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Information Technology Policy of Our Country's Mining Industry under the Impact of Industrial Revolution 4.0

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SUMMARY: Since 1997, the mining industry has been interested in developing the components of the Information Technology at industry sector- and enterprise level. However, due to many different reasons, including the level of interest of business leaders at sectoral level and limited resources, IT implementation in the mining industry in our country is still at a small scale, not linked into a network, not having a shared database and is therefore not shared. Under the impact of Industry 4.0, in order to develop the IT field as an important tool to promote the technologies of the 4.0 technology component, a systematic policy combination is needed. This article is responsible for meeting that demand of the IT field of our country's mining industry.

KEYWORDS: Industry 4.0, Information Technology, Information Technology policy

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I. INTRODUCTION

We are in the early stages of the 4th Industrial Revolution (abbreviated as Industry 4.0). Industry 4.0 has a fundamental difference from previous revolutions: higher production automation thanks to customized and flexible technologies. Machines work independently, communicating with each other to make decisions without human (or very little) involvement. The machines self-collect, process, self-adjust, analyze and make decisions by themselves. In other words, Industry 4.0 creates self-regulating, self-aware and customizable production. Humans, instead of controlling machines, are now indirectly with them via IoT or IoP.

Industry 4.0 has impact of on most of the socio-economic fields, science and technology in general and information technology (IT) in the mining industry in particular. Realizing that, our country's mining industry has been interested in investing and developing IT since 1997 up to now. The industry's large firms have invested in relatively modern hardware, system software, relatively wide application software, and network systems (Lan, Wan, and the Internet). However, due to many different reasons, including financial constraints and views of business leaders (including industry leaders), the above investment is still small, application software mainly solves business operations, but cannot organize data warehouses sharing interdisciplinary, even within an enterprise. The use of network means is still low, the network administrators are lacking, mainly from other branches. Information is not considered as a resource for the production process such as human resources, capital and other resources. The problem is: what solutions to the IT development of the mining industry are needed to meet the challenges under the impact of Industry 4.0.

This study aims to analyze the factors affecting the IT field of our country's mining industry, evaluate current policies and thereby propose some policies to develop that field under the impact of Industry 4.0.

II. SOME TOOL CONCEPTS

2.1. Industrial Revolution 4.0

According to Gartner, Industry 4.0 comes from the concept of "Industrie 4.0" in a German government report in 2013. "Industrie 4.0" "connects embedded systems and smart manufacturing facilities to create technical convergence between Industry, Business, functions and internal processes ".

According to Klaus Schwab [1], Founder and Executive Chairman of the World Economic Forum, Industry 4.0 is: "The first industrial revolution used steam and water energy to mechanize production. The second revolution took place through the application of electricity to mass production. The 3rd revolution used electronics and information technology to automate production. Now, IR 4.0 is sprouting from the third revolution: it combines a range of new technologies together, blurring the lines between physical, digital and biological worlds".

According to the author, Industry 4.0 is a network that takes place thanks to the combination of tools of a mega system including objects, digital and biological, in which: i) digital with core elements of artificial intelligence (AI), Internet of Things (IoT) and Big Data; ii) biotechnology - leaps in agriculture, fisheries,

medicine, food processing, environmental protection, renewable energy, chemistry and materials; iii) Finally, the field of Physics with new generation robots, 3D printers, self-driving cars, new materials and nanotechnology. The list of above technologies is considered technology component 4.0 [2].

2.2. Information Technology

The term "Information Technology" first appeared in 1958 in an article published in the Harvard Business Review. The two authors of the article, Leavitt and Whisler commented: "The new technology has not established a proper name. We will call it IT (Information Technology-IT) [3]".

The main areas of IT include the acquisition, processing, storage and dissemination of audio, film, text and digital information by microelectronics based on the combination of computers and communications.

Some prominent and modern areas of IT are: next generation Web standards, bioinformatics, cloud computing, global information systems, large-scale knowledge and many others.

The research development is mainly in computer science.

According to Article 4, Law on Information Technology, IT "is a collection of scientific methods, technology and modern technical tools to manufacturing, transmitting, collecting, processing, storing and exchanging digital information "[4].

From the above concepts, the author gives the concept of IT as follows:

Information Technology is a system of scientific methods, technology, media, communication networks and a system of data warehouses to organize, store, transmit and exploit and use effectively information resources in all areas of human activity.

2.3. IT development policy

According to the Vietnamese Encyclopaedia, "Development is a philosophical category that indicates the nature of the changes taking place in the world".

Development is an attribute of matter. All things and phenomena of reality do not exist in a different state from the time they appear to the moment of destruction,… the source of development is the unity and struggle between opposites "[5].

According to Mai Ha, *"Development is an increase in quantity and quality in a harmonious balance"*.

From the above concepts, the author of the thesis introduces the concept of information technology development policy as follows:

Information technology development policies are state decisions and actions aimed at setting specific goals with solutions and implementation tools to solve development problems in the information technology industry.

According to Thomas Kuhn [6], IT development policies in general and the mining industry in particular must meet the following requirements:

i. Accuracy: The mining industry's IT policy must achieve accuracy of specific standards: on system structure, concept of space, time, accuracy of operation and management of IT system throughout the industry system; having regulations on the use of equipment and applications in the IT system of the industry;

ii. The consistency with different data elements, different levels of accuracy, but when the system is used, there is no conflict, easy to upgrade, expand and secure;

iii. Wide range: can be used throughout the industry and to some extent consistent with international practice;

iv. Simplicity: Easy to use for the user who operates the system: updating, upgrading the system, data providers, analyst etc.;

v. Success: Tested and accepted by practice.

III. FACTORS AFFECTING THE IT DEVELOPMENT POLICY OF OUR MINING INDUSTRY

The IT policy of Vietnam's mining industry plays an important role, helping organizations and individuals orient to effectively apply IT in their operations. However, to implement IT policies effectively in the mining industry is a difficult and arduous process. If the IT policy is in line with the actual conditions, then the IT policy is considered to come into life, or in other words, the IT policy will be welcomed by the society. On the contrary, there is an IT policy that is inconsistent with reality, so it must be modified, supplemented or cancelled (not feasible) to evaluate and re-improve. The following are some of the factors that often affect and affect IT policy as follows:

i. *The economic - political environment in the country:* this environment has a dialectic relationship, so when one of these two factors changes significantly, they both have an impact and influence on the IT policy implementation. The Party, Government, and line ministries' change in the way of implementation can also change the IT policy itself. Therefore, the context of IT policy implementation is different in each specific situation, maybe in the short term, maybe in the long term and it depends entirely on the economic and political stability.

ii. *Social environment:* changes in social conditions such as population structure and educational attainment may affect the implementation of IT policies. Since this policy deals with science and technology and economics, it also addresses social problems. For example: creating new jobs, creating jobs for workers in general and for local workers in particular.

iii. *Cultural environment:* the IT policy is aimed at beneficiaries in certain localities. Therefore, cultures of ethnic groups and localities have a great influence on the design and implementation of IT policies. If a program is designed not in accordance with the target's culture or locality, it will not be approved by the local people.

iv. *International economic environment:* in the context of increasingly deep international integration, changes in the world (including changes in IT policies of major countries in the world and in the region) may positively or negatively affect the IT policy implementation process. In particular, changes in the international sponsor's IT policy will directly affect the donors' IT policy implementation. For example, a change in the oil policy of the US or OPEC may affect the petroleum policy of importing countries, including Vietnam.

v. *Geotechnical conditions of mines:* geological and technical conditions of mines decide which technology to choose and use (then IT will be considered) in the exploitation and geological exploration of current mines in Vietnam. It is very complicated and unstable, so it is very difficult to put mechanization into operation. But because this difficulty more or less has a direct impact on the application of IT in exploitation, so it will affect the practicality of IT policies.

vi. *Factors about IT capacity:* IT capacity is a very important factor of a country in general or an area / industry in particular for socio-economic development goals. If we have IT capabilities, we will promote the effective use of available technologies and implement successful technological innovation, on that basis, we will have complete control of the technology. According to the lecture on *Technology Management* of Nguyen Dinh Binh (2017), technological capacity includes:

- *Technology operation capacity includes:* operational and technical inspection capacity; maintenance capacity; capacity to prevent and troubleshoot problems; capacity in the production process. This is an important criterion to speak of the ability to master the technology: to master the operation of mining equipment, the equipment for exploitation, as well as to be able to repair and troubleshoot problems ... If our capacity is weak, the absorption and mastery of technology will be extremely difficult, leading to ineffective exploitation and use of technology, and dependence on technology suppliers when incidents occur.
- *Capacity to receive technology from outside:* the ability to seek and evaluate technology; capacity to choose new technology is transferred. This capacity is still weak, so the assessment and selection of technology will face difficulties and mainly depend on foreign consultants.
- *Technology innovation capacity, including:* capacity to adapt technology; capacity to copy technology transferred; capacity to conduct research and development; capacity to create technology, create new products. Due to low IT capacity, it is difficult to copy transferred technology or create technology successfully, so it is impossible to master technology [8].

vii. *The safety factor in exploitation:* The economy develops; the demand for industrial production is increasing, while the exploitation of tusks is falling deeply.

Due to the deeper exploitation, the risk of occupational accidents also increases (methane gas explosion, water platform, furnace collapse ...).

Vietnam's exploitation technology is still low compared to the world. The employees lack a sense of compliance with the law, the industrial behaviour of the employee and the employer is not high. The above-mentioned issues all have an impact, affecting the occupational safety for workers in the exploitation. The prevention of methane gas fire and explosion must be on top priority.

Therefore, it is necessary to have specific and mandatory regulations for all organizations or individuals participating in the exploitation activities to comply.

IV. EVALUATE THE IMPACT OF CURRENT IT DEVELOPMENT POLICIES OF OUR COUNTRY'S MINING INDUSTRY

4.1. Approach

The concept of the impact of policy *is the realization of the policy objectives in the behaviour of people and groups in society.* In this study, the author uses the assessment method according to 3 impact criteria:

i. Positive effects of a policy are effects that lead to consistent results with the policy's goals. This is the kind of impact the policy-making body wants to achieve.

ii. Negative effects of a policy are effects that lead to outcomes that are contrary to the policy's goals.
iii. Peripheral effects of a policy are effects that lead to outcomes outside of the data of the policy-making body. In the peripheral effects, it is divided into positive peripheral effects and negative peripheral effects:
+ Positive peripheral effects are external effects that contribute to improving the effectiveness of the policy.
+ Negative peripheral effect is the peripheral effect that reduces the effectiveness of the policy.
According to the document [7], any policy has a 4-tier structure: Philosophy, Relationship, Standards and Concepts. The policy paradigm consists of goals and means, and both are considered a four-tiered structure. This means that every policy has a philosophy of the goal, the philosophy of the vehicle, the relationship of the goal, the relationship of the vehicle.
It should also be added that if the goal is too overwhelming there is no means that can be achieved. Likewise, the unsuitable vehicle can restrain or fail the target.
For example, the target by 2020 is basically to form a system of 3,000 S&T enterprises. After 7 years of implementation we will only have 400. We cannot imagine with the current means of review, how to achieve the goal of 1600 businesses within 1 year.
Or the goal of a strong rich population by means of building farms in the former Soviet Union (bringing vehicles together - including land) is taking away the tools of the peasant's labour. As a result, everyone knows: the collapse of the Soviet Union.
The example above shows the negative marginal effects of policy.

4.2. Evaluate the positive impact of IT policy in the mining industry.
i) Building the IT sector of the industry contributes to reducing costs and improving labour productivity of the mining industry, allowing costs to be reduced and labour productivity improved.
In all ages, production processes are always controlled according to economic laws. It can be said that cost is one of the important factors determining IT development needs. No product can be competitive if the product price is higher than similar products with similar features. In the context of the economy is dealing with phenomena such as inflation, costs for materials, labour, etc., it is necessary to have optimal production methods to reduce product costs.
On the other hand, the need to improve product quality will increase the complexity of the production process. The volume of simple jobs that allow for low wages will be greatly reduced. The costs of training workers and service staff and equipment prices have also increased. This is the driving force that stimulates the development of IT.
ii) Build up the IT sector of the mining industry that allows for improved production conditions. In the mining industry that uses too much manual labour, it is easy to have instability in time, quality and labour productivity, making it difficult to operate and manage production.
The mining industry is allowed by IT to eliminate the above disadvantages. At the same time, IT has changed the working nature, improving the working conditions of workers, especially in the conditions of exploiting many hazardous and heavy risks, etc.
iii) IT of the mining industry allows meeting the intensity of modern production labour. Although in the mining industry, the means of labour are not diversified, quite a lot of specialized equipment is helping to modernize labour, meeting the required output with the smallest price.
iv) Building the IT sector of the industry, like any manufacturing process, allows for production specialization and swapping. As we all know, only a handful of complex products are made entirely by one manufacturer. The research and improvement only have to be done according to the deep expertise, so the quality is higher and the progress is faster. So the ability to standardize the product is very high. This allows for the application of the principle of interchangeability - one of the basic conditions that lead to the formation of mass production when making complex, low-volume products. It can be said that IT plays an important role in implementing standardization in the most effective way.
v) Develop an IT sector of the industry that allows for competitive performance and meeting production conditions. Competitive demand will eliminate mining companies with low quality and high cost. The competition forces the operators to improve their technology and apply IT to create better products at cheaper prices.
vi) Building an IT sector of the industry that allows for improved working conditions, occupational safety and sustainable development. Along with mechanization, automation and information technology, it contributes to reduce labour, control and prevent in time the danger of fire and explosion in the conditions of exploitation. High-speed surveillance network helps to enhance centralized management of mining operations.
With all the above positives, IT ensures higher sustainability for the development of businesses (companies) of the mining industry.

4.3. Assessment of negative impact of mining industry IT policy.

i) The IT industry of the mining industry requires a large investment, sometimes overwhelming for the size of the company. As we all know the automation equipment of the mining industry is quite specialized and quite expensive so it is not possible to invest in mass, synchronized campaign style. Investment, renovation and upgrading projects are often very large and require a high concentration of financial resources. That requires rigorous production management and prioritization with financial capacity. While the financial capacity of companies in our country's mining industry is not always available.

ii) IT requires investment in developing qualified human resources. Currently, in our country, the manual labour force is quite large, while IT requires a large number of S&T personnel with knowledge to operate the automatic control system. This requirement requires a sizable additional investment, which is a challenge for the mining industry.

iii)

IT along with the wave of Industrial Revolution 4.0 is causing the mentality of *"will be unemployed"* for the labour force in general and in the mining industry in particular, although for manual workers (especially skilled workers), this risk occurs later in comparison to the administration and office workers. This mentality, together with the sense of innovation, creates negative external effects on IT processes in general and in the mining industry in particular.

V. PROPOSING THE IT DEVELOPMENT POLICY FRAMEWORK OF THE MINING INDUSTRY

Based on the orientations and objectives as well as the list of priority technologies identified during the research process, the positive and negative effects of the current technology policy, according to the innovation policy approach , the author proposes a policy framework for the development of the mining industry to 2025 (see figure 1 below).

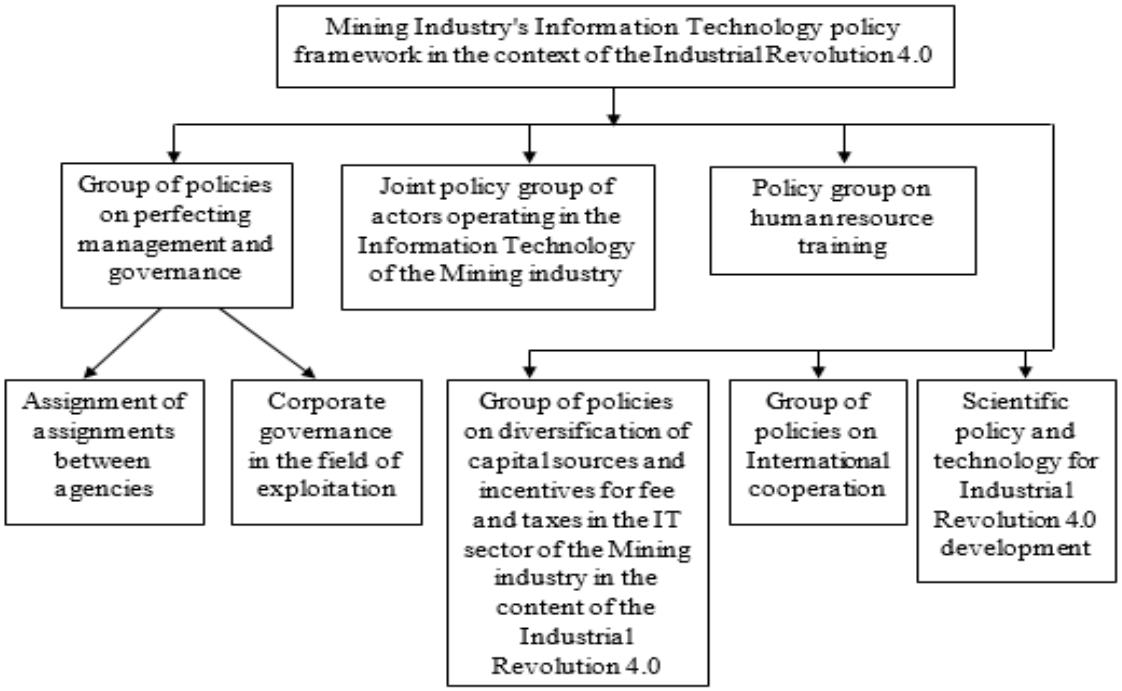

Figure 1: Policy framework for the development of the mining industry

5.1. Group of policies on perfecting management and governance

According to the innovation policy approach, the policy must be built on the basis of linking the policies of Science-Technology, Education, Trade, Finance, Monetary, etc. Therefore, it is necessary to consider the linking state management agencies (as policy actors) and improving governance within businesses themselves as policy beneficiaries (subject to policy).

Within this group, it is necessary to delineate the functions of the state management agencies in order to harmonize and coordinate government policy and co-clarifying the functions and duties of business leaders under the impact of policies.

5.2. Group of linkage policies of actors operating in the IT field of the mining industry.

Along with public-private policy, actors involved in coal mining industry include the Government (under PPP), S&T organizations in the field of computerization, service providers, and manufacturing enterprises of the mining industry.

This linkage plays a very important role; this activity contributes to strengthening the domestic and international resources (social capital) to promote the sustainable development of the mining industry and actors. This group of solutions is built according to the national innovation system approach.

5.3. Group of policies on human resource training

i) Research and implement human resource development mechanisms and policies to meet the requirements of industrialization and modernization, especially the requirements of IR 4.0.

ii) Restructuring, innovating and improving the quality of training institutions to create IT human resources of the mining industry capable of mastering and receiving new technologies.

iii) Re-plan the network of vocational and higher education institutions in the field of IR 4.0.

iv) Focus on a number of IT institutions for tertiary education and vocational training to reach international standards. Train and re-train human resources in the IT field in the multi-level method domestically and internationally.

5.4. Group of policies on diversifying sources of capital and preferential treatment on fees and taxes in the IT sector of the mining industry in the context of IR 4.0.

i) To increase the attraction of foreign investment capital, ODA capital and other social capital sources to implement innovative activities in the IT sector of the mining industry.

ii) In the immediate future, to set up a Development Fund to purchase IT products to innovate technology and equipment in order to create a source of funding to pay loans to the units.

iii) Capital incentives when exploiting, researching investment and using IT in domestic production to apply in exploitation.

iv) Provide funding for key organizations to purchase IT products to renovate their technology and equipment in order to create funding sources for loan repayment for the units.

v) Capital incentives when exploiting, researching investment and using IT in domestic production to apply in exploitation.

vi) To support funding for Science & Technology organizations to research and apply IT in exploitation when it cannot be manufactured domestically.

vii) Full funding or cost support for research projects to create regional advanced level of IR 4.0 equipment crucial for the creation of key products of the mining industry.

viii) Support initial research funding for research projects and application of existing foreign technologies or new IT research that can be applied in production, serving exploitation: environmental monitoring gas field, human monitoring system, loading-transport system, self-pumping system, ventilation system, etc.

ix) Provide partial funding, create favourable conditions for domestic organizations and individuals to participate in fairs, exhibitions, and promote IT products applied to the mining industry at home and abroad.

5.5. Group of policies on international cooperation

i)) Linking with partners with strong potentials in IT and mining industry (Japan, Russia, Poland, Australia, China, ...) to train and foster staff; attract good experts to act as consultants and participate in the implementation of S&T programs related to IT.

ii) Ensuring the conditions of salary, housing and working environment for foreign experts and overseas Vietnamese to return home to participate in training activities; scientific research in the IT field equivalent to the conditions they enjoy in the host country where they are working; Ensure non-discrimination in all areas of operation, all types of services; There is a flexible entry mechanism, in line with international practices, allowing foreign experts from overseas Vietnamese and skilled workers to enter with long-term visas, fully qualified in time to supporting domestic IT development.

5.6. Scientific and technological policy for Industrial Development 4.0

To build a national program for the development of industrial 4.0 technologies on the basis of which encourages enterprises and S&T organizations of the mining industry to participate in research according to the selection method.

Develop IT infrastructure and application, especially digital connection infrastructure (4G, 5G) to ensure safety and synchronization to meet the requirements of internet connection connecting people and connecting things. Develop a strategy to transform the number of mining industries. Invest, developing Big Data centers, analyzing, managing and processing Big Data to create new products and knowledge in the mining industry.

Creating easy, favourable and equal conditions for people and businesses to access digital content development opportunities in the mining industry

Support the construction and development of science and technology businesses in the industrial 4.0 context. Develop mechanisms and policies to encourage the development of technology incubators, science and technology business incubators, and start-ups in the priority technology sectors under the component of Industrial Technology 4.0.

VI. CONCLUSION

IR 4.0 is an irreversible process like any Revolution that happened before it. This is the mega system that unites the leaps and bounds in the fields of physics, digital and biotechnology.

The task of Vietnam in general and the mining industry in particular is to find a way to capitalize on its achievements as well as avoid the negative impacts it brings.

IT development is the key to approaching those achievements and also to developing new achievements on a national and industry level.

Considering the importance of IT in promoting such IR 4.0, it is necessary to have a systematic set of policy solutions to promote that field. IT in the mining industry also has that demand. On the basis of assessing the impact of current IT development policies of the mining industry, analysing the positive and negative impacts, the causes of the negative impacts.

By approaching the innovation system and innovation policy, the author has proposed a systematic combination of IT development solutions groups in our mining industry that can overcome the negative effects of the policy currently, promoting the development of IT in our country's mining industry./.

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