubts on whether Vietnam can achieve sustainable development and avoid the "middle-income trap" in the long-run.

3. CONCLUDING REMARKS

Vietnam has achieved impressive outcomes in building a global partnership for development. The past years witnessed massive liberalization of trade, reflecting deeper global integration of the economy. Thanks to trade liberalization, Vietnam's imports and exports have increased immensely. However, there are several issues, including rising trade deficits, non-tariff barriers created by foreign markets, and low competitiveness of Vietnamese domestic enterprises, corresponding to inadequate obstacles in the domestic market to support the young and infant industries of Vietnam. At the same time, the low value-added characteristics of export products and services, together with high dependency in a few markets, have become critical challenges for maintaining momentum in the expansion of global trade.

Trade liberalization has opened the way for tremendous foreign resources to enter the Vietnamese economy. Due to the impact of the global economic downturn, FDI flows have declined in recent years but still play a significant role in providing capital. Alongside these private inputs, ODA has been one of the most crucial investment capital resources for Vietnam's socio-economic development. These resources have continuously increased over the years, though their composition and structure changed away from grants and non-concessional loans as Vietnam has graduated to low middle-income status. Furthermore, to effectively utilize ODA, Vietnam has made efforts to enhance public investment management and has been prepared to address risks associated with borrowed funds, especially repayment capacity.

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CHANGE IN GROUNDWATER FLOW IN A LIMESTONE QUARRY BY DRAINAGE TUNNEL EXCAVATION

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Abstract: *Limestone has been excavated by the bench cut method in many quarries. In this quarry, rock displacement has been observed since September 2007, and it is reported that the displacement is related to the groundwater level. Therefore, a drainage tunnel was excavated a couples of years ago for reducing the groundwater level so that the rock displacement could be stabilized. The purpose of this study was to evaluate the change in groundwater flow in the quarry by drainage tunnel excavation.*

Change in groundwater quality before and after tunnel excavation was examined by collecting and analyzing groundwater samples. The results showed that the concentrations of calcium and bicarbonate ions in groundwater near the interbedded layer were reduced by the excavation. This indicates that the residence time of the groundwater was reduced due to the excavation. This means that the excavated tunnel is promising for confirming the stability of the rock slope by draining the groundwater near the interbedded layer.

Keywords: *groundwater flow, water quality, quarry, drainage tunnel*.

1. INTRODUCTION

It is common that limestone is excavated by the bench cut method in Japan. It is important to preserve the stability of rock slope in mine operation. However, collapses of rock slope have often occurred in Japan. A large-scale displacement of rock slope has been observed since 2007 in a quarry. Thus, the displacement of the slope and groundwater chemistry in and around the slope have been monitored. It is found that the rock displacement is related to the groundwater level. Thus, a drainage tunnel at an elevation of 970 m above the sea was excavated from 2017 to 2018 to stabilize the rock slope. After that, the rock slope became almost stable. The purpose of this study was to evaluate the effect of the tunnel excavation on the groundwater quality in the quarry by comparing before and after excavation.

2. MATERIALS AND METHODS

2.1. Outline of quarry and sampling of groundwater

Fig.1 shows a cross section of the quarry. The base rock is green rock while the surface is limestone. There is an interbedded layer between the rocks. There may be groundwater flow pathways around the interbedded layer. In this Fig, groundwater sampling points are also shown. Fig.2 presents the representative sampling points in the drainage tunnel. The tunnel is located at an elevation of 970 m, which drains the groundwater in the interbedded layer.

When taking groundwater samples, pH, electrical conductivity (EC), oxidation-reduction potential (ORP), and temperature were measured in situ as shown in Fig.3. Groundwater flow rates were also measured.

The collected samples were filtered using a 0.45 μm membrane filter in situ, and then the filtrates were stored in polyethylene bottles for analysis. The field campaign was conducted from May 2016 to December 2019.

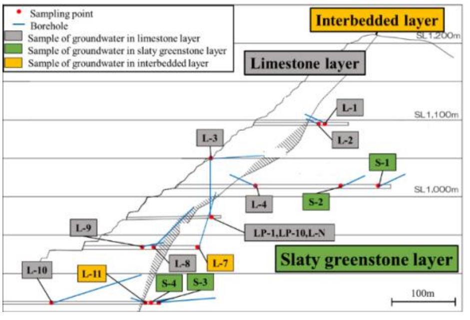

Fig 1. Cross section of the quarry and sampling points

Fig 2. Sampling points

Fig 3. In situ measurements

2.2. Analysis of groundwater samples

Major elements (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-}, NO_3^{-}, SO_4^{2-} and Si) were analyzed in the laboratory. Concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} and Si were measured by ICP-AES whereas concentrations of Cl^{-}, NO_3^{-} and SO_4^{2-} were measured by ion chromatograph (IC). Concentration of HCO_3^{-} was measured with titration by 0.01 M sulfuric acid (H_2SO_4).

2.3. Geochemical analysis

Saturation index of calcite (SI_{calcite}) and the partial pressure of carbon dioxide ($P_{\mathrm{CO2(g)}}$) were calculated by using the geochemical modeling software PHREEQC[5]. SI_{calcite} and $P_{\mathrm{CO2(g)}}$ are expressed in equations (1) and (2) respectively, and the hydrolysis of inorganic carbon dioxide is expressed in equations (3) to (5).

$$SI_{\mathrm{c}} = \log\frac{[\mathrm{Ca}^{2+}][\mathrm{CO}_3^{2-}]}{K_{\mathrm{c}}} \tag{1}$$

$$K_{\mathrm{c}} = [\mathrm{Ca}^{2+}][\mathrm{CO}_3^{2-}] = 10^{-8.48}\ (t = 25\ ^{\circ}\mathrm{C})$$

$$P_{\mathrm{CO2(g)}} = \frac{[\mathrm{H}^{+}][\mathrm{HCO}_3^{-}]}{K_0 K_1} \tag{2}$$

$$K_0 = \frac{[\mathrm{CO}_{2(\mathrm{aq})}]}{P_{\mathrm{CO2}}} \tag{3}$$

$$K_1 = \frac{[\mathrm{H}^{+}][\mathrm{HCO}_3^{-}]}{[\mathrm{CO}_2(\mathrm{aq})]} \tag{4}$$

$$K_2 = \frac{[\mathrm{H}^{+}][\mathrm{CO}_3^{2-}]}{[\mathrm{HCO}_3^{-}]} \tag{5}$$

[ ] is activity, K_C is solubility of calcite, and K_0, K_1 and K_2 are equilibrium constants of $CaCO_3$-H_2O-CO_2 system.

3. RESULTS AND DISCUSSION

All groundwater samples in the tunnels were of Ca-HCO_3 type (Fig.4). Some samples had higher concentration of SO_4^{2-}. This is due to the effect of blasting for tunnel excavation.

The groundwater in the limestone layer and the interbedded layer tended to decrease the flow rate after excavation (Fig.5 and Fig.6). It is because groundwater in the limestone and interbedded layers was drained by excavation of the drainage tunnel.

It can be seen that the alkalinity and Ca^{2+} concentration of most of groundwater samples in the limestone and interbedded layers decreased after the excavation (Fig.7 to Fig.10). After excavation, only in October 2019, the Ca^{2+} concentration increased due to heavy rain.

Focusing on $SI_{calcite}$ and $\log P_{co2}$ (Fig.11 to Fig.14), these parameters did not change dramatically before and after excavation. It is expected that the decrease in Ca^{2+} concentration caused the change in pH and led to new equilibrium of calcite dissolution. In October 2019, samples were collected immediately after a typhoon passed, so the heavy rain induced a large amount of infiltration into the quarry, causing a drop in $SI_{calcite}$.

Both Ca^{2+} concentration and flow rate decreased after excavation (Fig.15 and Fig.16). This is because the average retention time of groundwater decreased. This means that the excavation of the drainage tunnel was effective in reducing the retention time of groundwater.

The reduction in residence time of groundwater helps prevent the displacement of the rock slope in response to rainfall.

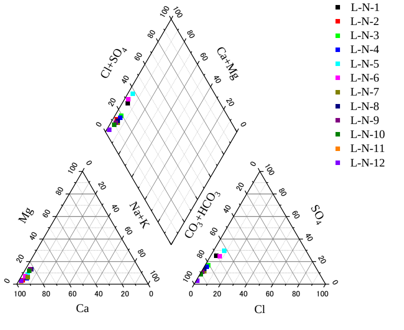

Fig 4. Piper diagram of groundwater collected in drainage tunnel in December 2019

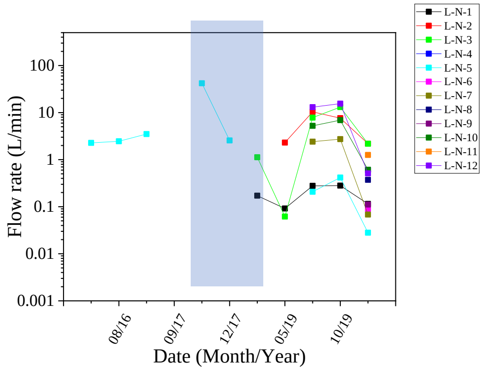

Fig 5. Change in flow rate of groundwater samples in drainage tunnel

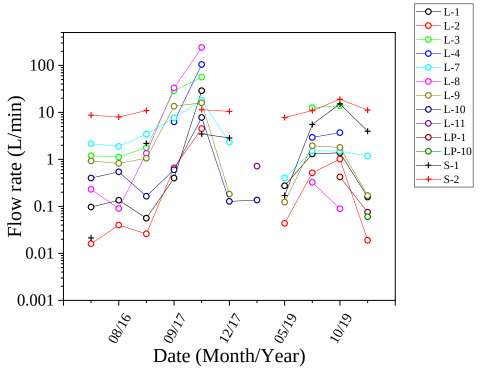

Fig 6. Change in flow rate of groundwater samples in the other tunnels

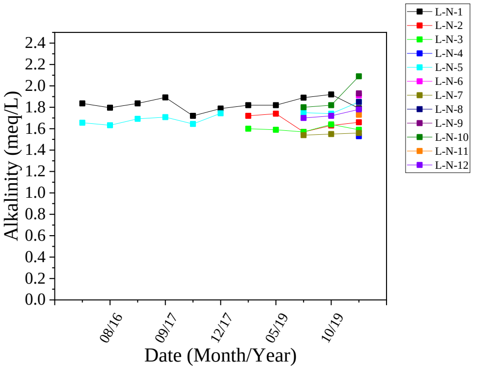

Fig 7. Change in alkalinity

of groundwater samples in drainage tunnel

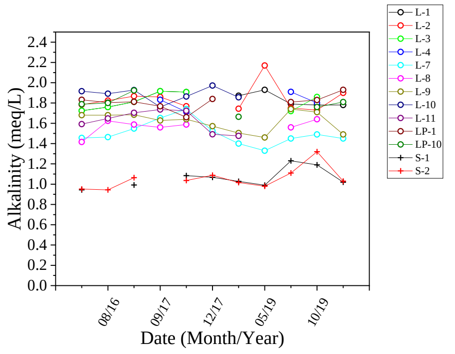

Fig 8. Change in alkalinity of groundwater samples in the other tunnels

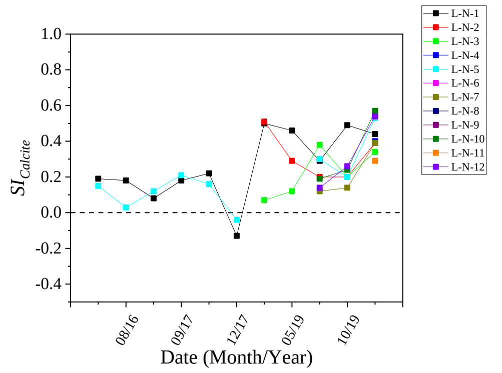

Fig 11. Change in SI_{calcite} of groundwater samples in drainage tunnel

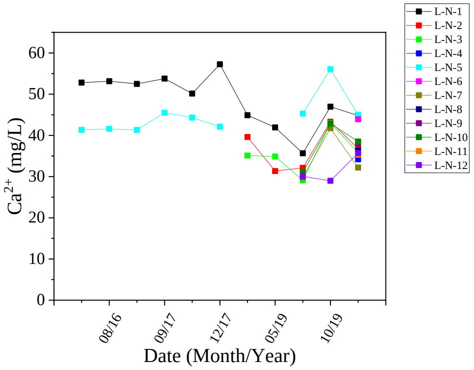

Fig 9. Change in concentration of Ca^{2+} of groundwater samples in drainage tunnel

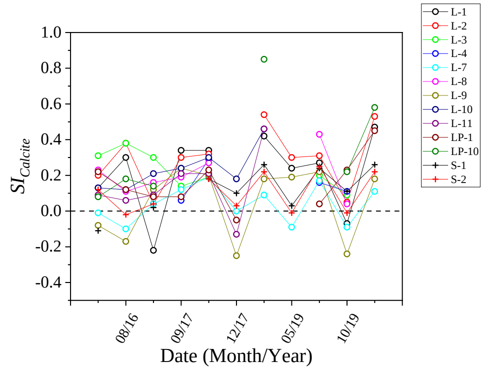

Fig 12. Change in SI_{calcite} of groundwater samples in the other tunnels

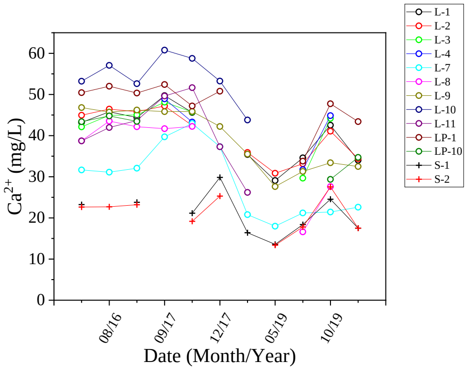

Fig 10. Change in concentration of Ca^{2+} of groundwater samples in the other tunnels

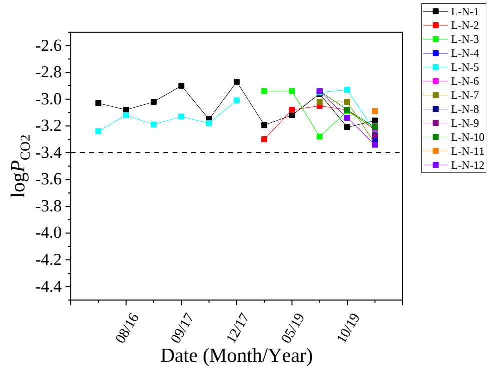

Fig 13. Change in $\log P_{co2}$ of groundwater samples in drainage tunnel

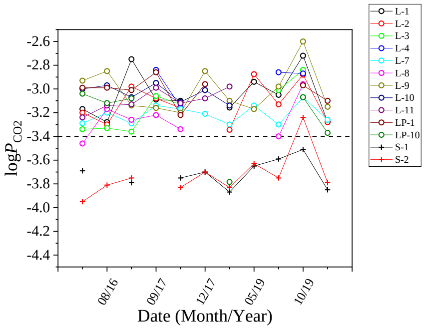

Fig 14. Change in logP_{co2} of groundwater samples in the other tunnels

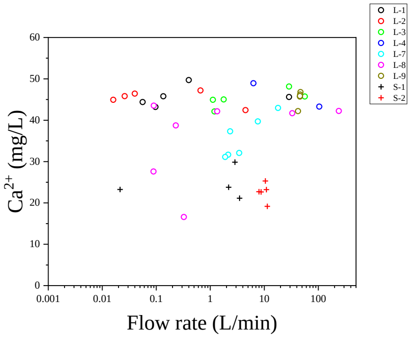

Fig 15. Relationship between Ca^{2+} concentration and flow rate of groundwater samples in the other tunnels (before excavation)

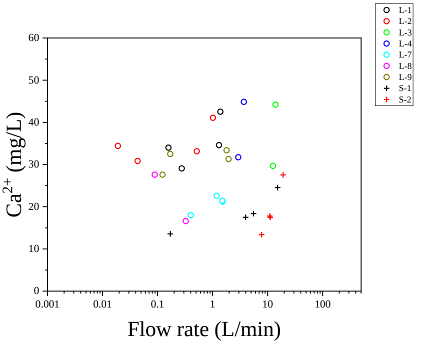

Fig 16. Relationship between Ca^{2+} concentration and flow rate of groundwater samples in the other tunnels (after excavation)

To confirm the stability of rock slope in quarries is required. The excavation of drainage tunnels is one of the promising countermeasures. In addition, it is important to evaluate the groundwater flow in quarries by considering climate changes in the future.

4. SUMMARY AND FUTURE WORK

Based on the results of groundwater quality before and after the excavation of a drainage tunnel, the following was revealed.

(1) Groundwater in the limestone and interbedded layers was effectively drained by the excavation of a drainage tunnel by considering the groundwater chemistry.

(2) However, it is necessary to continue to monitor groundwater quality to quantify the relationship between the deformation of rock slope and groundwater flow chemistry.

In addition, the residence time of groundwater by tritium analysis should be examined to identify the flow pathway of groundwater.

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