Aus4Reform Program

POSITIONING THE STATE-OWNED ENTERPRISES IN THE INDUSTRY 4.0

Hanoi, 2019

Foreword

The fourth industrial revolution (IR 4.0) has been increasingly affected all areas of Vietnam's economic and social life. According to a study of Ministry of Planning and Investment, an active participation in IR4.0 would help Vietnam to increase its GDP about USD 28.5 to 63 billion, accounting for a 7-16% increase of GDP in 2030. IR4.0 could make significant changes on the labor structure of the economy but in general, it would increase about 2.7-2.9 million jobs. Labor productivity measured by GDP/labor would increase about 315-640 USD/employee.

However, Industry 4.0 also poses challenges to Vietnam. The Resolution 52/NQ-TW dated in 27th September, 2019 shows that the level of active participation in IR4.0 is low. Institutions and policies have many limitations and drawbacks. The structure and quality of human resources do not met requirements. Science technology and innovation do not play as a driving force for socio-economic development. Besides, national innovation system has not been well established, lack of consistency and effectiveness.

In order to take advantage of opportunities and overcome challenges of IR 4.0, it requires stakeholders of the economy, in which enterprise should be the first one to carry out research, technology transfer and widely apply achievements of IR 4.0 for all fields of socio-economic life, especially for some key industries and sectors with potentials and advantages to boost up growth. That should be done in the spirit of catching-up, co-developing and even moving forward in some areas with comparison to the regional and the global level.

In the Vietnamese enterprise system, state-owned enterprises (SOEs) have played crucially important role. The question for policy makers is, what role will SOEs undertake in IR4.0 in Vietnam? How well is the preparation and readiness of SOEs for IR4.0? And what should SOEs do in order to adapt and thrive in IR4.0?

These above challenging issues pose a requirement for a comprehensive study, analysis and evaluation of the role, mission and policy recommendations to enhance the adaptability of Vietnamese SOEs in Industry 4.0.

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The prime objective of the study is to evaluate and analyze the current situation and readiness of Vietnamese SOEs in the context of Industry 4.0 and to propose key solutions for SOEs to grab promising opportunities and advantages of Industry 4.0. The report has four main parts, as follows:

Part 1: Overview of Industry 4.0 and the role of SOEs in Industry 4.0.

Part 2: Legal framework on the role and goals of SOEs in Industry 4.0.

Part 3: Assessing the readiness of SOEs in Industry 4.0.

Part 4: Recommendations and solutions for SOEs to thrive in Industry 4.0

We would like to sincerely thanks to the Aus4Reform Program for their great supports. The Team would also delicate our special thanks to experts in and outside the CIEM for their valuable comments.

All views, opinions in the Report are solely of authors and may not necessarily reflecting those of the CIEM and/or the Aus4Reform Program.

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1. THEORETICAL OVERVIEW OF INDUSTRY 4.0 AND THE ROLE OF SOEs

1.1 Overview of Industry 4.0

1.1.1 Definition

Industry 4.0 is believed to have appeared for the first time in the "Industry 4.0 Strategy" of the Government of the Federal Republic of Germany, presented at the Hannover Fair in 2011. However, the concept of The Fourth Industrial Revolution or Industry 4.0 was officially discussed at 46th Annual Meeting of the World Economic Forum (WEF), opening on January 20, 2016 in Davos-Klosters, *Switzerland*, under the theme "Mastering the Fourth Industrial Revolution". Accordingly, Industry 4.0 (or Industrie 4.0 in German) is defined as *"A collective term for technologies and concept of value chain organization" along with virtual copy of physical world, Internet of Things (IoT) and Internet of Services (IoS)."*

According to (Schwab, 2016), *"The fourth industrial revolution, however, is not only about smart and connected machines and systems. Its scope is much wider. Occurring simultaneously are waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing. It is the fusion of these technologies and their interaction across the physical, digital and biological domains that make the fourth industrial revolution fundamentally different from previous revolutions."*

According to another definition of PwC (2016) *"Industry 4.0 focuses on digitizing from the beginning to the end of all physical assets and integrating them into the digital ecosystem along with other partners of the value chain."*

According to (World Bank 2016), the nature of Industry 4.0 is based on digital technology which integrates all smart technologies to optimize production processes and methods. Artificial intelligence combined with big data, the internet of things and cloud technology will create quantum leaps of technology, bringing people into the era of the second information revolution.

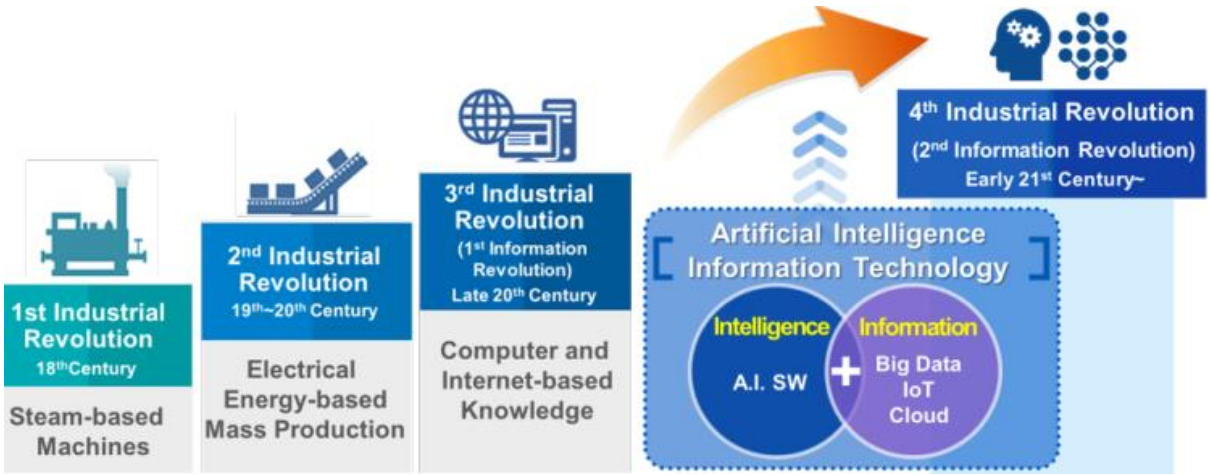
Therefore, it can be said that Industry 4.0 began to be formed in the early 21st century. In other words, humanity is putting its first steps into Industry 4.0. Industry 4.0 will create many new technologies to eliminate the boundary among the virtual, physical and biology world and thus affect all industries and fields, to all economies in the world.

The future of people in Industry 4.0 will be shaped by challenges and opportunities due to the penetration and universalization of automated machines at all levels of the economy. The Fourth Industrial Revolution helps automate production processes to a new level by introducing customized and flexible mass production technologies. This means that machines will operate independently or in cooperation

with people in creating a constantly changing customer-oriented manufacturing sector to maintain that production. Machinery becomes an independent entity that have capable of data collecting, analyzing and self-improving, or communicating with each other and with manufacturers to create cyber-physical production system (CPPS). This system helps industries combine the real and virtual worlds and allows computers to directly collect data, analyze them and even make decisions based on collected data.

The Fourth Industrial Revolution is also notable for its speed which is the speed of current breakthroughs that have never been preceded in history. It took nearly 4,000 years to go from an agricultural culture to the first industrialization, nearly a century to the 1st and 2nd industrial technology and another century from the 2nd to the 3rd. However, only nearly 50 years after the beginning of the 3rd Industrial Revolution, we are about to witness the establishment of the 4th Industrial Revolution. The technological progress of the 4th Industrial Revolution is also accelerating, threatening nations and economies are still struggling to adapt to The 2nd and 3rd Industrial Revolution

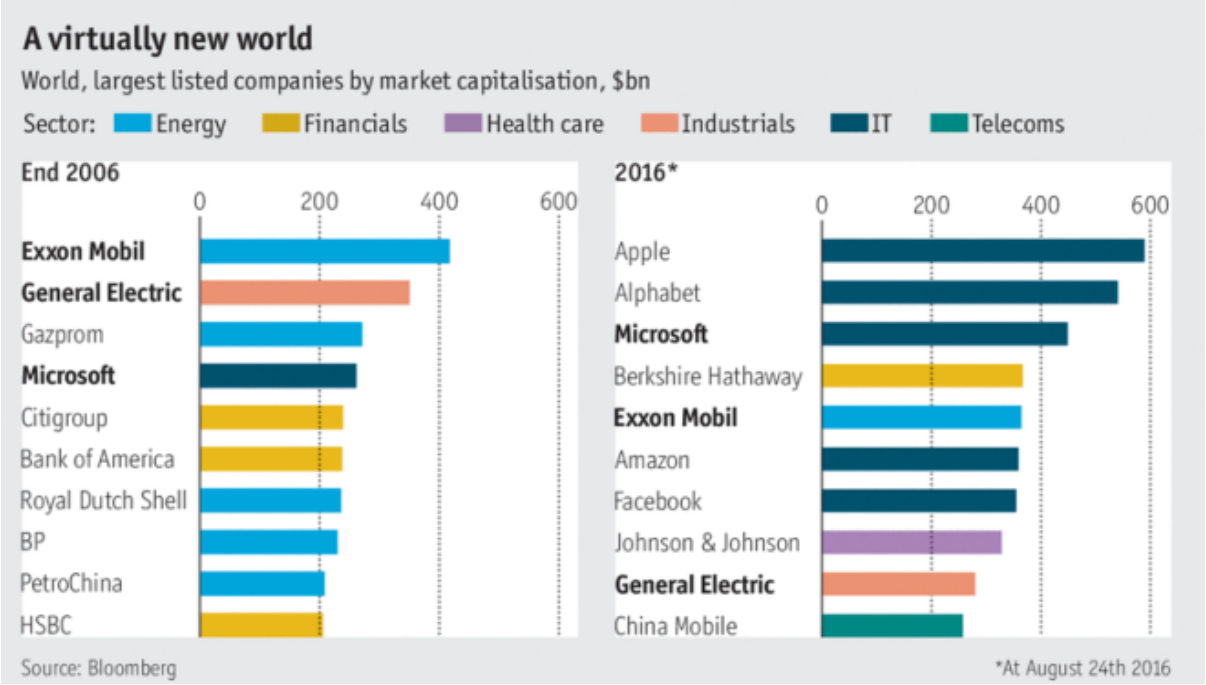
Figure 1.1: History of industrial revolutions



Source: BCG (2018)

The exponential growth of technology has caused the rapid growing of technological companies to become unicorns in a very short period, only about a decade. In the past, the largest enterprises in the world were still mainly banks, mining and oil enterprises, since 2016, technological companies such as Apple, Alphabet, and Microsoft, Amazon, Facebook and other have occupied the leading in the top largest enterprises in the world. This could mark the beginning era of Industry 4.0 when technological companies create breakthroughs, become dominant and future-proofing of the global economy.

Figure 1.2: Information technology companies occupy the top position in terms of market capitalization
Source: The Economist (2017)



1.1.2 Technological characteristics of Industry 4.0

The dramatic improvement performance of computer over the years has accelerated the speed of digitalization and connectivity. On average, every 18-24 months, technology allows for doubling the number of transistors per area of an electronic circuit. This improvement has led to the introduction and dissemination of smart phones since 2007 and its further acceleration, then, by cloud computing services. According to OECD (2017) instant mobile connectivity, a wide range of new products, applications and services have emerged over the past decade and formed a technology and application ecosystem that is increasingly being used by individuals, businesses and governments. This ecosystem will lead the trend of digitalization and transformation in Industry 4.0. There are four main components of this ecosystem, including:

- Internet of Things, including devices and objects whose state *can* be altered *via the Internet*, without *active* involvement of individuals (OECD 2015). It consists of objects, sensors that can collect information, data and communicate, exchange between devices or with humans. Network sensors in the Internet of Things can monitor the health, places and actions of people and animals; production status; the efficiency of the local public services and the natural environment through various applications. The number of connected devices in and around people's homes in OECD countries will probably increase from 1 billion in 2016 to 14 billion by 2022 (OECD 2015). These devices are the main source of data for big data analysis.

- Big Data, which is a collection of tools and techniques used to process and interpret a large amount of collected data due to the increased digitalization of content, greater monitoring of human activities and the dissemination of the Internet of Things. Big data can be used to find relationships, establish dependencies and make predictions of results and behavior. Businesses, governments and individuals are increasingly able to access vast amounts of data from a variety of sources. Big data can help develop machine learning, which is the foundation of artificial intelligence.

- Artificial Intelligence (AI) can be understood as machines that perform cognitive functions like humans. Recently, AI has become increasingly popular thanks to the breakthroughs in computer science, an area of AI that can automatically identify patterns in complex data sets. AI makes devices and systems smarter and empowers a wide range of software and robots so that they can act as an independence entity, operating much more actively without the operator's control and determination as those in the previous. It is expected that AI can solve complex math problems, improve productivity, enhance the efficiency of decision-making processes, and reduce costs.

- Block Chain is a type of decentralized technology that promotes economic transactions and peer-to-peer interactions. Besides supporting information exchange, this technology also enables protocols to perform value exchange, legal contracts and other applications. Permissionless blockchain, such as Bitcoin proved that the data can be distributed and act as a reliable, sharable and open public ledger. This technology is assessed as not to be tampered with and can be monitored by everyone. The combination of transparent transactions, strict rules and regular monitoring creates the characteristics of blockchain-based network. As a result, users can rely on transactions made on this network without having to depend on intermedium or other competent authority.

Besides these four pillars of technology above, Industry 4.0 can also include various types of technologies and techniques:

- High-tech robot which develop machines that can replace people, enhance the ability to perform tasks that require thinking, multitasking and sophisticate skills.

- Additive manufacturing technology, such as 3D printing technology, using to manufacture products by accreting layers of materials to form products.

- Simulation technology and augmented reality: Future interfaces between humans and computers will include simulated environments, hologram displays and digital overlay layers to create virtual reality experiences.

- New computing technologies: New computing technologies will appear such as quantum computers, biological computers or neural network processing, as well as the innovative expansion of existing computing technologies. Technologies with high applicability including: vertical/horizontal integration, cloud computing, artificial intelligence and big data.

- Advanced materials and nanomaterials: New materials and nanostructures will be created to develop useful features for the material, such as increasing thermal efficiency, keeping shape and new functions.

- Collection, storage and transmission of energy: There are breakthroughs that improve the efficiency of batteries and fuel tanks; use renewable energy through solar, wind and tidal technologies; distribute electricity through intelligent grid systems; transmits wireless power.

- Cyber-physical production system: This is the foundation for building smart and digital factories. CPPS is a social network of online communication between machines. In particular, physical space systems will monitor physical processes, creating a virtual copy of the physical world. With IoT, these virtual space systems interact with each other and with humans in reality, and through IoS, users will be involved in the value chain through the use of these services.

- Biotechnology: Initiatives in gene technology, sequencing and therapy, as well as interfaces for computational biology and synthetic biology.

- Geotechnical: Using technological interventions in the planetary system, typically reducing the impact of climate change by excreting CO2 or adjusting the amount of radioactivity of the sun.

- Neurological technology: Initiatives such as smart drugs, neurological and biological interfaces that allow reading, communicating and affecting the operation of the human brain.

- Space technology: Developments that allow access and exploration of larger spaces, including micro satellites, advanced telescopes, reusable rockets and integrated rocket jet engines.

1.1.3 New business models in Industry 4.0

The fundamental technologies in Industry 4.0 not only change production and human life, but also change business models. This is the new business trends that have been and expected to thrive in Industry 4.0.

a. Creating value together

Today, value-creating activities are taking place on an unprecedented scale, and growing day by day. In the top 10 largest companies in the world in 2016, there are four companies invested and successful due to the value-creating activities with their customers, including: Apple, Alphabet, Amazon, Facebook. Thanks to technological applications, these companies have allowed customers to become voluntary employees, to co-produce and create values in the ecosystem associated with the company's main products. Millions of users have programmed millions of applications for the Apple Store, millions of Facebook's social network users have created extremely diverse content, information, stores, and products for Facebook. With Amazon, the company's customers can become appraisers, commentators for books, sellers using Amazon's platform. The same thing happens with Google as millions of Google search engine users can participate in posting ads, developing applications and even finding bugs for Google. In addition, new business models such as Airbnb,

Ubers, Grab allow users to play a role of monitoring, evaluating service quality and being able to participate in providing services.

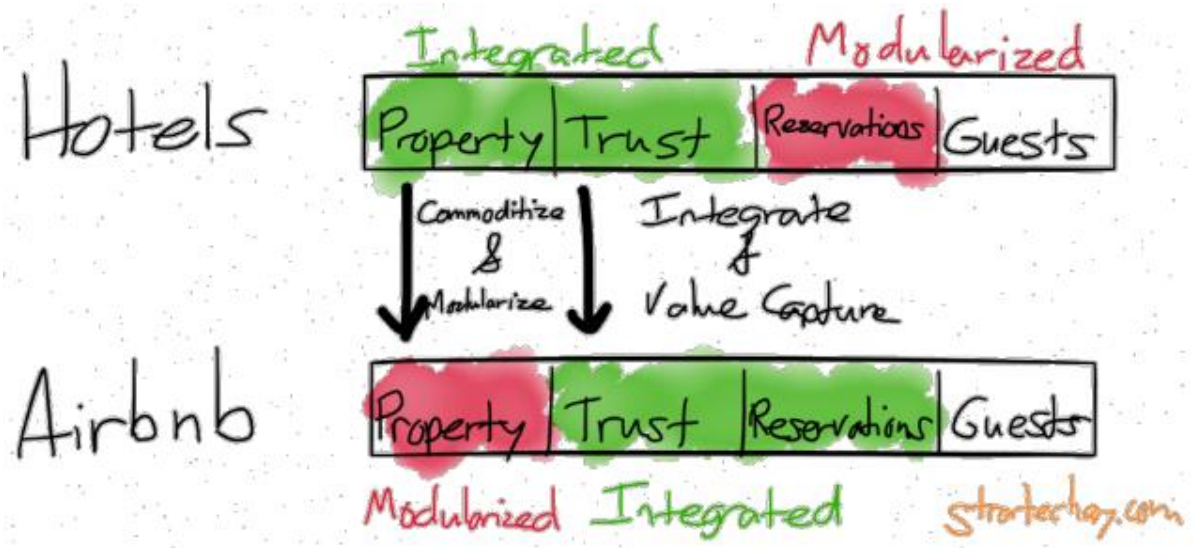
In business, creating value together takes place excitingly that has attracted economists. Since 2000, starting with the researches of Prahalad and Ramaswamy (2004), the branch of "creating value" in business and management has become one of the development research branches with many theory and experiment studies. However, economists haven't reach consensus of a complete, systematic approach to explain the model of "creating value together" and its impacts on economic and environmental and society aspects. Neoclassical economic theory does not seem to explain the evolution of diversity in modern co-value business models as business networks and customers become interdependent in a diversified manner. The boundaries of firms have become more blurred than ever when consumers have also become part-time employees of the firm (Bowers et.al 1990).

b. Sharing economy:

More and more shared business models are emerging in which companies create value by collaborating with free suppliers in the market in new stages that were previously run by businesses. For example, Airbnb cooperates with the owners of houses and rooms around the world to provide accommodation for tourists. Uber works with owners of idle cars and motorbikes to provide passenger transportation services, or Netflix partners with entertainment and film producers to provide services to customers. Distributed and shared-based business models such as Airbnb, Uber, and Netflix make a profit by acquiring orders, payments, and connecting customers with source suppliers. With customers and suppliers, they also benefit from the sharing platform because they will spend less on transaction costs and reduce dependence on intermediaries.

Figure 1.2: Airbnb model compared to traditional hotel model

Source: Cosmiqo (2018)



• Tax software such as TurboTax has eliminated tens of thousands of jobs in tax accounting.

• Traditional newspapers, especially the printed press, have experienced a gradual decline in revenue due to being replaced by electronic newspapers and blogs.

• Translation jobs have become more and more accurate thanks to machine learning, artificial intelligence and little need for human translators.

• Jobs such as secretaries, call centers and assistant directors are gradually being replaced by enterprise software, autoresponder mailboxes or phone applications.

• Electronic bookstores such as Amazon have been in fierce competition and gradually closed traditional bookstores.

• Financial experts such as stock market traders and consultants also lose their jobs due to the emergence of online trading websites such as eTrade and robotics consultants such as Betterment.

• Employers, headhunters have also been replaced by job search sites such as LinkedIn, Indeed.com and Monster.

• Online education sites such as Khan Academy, Udemy and a series of online training courses organized by leading universities will replace the majority of university professors and lecturers.

1.1.4 Opportunities and challenges for businesses in Industry 4.0

In Industry 4.0, enterprises are both the center and the driving force for smart technologies, new technologies, and digital economy development. Therefore, the impacts of Industry 4.0 on enterprises will have a great influence on the development of the economy. The impact of Industry 4.0 on enterprises can be divided into two parts, which are opportunities and challenges.

In terms of opportunities, there are 5 factors that help Industry 4.0 to be penetrating and valuable to all businesses of all sizes and fields, including:

• Impacts on investment costs of building tangible assets

• Prospects to increase sales

• Increasing the diversity and saving of technologies

• The importance of technology and human resources in developing competitiveness

• Great interest from many governments

Industry 4.0 helps create new business routes with less cost. Smart systems will increase productivity, thereby reducing the need to invest in infrastructure and the cost of materials and conversions. In manufacturing, researchers estimate that if Industry 4.0 were fully implemented, it could reduce conversion costs by 25-40%, depending on the economic sub-sector. According to the Global Survey of Industry 4.0 in 2016

from PwC, which was attended by more than 2,000 respondents, in 9 industries, in 26 countries, the respondents expected to grow revenue 2.9%/year and reduce costs by 3.6%/year on average. Over the next 5 years, the respondents estimate that they will reduce US $ 421 billion in costs and increase US $ 493 billion in revenue thanks to Industry 4.0.

Table 1.1: How Industry 4.0 is delivering revenue, costs and efficiency gains

Source: PwC (2016)

Additional revenue from	**Lower cost and greater efficiency from**
Digitizing products and services within the existing portfolio	Real-time inline quality control based on Big Data Analytics
New digital products, services, and solutions	Modular, flexible and customer-tailored production concepts
Offering big data and analytics as a service	Real-time visibility into process and product variance, augmented reality and optimisation by data analytics
Personalised products and mass customisation.	Predictive maintenance on key assets using predictive algorithms to optimise repair and maintenance schedules and improve asset uptime
Capturing high-margin business through improved customer insight from data analytics	Vertical integration from sensors through MES to real-time production planning for better machine utilisation and faster throughput times
Increasing market share of core products	Horizontal integration, as well as track-and-trace of products for better inventory performance and reduced logistics
	Digitisation and automation of processes for a smarter use of human resources and higher operations speed
	Digitisation and automation of processes for a smarter use of human resources and higher operations speed
	Increased scale from increased market share of core products

Industry 4.0 brings many opportunities for businesses to expand their business activities from products to services. Many businesses have in fact transformed their business operations, from selling one type of machinery product to selling the services that machines perform with 4.0 technologies.

Industry 4.0 promises to open up a variety of technologies that can be applied in all sectors of the economy. Companies can choose one or more 4.0 technologies depending on their capabilities and needs. Technologies are also quite flexible as they allow companies to test them so that they can check their return on investment and determine the most appropriate technology before investing in mass.

4.0 technologies are also becoming cheaper, affordable, even for developing economies, small and medium enterprises thus creating a level playing field for economies and businesses. Compared to Industry 3.0, which requires huge investment in machinery and factories, Industry 4.0 with less capital-intensive nature will create favorable conditions for emerging economies such as Vietnam and SMEs. . On the other hand, low-cost technologies also expose large companies to backward technology risks when compared to smaller agile companies.

New technology and high quality personnel will be the key elements of Industry 4.0 to create a major change in manufacturing on a global scale. In the first dimension, they will create a reverse flow when manufacturers pull factories, jobs from developing economies to developed countries. For example, the case of Technology 4.0 can help developed countries to compete on production costs with developing countries. Thanks to smart factories with new technologies such as producing additive (3D printing) intelligent robots, Adidas factory has pulled the production of sports shoes and training products to Germany to shorten the supply chain without losing a cost advantage. In the context of rising labor costs in Asian countries and pressure to reduce the time it takes to launch products to market. Adidas is planning to move production to developed countries which have high demand for the trendy products. New technology has clearly affected the landscape of the USD 80 billion industry a year that has traditionally been outsourced primarily to countries like China, Vietnam, and Indonesia.

In the second dimension, new technologies also enable developing countries to move faster and catch up with developed countries if they have a strategy to make good use of new technologies and talented human resources. In Industry 3.0, developing economies have few opportunities to improve their competitiveness as they face a vicious cycle of lack of capital investment in modern machinery. However, in Industry 4.0, talented human resources are more valuable than capital resources, R&D activities, talents and technology application speed will greatly affect the success of enterprises. With emerging economies like Vietnam, with a youthful, talented and youthful workforce, there will be many opportunities to catch up even ahead of rivals from developed economies. If Vietnamese enterprises have appropriate strategies and implement them effectively.

Finally, another opportunity that Industry 4.0 brings is the concern of governments. This implies that more resources, opportunities, and social investments will be used and distributed by governments to businesses. Theoretically, Industry 4.0

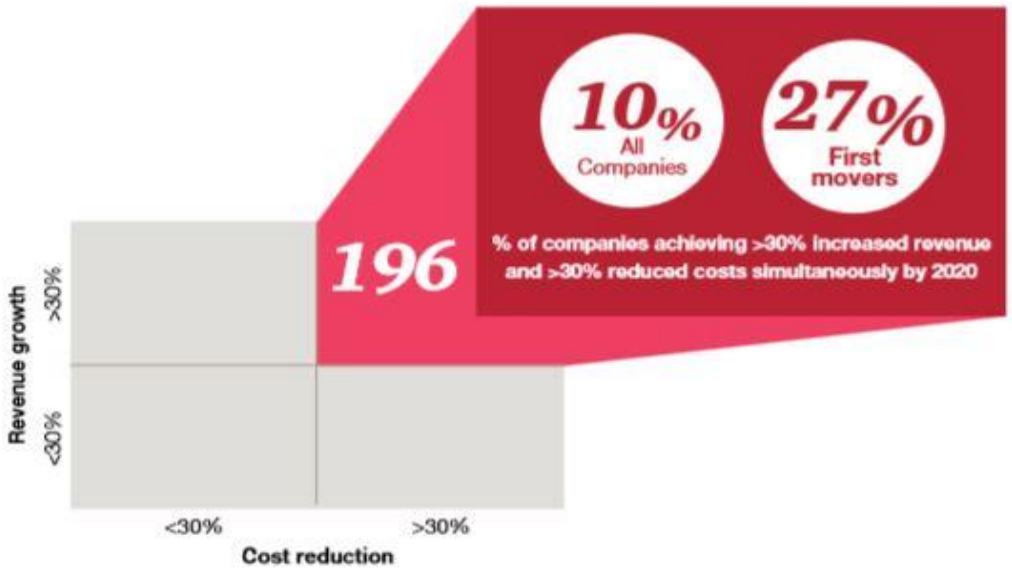
is the realization of countries' national strategies on 4.0 to increase investment, R&D, support for businesses, especially SMEs.

Challenges:

Industry 4.0 not only brings great growth prospects to industries but it can also disrupt the sustainability of the current industrial system (Hermann et.al 2016).

The breakdown of industrial systems especially in developing countries and small companies in many fields is due to the best opportunities, and the greatest benefit of Industry 4.0 belong to the minor winners of the comunity. Due to the digital nature of Industry 4.0, if the suitable products are developed, only pioneering businesses will be able to increase their size rapidly to occupy the majority of the market share. According to PwC (2016), the pioneering enterprises in Industry 4.0 are approximately 3 times higher probability than other to grow more than 30% of revenue and cut over 30% of expenses.

Figure 1.3: Pioneer enterprises benefit the most from Industry 4.0



Source: PwC (2016)

The rapid pace of technological change creates a huge advantage for businesses that adopt new technologies but also create barriers to entry and reduce profits for latecomers. Therefore, without a proper strategy, SMEs will bear great risks when they lose a great opportunity to close the gap and catch up with these enterprises and large enterprises and FDI enterprises.

Another significant challenge is human resources. According to PwC (2016), the biggest challenge for the surveyed enterprises is not the selection of appropriate technology but a shortage of "digital" culture and lack of appropriate skills in

eployees. In addition, the replacement of machines for people due to technological advancements, will also create barriers that make businesses falter when innovating in the context of Industry 4.0. Half of CEOs and managers in the survey of PwC concerned that investors, workers and the public will not trust and support Industrial Revolution 4.0 because of labor elimination. The challenge of retraining labor and solving redundant labor has become a very important issue for both businesses and society.

In addition, the challenges of information safety and security will become larger for many businesses, especially SMEs. With limited financial capacity and human resources, the risk of information insecurity from participating in regional and global networks is huge, especially the risk of losing intellectual property, know-how, and customer information.

A fairly elaborate literature review of two Indian economists, has summarized four groups of key challenges from 18 typical challenges that Indian manufacturing and processing enterprises facing in sustainable supply chain in the context of Industry 4.0.

Table 1.2: Four key groups of challenge that prevent businesses from developing a sustainable supply chain

Source: Luthra & Mangla (2018)

Organization	Legal and ethical issues	Strategies	Technologies
•Financial restrictions •Lack of determination and support for management • Afraid to change, receive Industry 4.0 •Limited vision of digital applications in businesses •Poor ability to apply new business models •Lack of knowledge about Industry 4.0	•Legal conditions •Collaboration issues •Security risks •Complicated issues, personal information	•Lack of governmental supporting policies •Lack of investment in research & development of Industry 4.0 applications •Lack of economic benefits of digital technology investment •Lack of "digital" culture	•Lack of international standards and data sharing agreements • Poor data quality •Lack of consolidation, connectivity between technology platforms •Lack of infrastructure and internet connection network

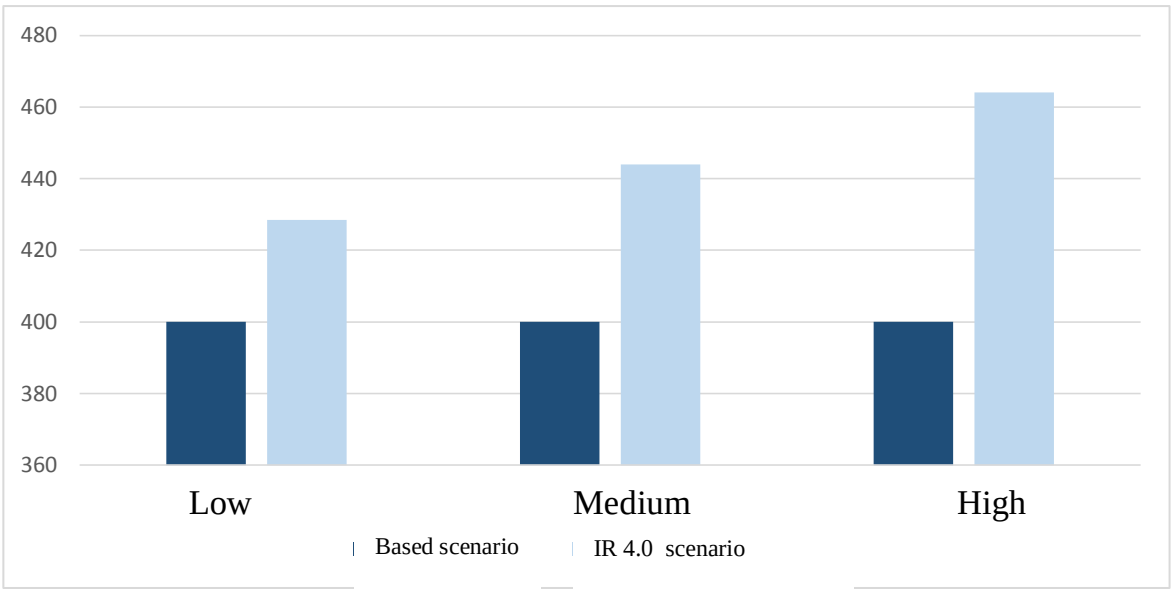
1.1.5 Impact of Industry 4.0 on Vietnam's economy

Figure Industry 4.0 is forecast to fundamentally change the structure of Vietnam's economy. According to a recent study by BCG (2018), Industry 4.0 could affect Vietnam's economy under three scenarios, depending on the level of technology and government pursuing and applying. In terms of GDP growth, Industry 4.0 could increase US$28.5 - 63 billion by 2030, corresponding to an increase of 7-16% of GDP compared to the scenario of no Industry 4.0. This strong growth momentum stemming

from the new technologies of Industry 4.0 will boost productivity and create new products and services in both current and future industries.

Figure 1.4: Forecasting the impact of Industry 4.0 on Vietnam's GDP by 2030

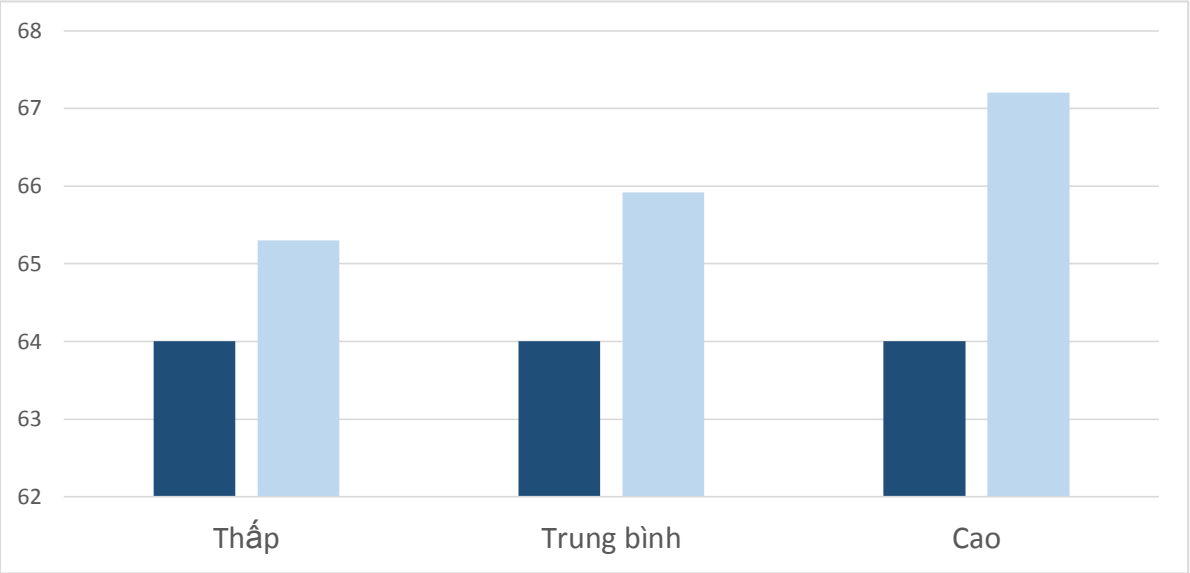
Source: BCG (2018)



Regarding employment, the BCG report estimates that Industry 4.0 will change the employment structure of the economy. The impact on labor comes from the change of labor structure in current industries and the increase in labor in new industries and fields in the future. It is noted that the effect of Industry 4.0 on employment is a two-way effect. New technology can reduce some types of employment while increasing job demand in other areas. For example, new automation technology will replace simple, manual jobs in automobile production, and increase jobs that require higher skills in repairing, maintaining and operating machinery. According to calculations of BCG, the number of job losses by the impact of new technology in Industry 4.0 is about 2.9 - 3.7 million people by 2030. The majority of them are manual labor with low skills, in processing, manufacturing, agriculture, forestry and fishery areas. However, the increase in productivity, the creation of new products and services also creates a lot of new jobs. In short, the employment effect of Industry 4.0 is remarkable and will add 1.3 to 3.1 million jobs in total.

Figure 1.5: Forecasting the impact of Industry 4.0 on Vietnam's total employment in 2030 (million jobs)

Source: BCG (2018)



In tern Low Medium High am have great benefit. By 2030, the added value of manufacturing industry will be USD 7-14 billion; traditional agriculture will be about USD 4.9 billion, finance will be USD 3.5 billion; information and communication will be USD 2.5 billion (increasing 77% compared to the scenario without Industry 4.0); power supply industry will be about USD 4.2 billion; water supply, sewage treatment and waste treatment will be about USD 0.4 billion. The public sector will also save about US $ 0.6 billion thanks to the application of new technologies. Other industries also receive significant benefit from Industry 4.0.

Industry 4.0 will help Vietnam gain more new economic sectors, which are considered to be an important growth engine of Vietnam in the future. These industries are expected to account for 30% of additional revenue by 2030. Newly created industries will both be a driving force of growth and help other economic sectors be more productive and competitive.

Industry 4.0 will change the employment structure. Therefore, Industry 4.0 has the potential cause of income inequality in the population if a part of low-skilled workers who fail to change their skills lose their jobs or have to perform low-productivity jobs in the informal sector and without social security. However, Industry 4.0 also helps the Government to have better tools and resources in developing and implementing social policies, minimizing the adverse effects of implementing Industry 4.0.

1.2 The role of SOEs in Industry 4.0

Industry 4.0 offers great opportunities for businesses and pioneering countries to make quantum leaps to upgrade their science and technology, create jobs, and

improve their incomes and living conditions. Yet, how can a country promote innovation and creativity in science and technology to receive Industry 4.0? What is the role of the type of business and the role of government in promoting and implementing Industry 4.0? Especially for state-owned enterprises (SOEs), what is the role and mission of this sector in Industry 4.0?

This section will review some case studies on the role of enterprises in innovation, science and technology innovation as well as the strategies of industry 4.0 of countries around the world to clarify their approaches to SOEs and the role and mission of SOEs in Industry 4.0.

1.2.1 Origin of innovation

The above sections have shown that Industry 4.0 is a revolution in innovation of science and technology, a comprehensive business model in the economy. Therefore, to understand the meaning and importance of Industry 4.0, we first need to understand the nature of innovation in a market economy.

In the neoclassical model, the economy is in equilibrium under the assumption that people have rational decisions, information in the market is perfect and competition is perfect. The business is reduced to a black box, or a production function, receives inputs such as capital and labor and automatically produces outputs. Because of overly simplistic and unrealistic assumptions, neoclassical economics did not explain the origin of innovation that stimulated economic growth.

Innovation, also known as "creative destruction" was first proposed by Schumpeter (1942), which implies a continuous innovation mechanism of processes and products in which units , new ways and models of production to replace outdated things. Also according to Schumpeter, innovation is a characteristic of capitalism and it represents the nature of evolution and change rather than balance as hypothetical models of neoclassical economics.

Following Schumpeter's ideas, economists continue to query the source of innovation. Kasper & Streit (1998) argued that competition is the driving force behind innovation. While inventions can take place independently, thanks to scientific research, it is only when these inventions are successfully commercialized that it can transform and become innovation. To be an innovation, inventions must be economically viable, tested in a market where customers value the benefits and costs of the invention. The people who turn inventions into innovation are businesses or entrepreneurs. Entrepreneurs are sensitive to opportunities, willing to take risks and overcome obstacles to take advantage of, exploit new knowledge to find economic profits for themselves. In other words, innovation is an ongoing process of knowledge discovery conducted by pioneering entrepreneurs in a competitive market.

Nelson (1993) promotes a view of how technological progress is made in the modern world. He explained that most new technologies are based on science,

although technology can also create new sciences. Most innovations go through a process of trial-and-error, where new process products will have to test, solve problems, and make design changes to achieve the desired effect. His research also highlights the importance of institutions that support businesses, recently called national innovation systems, such as universities, government agencies, and public policy; universities, vocational training and vocational re-training; institutions in the labor market; financial institutions and regulators at all levels. These supporting institutions will create an ecosystem that promotes innovation in the market.

Quantitatively, Dobson & Safarian (2008) provides additional evidence to support the theory of innovative systems based on competitive markets. The study examines the relationship between competition pressures for innovation activities in private enterprises in Zhejiang China and finds that the increase in competitive pressure, measured by competition product competition and customer demand increase are positively correlated with internal learning, investment in development research and the formation of international research and cooperation links.

1.2.2 SOEs and innovation

Although the researches on the effectiveness of innovation of SOEs are not numerous, they provide insight into the innovation activities of state-owned enterprises. According to the relevant studies, it can be seen that innovation appears less in SOEs than enterprises in other sectors. In order to implement innovations, SOEs often need other external impacts, such as diversifying ownership, investing in information technology infrastructure, and participation of foreign shareholders and competitive pressure in export activities. Some typical cases of SOE innovation are as follows:

The application of information technology to improve the efficiency of equitized SOEs (Ahsanullah Dewan, Siafullah M Dewan and Shams Ara Nazmin, 2009). The authors surveyed CEOs and managers of 25 equitized SOEs in Bangladesh in 2007 to determine the extent and impact of the application of information technology in this type of enterprises. The study found that only equitized SOEs take advantage of information technology to improve productivity and revenue.

Through in-depth interviews with executives, the research also found that SOEs applying information technology would gain five opportunities and positive effects, including: strengthening cooperation between SOEs, increasing connectivity with partners in the chain; providing opportunities for SOEs to cooperate with foreign partners; expanding markets and business opportunities for SOEs; increasing the ability to influence the market as well as create value from new products and services; supporting the innovation and creativity of SOEs and private enterprises through the application of new external technologies.

In addition, the study also identified 5 challenges facing should be overcome when Bangladesh SOEs applied information technology, including: lack of investment

in network infrastructure; lack of quality information technology personnel; expenses for development and maintenance of information technology infrastructure and systems; lack of applicability to business and challenges of building trust and ensuring network security.

Girma, Gong and Görg (2009) used a table dataset of 20,000 observations on SOEs from 1999 to 2005 to perform a quantitative analysis of the impact of foreign direct investment on innovative activities in Chinese SOEs. The results show that SOEs with foreign shares tend to have more innovation activities. In addition, if foreign investors invest in a sector, they also encourage export-oriented SOEs in the same industry to increase investment in human capital or conduct R&D. Thus, the pressure of competition or ownership of foreign investors in SOEs is positively correlated with SOE's innovation capacity.

1.2.3 Poor SOE governance is a barrier to innovation

The above-mentioned international studies on SOEs and innovation have shown the correlation between corporate governance improvement and innovation performance of SOEs. This section further analyzes some of the obstacles in corporate governance of Vietnamese SOEs.

Regarding the governance structure, curently, 100% of SOEs are organized as single-member limited liability company and are directly governed by the state ownership representative agency. SOEs have the legal status assigned by the State to the business capital and take responsibility for production management, which is responsible for the economy and compensates for or benefits from the allocated capital. The management apparatus in a SOE consists of the company president or the Members' Council, the director/general director and inspectors. The rights and obligations of these entities are stipulated in the Enterprise Law 2014.

In the legal framework, SOE governance regulations are detailed and clearly defined with the aim of improving SOE governance under international best practices, such as OECD standards on corporate governance in SOEs. However, in reality, corporate governance in SOEs is still weak and profoundly affects competitiveness in general and innovation in particular.

Firstly, SOEs do not have sufficient autonomy and self-responsibility to operate under the market mechanism. In the context of Industry 4.0, enterprises that are lack of sensibility to the market, lack of connection with partners in the chain, and poor connections with customers will be less likely to make technological breakthroughs. SOE autonomy meets some bottlenecks, including:

+ Regarding the autonomy to recruit and appoint managers: According to the current regulations on conditions for appointing managers, initially, the conditions for personnel planning will be very difficult to seek, recruit, and sign contracts with good managers from the market to appoint to the positions of Chairman of the Members

'Council, Chairman of the Company, members of the Members' Council, Controllers, General Director, Deputy General Directors, Directors, Deputy Directors, Chief Accountant of SOEs.

+ Regarding autonomy in managing remuneration and employment: The current law stipulates that remuneration are depended on their production and business efficiency but still control the maximum levels, as well as obtained consent from the Ministry of Labor, War Invalids and Social Affairs for approving the salary fund, remuneration fund, bonus fund and the managerial salary and remuneration fund for State economic corporation.

+ Regarding autonomy in financial and possession, utilization and disposition of corporate assets: The current law details the cases under the deciding competence of enterprises (the Members' Council) but must be consulted or received approval of the owner's representative agency, finance agency and relevant agencies in charge of financial management, assets, expenses, revenue, profits, outward investment, capital mobilization ... SOEs must comply with specific regulations on restriction of property rights, such as the scope of investment capital for establishment or participation in capital contribution to enterprise establishment, additional investment capital, investment in acquisition of other enterprises which must ensure that the debt payable ratio does not exceed three times the equity; contribute capital or invest outside the industry or decide on their own the transfer of investment capital, including low-value investments; strictly abide by the principle of preserving capital in the transfer of shares and contributed capital; ask for comments, appraisal opinions of many management agencies in investing in large size projects (including self-liquidating loan projects), etc.

Even though these regulations are necessary and appropriate in the context of restructuring, reducing financial risks, avoiding loss of state assets, in the long term, from the perspective of corporate governance in accordance with market economy practices; this is one of the factors reducing SOE autonomy compared to other enterprises.

Secondly, SOEs have not yet applied modern and effective management due to internal weaknesses. These administrative constraints also threaten the prospect of fostering innovation at the enterprise itself, including:

+ Board of Directors, Board of Members of SOEs are lack of the foundation knowledge to perform their tasks professionally and independently. In SOEs with a part of the state capital, the regulations of authorizing the entire management of state capital through a representative may raise some "hidden" risks, which is difficult to control. In addition, the members of the Board of Directors and Members' Council are mostly non-specialized officials with little compatibility and appropriate capacity to improve the efficiency of corporate governance.

+ The organization of management, production and business activities is slowly renovated which isn’t keeping up with the development of enterprises in the market mechanism; lack of forecasting capacity. Furthermore, the formulation and implementation of strategies, plans on investment, development of production and business still are inappropriated with the ability to raise capital, and the management ability of the enterprise.

+ The investment management, financial management, risk management, thrift practice and waste combat are still loose; Production and business expenses are still large. Some SOEs have not paid enough attention to complying with financial management regimes and financial statements which provide updated, transparent information in accordance with the regulations on business activities and the financial situation of enterprises.

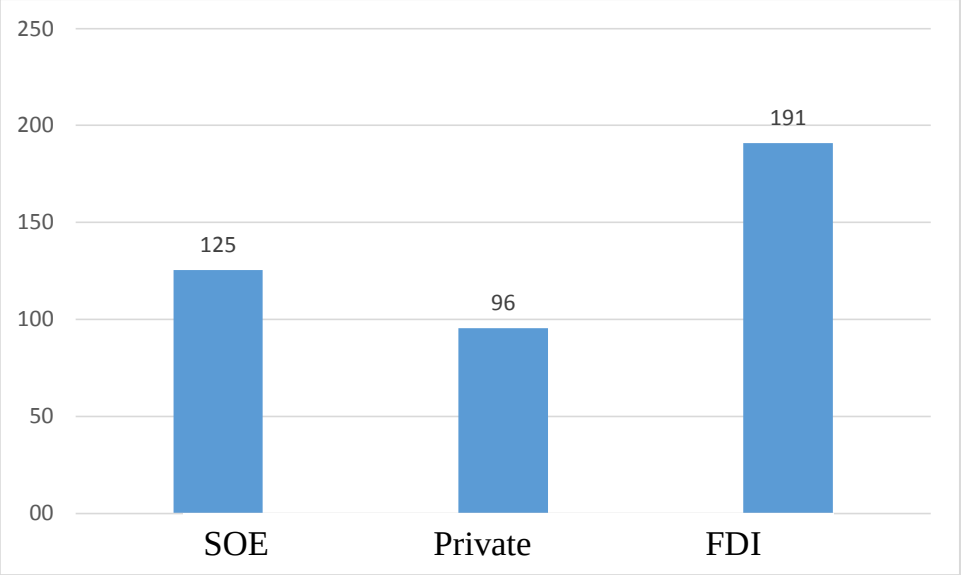
+ In general, the SOE governance model is slow to be renewed, still out of fashion and ineffective, as well as don’t comply with the standards and modern management models in the world. Lack of modern corporate governance tools leads to slow or undetectable problems arising in the business as well as business losses and negatives. Financial reports of enterprises are lack of credibility which makes impossible to transparent the operation of enterprises, and sometimes becomes a "frontier" to cover up the loss and corruption, affecting the confidence of business partners and the people.

Thirdly, the SOEs' remuneration and recruitment mechanism does not attract elites. In Industry 4.0, human resourse will determine business success. Therefore, the constraints on salaries, bonuses and employment of SOEs can lead to brain drain when SOEs not only hire skilled technicians but also lose talented employees to other businesses. Specifically, there are the following issues:

+ Currently, except for Viettel, which is allowed to pilot a separate mechanism, for *wholly*-owned *and* partially owned SOEs, the remuneration mechanism for laborers and managers of enterprises shall be implemented under Decree No. 51/2016, No. 52/2016 and No. 53/2016 ND-CP and guiding circulars. However, they are generally not based on the job position, which paid to lower-skilled workers higher than the market, whereas paid to high-tech workers lower than the market, leading to labor transition status with high professional and technical qualifications to other businesses. According to the enterprise survey results in 2017, the average salary of employees in *wholly*-owned *and* partially owned SOEs in information and telecommunication sector reached VND 125.3 million/year. Although this is higher than that of private enterprises (VND 95.6 million/person/year), it is much lower than that of FDI enterprises (VND 190 million /person /year).

Figure 1.6: Average income of enterprises in telecom industry (million VND/person/year)

Source: GSO (2017)



+ Another limitation is the ability to raise salaries in SOEs, especially in corporations which are rigidly designed based on productivity and profits. Accordingly, SOEs will have the right to raise wages for their employees and managers if the profits are higher than the previous year. While this may bring short-term benefits, it is clearly not recommended that directors and managers make long-term and risky investments in science and technology due to the impact on short-term profit prospects.

+ SOE managers are also attached to the regulation of officials and civil servants. The application of hiring and labor contracts to the CEO and members of the SOE management board is slow. Remuneration and handling of responsibilities for SOE managers are still based on the same principles as for state officials, failing to create incentives associated with responsibilities, consistent with the operation of enterprises. market mechanism[13]. In fact, the rank salary is much smaller than the "surcharges".

+ In many cases, the implementation is "in accordance with the process" but not in reality; The "process" in many cases has become a front for wrongdoing, self-seeking, and obscure staff selection and arrangement. Administrative management mindset and group benefits are still lurking and dominating in recruitment and and

[13] The salaries and bonuses for managers have been adjusted in Decree No. 52/2016/ND-CP, but overall are still low (only 40-50%) compared to the equivalent in private enterprises and FDI enterprises, which has not created the motivation for the good managers. There is no separation between salaries and bonuses of the owner representative (the board of directors, the board of members, the controller) and the executive management board (the board of directors) to ensure objectivity, independence and effective in directing and operating the business.

appointing of SOE managers. Meanwhile, the system of criteria for evaluating, appointing, training and retraining cadres in SOEs is still limited, leading to a number of weak SOE managers in management, administration, and violating the law, corruption and causing losses for some SOEs.

In summary, the situation of SOE governance in Vietnam shows many limitations and weaknesses. Although the equitization process has recently promoted an innovation in SOE governance, equitization does not really improve governance if the equitization trend continues to meet the goal of reducing capital in state ownership. Weak governance also creates many obstacles for businesses to improve their competitiveness and carry out innovation.

1.2.4 Industry 4.0 strategies of countries and the role of SOEs

Can SOEs lead the innovation of industries, sectors or countries? What is the role and mission of SOEs in Industry 4.0? Which strategies, tasks, and solutions related to SOEs have other countries done in Industry 4.0? In this section, the research will summarize some Industry 4.0 strategies or related strategies of countries to clarify the answers to the above questions.

By compiling the strategies with the 4.0 vision of China, South Korea, Japan, Thailand and India, there are two approaches to the role of the state and SOEs in Industry 4.0.

- The first approach, which can be called **the state-led innovation approach**, is typically the Made in China 2025. In this approach, the state proactively increases control, intervene and invest in the economy to promote the development of key economic sectors, preferential policies for domestic enterprises to replace technology import and aims to become the champion in the global value chain. State-owned enterprises continue to play an important role, encouraged to merge to increase scale and technological strength. SOEs are also supported and encouraged by the state to increase investment in R&D, develop new technologies, acquire the world's modern technology know-how and hold important resources and major brands.

- The second approach is **innovating according to ecosystem model**, with typical examples are Industry 4.0 and Society 5.0 strategy of Japan, Thailand 4.0 strategy of Thailand, Korea IR4.0 of Korea and Singapore 4.0. In this approach, the state plays the role of creating and removing barriers between industries, sectors, companies and countries, promoting human resource development and improving the flexibility of the labor market. To create an ecosystem connecting various types of enterprises to promote cooperation and cross-sectoral research, especially to promote public-private cooperation with a focus on small and medium-sized enterprises. This approach is similar to the one in China where the state selects a number of priority sectors and has policies to support the development of industries and encourage R&D.

The ecosystem-based creative approach is different from the state-led innovation approach at three points. Firstly, the objectives of the ecosystem-based creative strategy include the goals of sustainable development where human, society, the environment are the center, especially in Society 5.0 strategies of Japan or Korea IR 4.0. All strategies identify technological and scientific innovations towards addressing and serving social and human issues, such as aging population, vulnerable groups protection, and life, health, education quality improvement.

Box 1.1: "Made in China 2025" Strategy

Source: Compiled from United States Chamber of Commerce (2017)

China is one of the first countries to come up with the "Made in China 2025" strategy (MIC) under the vision of Industry 4.0 with the goal of repositioning the manufacturing industry to become a global champion in high-end manufacturing by upgrading production quality.

MIC was issued in May 2015, covering 10 priority sectors: i) next-generation information technology; ii) high-end numerical control machinery and robotics; iii) aerospaceand aviation equipment; iv) marine engineering equipment and high-tech maritime vessel manufacturing; v) advanced rail equipment; vi) energy- saving manufacture and new energy vehicles; vii) electrical equipment; viii) new materials; ix) biomedicine and high-performance medical devices, x) agricultural machinery and equipment. These industries constitute nearly 40% of China's entire industrial value- added manufacturing, according to Rhodium Group analysis.

To accomplish these goals, China is expected to invest hundreds of billions of RMB in the coming years, not only to support and invest in domestic innovation but also to acquire important technology of foreign countries. According to the US Chamber of Commerce (2017), MIC shows the new nature of China's new industrial policy, increasing the state's intervention and control of the market.

Regarding state-owned enterprises, this area is expected as a great tool to implement MIC 2025. China has used state budgets, preferential policies, incentives and financial policies to promote consolidation of SOEs in some key sectors of MIC 2025. In July 2016, the State Council of China issued a "Guiding opinions on promoting SOE restructuring and reorganizing" to encourage SOEs to enhance global competence and dominance. The guiding opinions set targets for several industries that overlap with MIC 2025, including telecommunications, new energy, aviation, and smart manufacturing. The guiding opinions also encourage SOEs to acquire critical technologies, key resources, and well-known brands. According to the U.S. Chamber of Commerce (2019), from official documents and speeches, the Chinese Communist Party (CCP) is strengthening its role in SOE operations and decision-making. In October 2016, President Xi Jinping said Party leadership is the root and soul of SOEs to become an important force in implementing major strategies.

This trend of MIC causes deep concern for the United States and other countries for market distortion, declining competition, discrimination against foreign enterprises and possibly even creating ineffective resource allocation, excess production on a global scale (US COC 2019).

Secondly, these strategies aim to promote a competitive and equal environment for both domestic and foreign investors rather than giving priority to localization and import substitution as China's strategy.

Thirdly, ecosystem-based creative strategies have new open ecosystem development solutions, connecting public-private partnerships such as businesses, universities, research institutes, SMEs supporting... This open ecosystem will play a key role in promoting research and innovation in the market. In addition, these strategies do not address the goal of developing state-owned enterprises. SOEs have not been identified as a key component leading innovation.

Through the compile of Industry 4.0 strategies of the countries, it showed that the innovation strategy based on the ecosystem model is a more popular and suitable strategy for Vietnam due to the following reasons:

- Firstly, the innovation strategy based on the ecosystem model is more in line with economic theory than the state-led innovation model. The process of innovation and creativity is a process of trial and error, and the active, profit-driven and risk-taking businesses will be the ones who test new inventions and turn them into innovation. The state creates an innovative ecosystem for entrepreneurs to gain more knowledge, resources, relationships, beliefs, thereb enhancing the process of discovering knowledge. Meanwhile, if SOEs play a leading role, it may slow down the discovery process because SOEs are less willing to accept risks, less motivated, competitive pressure and are also more dispersed because of their other social security responsibilities.

- Secondly, international experience shows that except for China, there is no country that put SOEs in charge of leading role in Industry 4.0. However, China has a distinctive feature from other countries that is having large size SOEs, technological potential and a large domestic market. This feature is similar to Vietnam when the SOE sector in Vietnam has been determined to play a sizable role and hold many important resources of the economy.

- Thirdly, the state-led innovation model in which state-owned enterprises play a leading role can create the risk of being sued by trading partners for violations of international commitments and bilateral agreements on free trade and market principles. Incentive policies for SOEs, consolidation, merger, expansion and acquisition of technology will distort the market, create inequality in the economy. Certainly, trading partners, especially the United States, will have sanctions as the actual US-China trade war illustrates recently. Vietnam is only a small economy, with large openness and dependence on exports, so trade sanctions will create great losses. Therefore, when implementing solutions to increase innovation capacity for SOEs, it is necessary to base on in-depth assessments on the correlation between SOE operations and innovation.

1.3 Impact of Industry 4.0 on SOEs

With the orientation "SOEs perform the leading role in the development of enterprises in other economic sectors" (Resolution No.12/NQ/TW of the fifth plenary meeting of the 12th Communist Party Central Committee), SOEs will be greatly affected in the 4.0 industrial revolution, including both opportunities as well as challenges.

Positive impacts / opportunities

- Creating conditions for increasing the efficiency of SOEs: increasing management capacity/efficiency (applying new management methods with modern technologies to shorten the decision-making process in SOEs which is one of the weaknesses of the SOE sector compared to other enterprises); increasing labor productivity

- Sectors and fields of SOEs operation also benefit greatly from Industry 4.0, especially in terms of digitalization and innovation (technology).

- As large size enterprises, many SOEs have potentials in science and technology, so in the first phase of Industry 4.0, the leading role of SOEs in research, application of digitalization and science and technology is very necessary, especially for potential businesses.

- Ownership management of SOEs is gradually being transferred to the Committee for Management of State Capital at Enterprises

- Increasing opportunities to strengthen cooperation with other businesses, especially domestic SMEs

Challenges

- Compared with enterprises in the industry of developed countries, Vietnamese SOEs have lower technological and technical capacity.

- Industry 4.0 requires businesses to have modern governance model, which is proactive and highly flexible, especially in the era of Industry 4.0 with the common application of information technology in many aspects of the business process, including decision making (online meetings, real-time management, etc.) However, management at SOEs in Vietnam has not really applied modern management rules; the decision-making still through many steps has led to limitations. Therefore, the economic corporations need to change their operating and governance models to increase their activeness.

- The rate of highly qualified labor, suitable to Industry 4.0 among SOEs remains low, failing to meet the requirements of applying the achievements of the Industry 4.0. According to the World Bank (WB), the quality of human resources in Vietnam is currently at 3.79/10 points, most of which lack soft skills such as foreign

languages, information technology, teamwork, communication skills, professional manner..

- The economic corporation is forced to change its development strategy from resource exploitation to technology, innovation and creativity-based strategy to meet the trend of the world. Meanwhile, most of Vietnam's potential economic groups mostly rely on exploiting natural resources such as oil, coal, minerals, forests and concentrating on medium or low quality employees, which is a limited growth factor.

2. LEGAL FRAMEWORK, POLICIES ON THE ROLES AND GOALS OF SOES IN INDUSTRY 4.0

In the late 1990s and early 2000s, although the rapid equitization process significantly reduced the presence of SOE but it is still an important sector of the Vietnamese economy. In this section, we will summarize related policy directions, orientations of the Party, Government on SOEs and science and technology to clarify the orientations, direction as well as promotion policy that encourage SOEs to engage in scientific and technological innovation.

2.1 Direction, policy on SOE and its roles in developing science and technology

2.1.1 On the roles of SOEs

The roles and position of SOEs in Vietnam are, first and foremost, determined and guided by the Party's directions and guidelines on state economic development (SAV), and the arrangement, renovation and development of SOEs. Specifically, the Document of the 12th National Congress of the Party, affirmed that the socialist-oriented market economy has many forms of ownership, many economic sectors and it also identified **"the state economy (in which SOEs play a key role) plays the leading role in the economy".**

a) The Resolution No. 12-NQ / TW dated in June 3rd, 2017 of The fifth plenary meeting of the 12th Communist Party of Việt Nam (CPV) on "Continuing to renovate, restructure and improve the efficiency of State owned enterprises" highlighted the role of SOEs by clarifying the direction of the XII Congress in more detail: "SOEs play a key role and is an important material force of the state economy, that contribute to promote economic development, facilitate social progress and justice; SOEs play a leading role in developing enterprises of other economic sectors in order to ensure that Vietnamese enterprises would truly become a driving force in socio-economic development, industrialization, modernization to create an independent and autonomous economy in the context of globalization and international integration."

The Resolution sets out the overall goal: "Restructuring, innovating and improving the efficiency of SOEs on the basis of advanced technology, innovation and management capability according to international standards, in order to mobilize, allocate and utilize effectively social resources; to preserve and grow state capital in enterprises so that SOEs can maintain a dominant position and play as an important material force of the state economy, contributing to promote economic development and facilitate social progress and justice. "

The Resolution also sets out specific targets for each phase:

- Objectives to 2020:

+ Restructuring and renewing SOEs in the period of 2017-2020 by introducing criteria for classifying SOEs and enterprise with state capital by sectors and fields; Commiting to complete the divestment in enterprises which the state does not need to hold shares or contribute capital.

+ Focusing on completely solve problems of State business groups, General corporations and SOE's investment projects which are proven as ineffective or generating a heavy debt burden. Commiting to meet international best practices on corporate governance; improving significantly the effectiveness and efficiency of production and business, product quality and competitiveness of SOEs.

+ Improving and completing the model for management and supervision of SOEs and state capital, assets invested in enterprises. Setting up a specialized ownership agency to act on behalf of the state owner in SOEs.

- Objectives to 2030:

+ Most SOEs have mixed ownerships with a legal form as a joint stock company. The level of advanced technology and production techniques is equivalent to that of regional countries; fully meet international standards on corporate governance; forming a professional management team, with high qualifications and good moral qualities.

+ To strengthen and develop a number of large size state business groups, which are effective and competititive in a number of key sectors and industries in comparision with regional and international level.

b) In order to implement the Party's Resolutions, the Prime Minister made decisions on SOE restructuring (Decision No. 929 / QD-TTg dated July 17, 2012 approving the project "Restructuring enterprises". The Government focuses on Business groups and General Corporations in the period 2011-2015 and Decision No. 707 / QD-TTg dated May 25, 2017 of the Prime Minister approving the project "Restructuring. State-owned enterprises, with a focus on state-owned business groups and general corporations in the period of 2016-2020). According to these decisions, specific restructuring targets of SOEs include:

- For the period of 2011-2015:

+ SOEs have a more appropriate structure, focusing on key industries and sectors, providing essential public goods and services for society and national defense and security, serving as the core for the state economy to play a leading role and important material force for the State to guide and regulate the economy and stabilize the macro economy.

+ Improving the competitiveness, profitability of business enterprises; fulfilling the tasks of production and supply of essential public-utility products and services to the society, national defense and security for public-utility enterprises.

- For the period 2016-2020:

+ Implementing the restructuring, equitization, divestment of state capital in order to create a more reasonable structure for SOE; focusing on key industries and sectors; providing essential public products and services to the society; defence security; natural monopoly sectors; applying advanced technologies; making large investment; facilitating socio-economic development in fields, sectors which enterprises of other economic sectors do not invest. Performing equitization publicly and transparently based on market mechanisms and legal regulations. In the

equitization and divestment process, measures should be made to avoid the loss of capital and state assets, the negative consequences or chances for interest groups making illegal profit.

+ SOE's investment focus on science and technology fields; leading sectors and industries of strategic importance which play a driving role in a knowledge-based economy with high technology content, contributing to improve the competitiveness of the whole economy. Improving operational efficiency, production and business performance, increasing competitiveness, increasing profit-to-equity ratio of SOEs; strengthening management capacity and management capacity according to international standards; SOE operations are managed, supervised closely, openly, transparently and equally with enterprises of other economic sectors.

+ Focusing on resolving shortcomings and weaknesses of SOEs in accordance with the provisions of law, ensuring publicity and transparency based on market mechanism.

+ Improving the model of management and supervision of SOEs and State capital and assets invested in enterprises. Separating state ownership functions and state administrative functions conducted in SOE of state agencies, such as ministry, provincial people committee.

c) The Prime Minister also issued regulations on criteria for classification of SOEs. The classification of SOEs is currently under the Prime Minister's Decision No. 58 / QD-TTg of December 28, 2016 on the criteria for classification of State-owned enterprises, enterprise with state invested capital and the List of restructuring SOEs in period 2016-2020. According to the Appendix attached to this Decision, SOEs will include:

- The State will hold 100% of charter capital of enterprises in 11 sectors and fields: 1. Mapping services for national defense and security.2. Manufacture and sale of industrial explosives.3. Electricity distribution, national electricity system dispatching, management of electrical grids, multipurpose hydropower and nuclear power playing a significant role in socio-economic development, and national defense and security.4. Management of national and State-invested municipal railroad infrastructure, coordination of State-invested national and municipal railroad traffic. 5. Air traffic services, aeronautical information services, and search and rescue services. 6. Maritime safety (excluding dredging and maintenance of public navigable channels). 7. Public postal services. 8. Lottery business. 9. Publishing (excluding printing and publication) 10. Printing and manufacture of notes and gold bullion and golden souvenir. 11. Credit instruments for socio-economic development, services for banking system and credit institution safety.

- The State will hold 65% - less than 100% of charter capital in enterprises in the following 5 sectors and fields: 1. Airport management and operation; airfield operation services. 2. Air navigation services, aviation meteorological services. 3. Large size mineral mining under current regulations of laws on classification of mineral mines. 4. Gas exploration and extraction. 5. Financial and banking services (excluding insurance, securities, fund management companies, financial companies and financial leasing companies).

- The State will hold from 50% to less than 65% of charter capital for enterprises in the following 8 industries and fields: 1. Manufacture of basic chemicals. 2. Air transport services. 3. Enterprises whose market share is of at least 30%, making contribution to the economic balance and market stability and operating in: a) Rice wholesaling;b) Petrol and oil leading importers. 4. Cigarette manufacture. 5. Telecommunications services having network infrastructure. 6. Growth and processing of rubber and coffee in strategic regions, mountainous, isolated and remote areas with the purpose of national defense and security. 7. Enterprises which are able to satisfy the essential demand for a rise in production, and spiritual and material life of ethnic groups in mountainous, isolated and remote area. 8. Electricity retailing (conformable to the roadmap for formation and development of electricity market levels).

2.1.2 SOE's role on developing science & technology

According to Decision No. 707/2017 / QD-TTg, SOEs should focus on investing in science and technology:

- Investment of SOEs focusing on science and technology fields; sectors and industries of strategic importance, drivers of a knowledge-based economy with high technology content, contributing to improve the competitiveness of the whole economy. Improving operational efficiency, production and business performance, increasing competitiveness, increasing profit-to-equity ratio of SOEs; strengthening management capacity and management capacity according to international best practices; SOE operations are managed, supervised closely, openly, transparently and equally with enterprises of other economic sectors.

Resolution No. 12-NQ / TW dated June 3, 2017 of the Fifth Conference of the Central Party Committee of the XII Party also set the goal of innovating and improving the efficiency of SOEs on the basis of advanced technology: Restructuring, innovating and improving the efficiency of SOEs on the basis of modern technology, innovation and management capability according to international standards, in order to mobilize, allocate and effectively use resources. Preserving and developing state capital in enterprises so that SOEs can maintain their key positions and be an important material force of the state economy, contributing to promoting economic development and social progress, equality.

Resolution No. 12-NQ / TW dated June 3, 2017 also sets goals for SOEs by 2030:

+ Most SOEs have mixed ownership structure, mainly in the form of joint stock companies. The level of modern technology and production techniques is equivalent to that of regional countries; fully meet international standards on corporate governance; forming a professional management team, with high qualifications and good moral qualities.

+ To strengthen and develop a number of large size state business groups, which are effective and competititive in a number of key sectors and industries in comparision with regional and international level.

To accomplish the technological development goals, **Resolution No. 12-NQ / TW of June 3, 2017 sets out the tasks for SOEs**:

- Increasing investment, improving the capacity of SOEs in terms of innovation, R&D, transfer of science, technology, modern production techniques, energy-saving and eco-friendly use. This is a decisive factor to improve the productivity, quality, efficiency and competitiveness of SOEs.

Recently, the Politburo issued Resolution No. 52-NQ / TW dated in September 27, 2019 on a number of policy guidelines to actively participate in the 4.0 Industrial Revolution. The resolution set out tasks for SOE sector: " It is neccessary to design mechanisms for SOEs to make investments in technological R&D, venture capital, and innovation startups."

Comment: "The Party's documents and resolutions still define the key role of SOEs in the economy, and at the same time they do not deny the important role of other economic sectors. SOE is directed to become a key force, leading other economic sectors to develop together. However, the specific goals of SOEs in Industry 4.0 have not been mentioned regularly and clearly in the Party's resolutions, directions. This is due to the fact that Industry 4.0 is a relatively new concept and the Party's strategic guidelines have not been updated in time.

But the strategic directions also revealed the directions for SOEs to develop in Industry 4.0. The Resolution of the Politburo has set out tasks on mechanisms and policies for SOEs to invest in R&D of technology, venture capital and innovation startups. Decision 707 / QD-TTg clearly stated that SOEs need to invest in order to lead and drive the knowledge economy. The nature of Industry 4.0 is the second knowledge revolution, so it can be said that Decision 707 / QD-TTg indirectly stipulated that the mission of SOEs in Industry 4.0 is to invest in scientific, leading industries.

2.2 Legal documents, policy in promoting the development of sicence and technology in IR 4.0

Vietnam has not officially issued a national strategy on IR 4.0. However, the Politburo issued Resolution No. 52-NQ / TW on September 27, 2019 on policy guidelines to actively participate in the IR 4.0. The draft of national strategy on IR4.0 has already published and opened for comment since July 17, 2019. While the official national strategy for Industry 4.0 has not been approved yet, we can learn about other major science and technology development policies and SOE's respectively roles and duties. This study provide a summary and review of important policies and strategies on science and technology from 2011 to the present.

Table 2.1: Summary of documents, policies on science and technology, innovation in period 2011-2019

Source: chinhphu.vn

Date	Summary of content
2011	Plans to promote international integration in science and technology and the establishment of the Department for Market Development and Science and Technology Enterprises (NATEC).
2012	Prime Minister issued the Science and Technology Development Strategy 2011-2020 and Decision 592 / QD-TTg Approving the Program on supporting the development of science and technology enterprises and real public scientific and technological organizations present autonomy and self-responsibility mechanism. This decision aims to set up 3,000 small and medium-sized science and technology enterprises by 2015 and 5,000 enterprises by 2020.
2013	The National Assembly promulgated the Law on Science and Technology No. 29/2013 / QH13, acknowledging science and technology enterprises and creating many incentives and incentives; Central Resolution 6 orientates science and technology development in the context of socialist-oriented market economy and international economic integration; The Ministry of Science and Technology proposes a proposal to establish Vietnam's Silicon Valley.
2014	Decree 95/2014 / ND-CP: Encouraging enterprises to set up science and technology development funds.
2015	The Ministry of Science and Technology organizes Techfest Vietnam, an annual event for innovative start-up ecosystems. Establish national technology innovation fund.
2016	The Prime Minister issued Decision 844 to support the national start-up ecosystem by 2025.
2017	The Law on Supporting Small and Medium Enterprises creates tax incentives, access to credit and accounting support for SMEs.
	Directive No. 16 / CT-TTg of the Prime Minister on strengthening the capacity to access the 4th industrial revolution Decision 4246 / QD-BCT on Industry and Trade Action Plan to strengthen the capacity to access the fourth industrial revolution (Industry 4.0).
2018	The SME Support Law and Decree No. 38/2018 / ND-CP detail the investment for small and medium-sized start-up businesses.
2019	Decree No. 13/2019 / ND-CP on science and technology enterprises specifying state incentives for science and technology enterprises prescribed in Article 58 of Law on Science and Technology 2013; Decision 4246 / QD-BCT promulgating an action plan of the Ministry of Industry and Trade on strengthening the capacity to access the fourth industrial revolution; Draft National Strategy on Fourth Industrial Revolution to 2030 of Ministry of Planning and Investment.
2019	Resolution No. 52-NQ / TW of September 27, 2019 of the Politburo on a number of policy guidelines to participate actively in the Fourth Industrial Revolution.

The above table summarizes regulations, policies and institutions to promote science and technology in Vietnam since 2011. In general, these policies show the consistent trend of promoting more marketization of scientific and technological research activities. Generally, issued guidelines and policies of the Party and the State are complete and relevant. Ministries and relating government agencies have actively developed and promulgated complete and clear legal and policy framework for enterprises of all economic sectors, research institutes, universities, public entitities to create technological innovation, invests resources in scientific and technological activities through renovating financial mechanisms, establishing science and technology development funds, and promoting innovation ecosystems, etc.

Major policies, strategies, national projects on S&T development and pursuing IR 4.0 in recent years include:

- National Scientific and technological strategy for the period of 2011-2020, set the goal of producing high-tech products and high technological applications with total value about 45% of GDP, the growth rate of technological and equipment innovation was 10-15% (2011-2015) and more than 20% for the period of 2020, the transaction value of science and technology market increases on average 15-17% annually; international publication funded by state budget increases by 15-20%; total social investment for scientific and technological research made up to 1.5% of GDP in 2015 and 2% of GDP in 2020, and investment from the state budget for science and technology would be not less than 2% of total budget expenditure in a year; By 2020, there would be 11-12 S&T researchers/10,000 people, 10,000 engineers, 60 basic and applied research institutes recognized by regional and international standards, 5,000 S&T enterprises and 60 start-up incubators.
- The Silicon Valley Vietnam 2013 Project (supported by Ministry of Science and Technology) carried out many activities and programs to support potential startups, including: start-up training provided by professional experts from American Silicon Valley; organizing a Demo Day event for graduates; introducing potential Vietnamese start-ups to access venture capital funds, establishing a network of start-up training organizations in the US; set up a social investment fund for incubating start-up businesses, named "Vietnam Startup Fund". According to Kingler-Vidra & Wale (2019), the budget for this project was about $400,000, mainly contributed by private investors, in June 2013.
- The Project 844 issued with the Prime Minister's Decision No. 844/2016 / QD-TTg on supporting the national start-up ecosystem by 2025 with the goal of creating a favorable environment to promote and support the formation and development of ”unicorns” business based on the exploitation of intellectual property, technology and new business models; completing the legal system to support start-up innovation; establishing a national innovation start-up portal; supporting atleast 800 projects, 200 startups, of which 50 startups would successfully raise capital from venture capitalists; total value of mergers and acquisitions estimated to reach VND 1,000 billion.
- The Ministry of Industry and Trade has issued an action plan on strengthening the capacity to access the fourth industrial revolution (promulgated under Decision 4246/QD-BCT) with the following contents: to improve policies and institutions; to support enterprises to access and quickly absorb and develop technologies of Industry

4.0; to enhance technology application capacity of state management agencies in industry and trade; to promote research and application of science and technology; to develop human resources of the industry and trade sector to meet the requirements of Industry 4.0; to promote information and communication, training, raising awareness and international cooperation. In addition, the Ministry of Industry and Trade also built a roadmap of 26 activities to realize the above 6 contents.

Policies, laws and science and technology development projects directly address the role, responsibilities and action plans of SOEs in the development of science and technology, specifically as follows:

- According to the Decision 418 / QD-TTg of the Prime Minister on approving the Science and Technology Strategy for the period of 2011-2020, it defined the orientation of developing science and technology organizations, including State Business Groups: "To support for the formation and development of scientific and technological research organizations in enterprises, especially state business groups." Especially in this Strategy, the Government identified that information technology, biotechnology, new material research and automation were the priority sectors for development. Another technology of Industry 4.0 such as artificial intelligence, robots, network security, computing centers, system simulation, etc. have also been mentioned.
- Article 63 of the Law on Science and Technology No. 29/2013 / QH13 specifies the obligations of SOEs to set up science and technology development investment funds: State enterprises must deduct a minimum percentage of income for calculating enterprise income tax to set up the Science and Technology Development Fund of enterprises. ”Next, Decree No. 95/2014 / ND-CP of the Government stipulated: State-owned enterprises must deduct 3% to 10% of their taxable income annually to set up science and technology development funds of enterprises. If the fund is not fully used, SOEs must return it to the National Science and Technology Development Fund or the science and technology development fund of the managing ministries, provinces and cities.
- The draft of National Strategy on IR4.0 up to 2030 was drafted by the Ministry of Planning and Investment and has been opened widely for gathering online comments since July 17, 2019. The draft outlined specific tasks and solutions that the SOE sector need to implement in order to achieve objectives in Industry 4.0. In particular, the Draft also specified the role of the Commission for the Management of State Capital at Enterprises (CMSC) as a focal point to guide, promote, and coordinate large size SOEs to play the leading role in Industry 4.0. The draft proposed 6 specific directions for SOEs:

• SOEs actively make investment projects in order to apply IR4.0 technologies, improve their productivity and competitiveness and create a good model for other enterprises to follow.

• SOEs establish venture capital funds to invest in innovative startups, develop and integrate technologies developed by innovative startups into their businesses, and promote the application of IR4.0 technologies to other businesses.

• SOEs enhance cooperation with each other and with private technological enterprises, forming technological alliances to coordinate and support each other in applying Industry 4.0 technology in production and business.

• SOEs with abundant financial and technological conditions, should utilize their resources to conduct R&D of some key technologies of Industry 4.0 and next-generation technologies, such as 5G, Artificial Intelligence, Data Analysis, Big data, block chains, ... to solve business problems, foster the domestic economy and increase export to global markets.
• Encouraging SOEs with financial and technological capacity to set up centers and research institutes to both participate in developing human resources and develope technologies of Industry 4.0, improving the leading role of SOEs in R&D and innovation.
• SOEs strengthen their leading role in developing science and technology capacity; formulating strategies, plans on investment in developing and applying science and technology; proposing new policies to facilitate R&D activities.

Comments:

In terms of strategies, policies and laws, the Vietnamese Government has shown high determination and made great efforts to promote country's scientific and technological development in the period of 2011-2019, by issuing many plans, solutions and incentives for businesses to upgrade technology, to launch start-up and innovate.

However, S&T policies in this period was not very effective in practice. The global competitiveness report shown that Vietnam had a relatively low rank of 56/144 (2016) without big improvements for years. It suggests a poor capacity of innovation and technology creation to improve the efficiency and diversity of new products. There are two main reasons for the poor effectiveness of S&T development policies:

- *Firstly*, the real investment capital for R&D was low and slowly increased. The Government does not publish reliable and internationally comparable statistics on total R&D expenditures with detailed components. According to the Vietnam 2035 report (2016), R&D expenditures only accounted for 0.3% of GDP. However, most of this is salaries for employees at public research institutions, of which about half of the staff may not be directly involved in research activities. Vietnam's spending on science and technology is estimated at 1 USD/person, while this rate in OECD countries may be nearly 1,000 USD. According to a recent study, the government's expenditure on science and technology was only 0.77% of total budget expenditure and 0.4% of GDP in 2017, of which a large portion had to allocate to the Ministry of Defense (Klingler-Indra & Wade 2019).
- *Secondly*, the lack of specific targets on quality improvement and pushing up the limits of technologies have made S&T policies ineffective in reality. According to Klingler-Indra & Wade (2019), the difference of S&T policy between Vietnam and China is that Vietnam did not set a clear ambitous goals to upgrade domestic industries, sectors and technologies close to the world level. Most goals stated in the national strategy for S&T or Vietnam Silicon projects focus on quantity not quality, such as the number of innovative startups set up or the number of incubators set up. There were a serious lack of quality oriented targets such as new business models or the innovation capability.

Although the SOE sector is expected to play a key role in the economy, a driving force for growth and leading other economic sectors, this sector still plays a relatively vague role in scientific and technological activities. No legal documents, policies or strategies have set clear goals for SOEs in promoting science and technology. Even

the draft of National Strategy on Industry 4.0 did not set specific goals of SOEs but only outlined the directions, solutions and tasks that SOEs are encouraged to implement.

The only constraint imposed on SOEs is to set up a S&T development fund and deduct 3% -10% of the taxable income for this fund. Obviously, this regulation is quite rigid because it does not take into account the diversity of industries, sectors, market competition and effective utilization of the fund. Apart from tight funding sources, SOEs are not priority subjects to receive government budget to conduct scientific and technological research and development.

Science and technology development projects, such as the Vietnam Sillicon Project, the project to support the national start-up ecosystem by 2025 and the action plan to enhance the capacity to approach the industrial revolution Ministry of Industry and Trade, did not identify SOEs as an important target in the ecosystem. These projects mainly promote the formation of startups, business incubators, support SMEs and connect investors, businesses and banks to participate in the startup ecosystems.

SOEs play a dominant role in many markets but there are no regulations or policies that force them to cooperate, transfer technology, and SMEs to develop their ecosystems. thai business. In many markets, SOEs hold a monopolistic or dominant position and sometimes have harmful behaviors for competition. This could explain for SOEs' weak linkage with the domestic private sector.

According to the Decision No. 707 / QD-TTg of the Prime Minister, the State has a policy of restructuring SOEs on the basis of modern technology, capable of innovation and management according to international standards. In fact, the 19 restructuring projects of State business groups and General Corporations under CMSC, demonstrated that there was no S&T requirements or goals. The approved SOEs renovation projects, if any, only set very common and loose scientific and technological goals without specific and measurable goals in science and technology, such as the number of patents granted, number of technological solutions, the goal of bringing the industry's technology close to the world level, the target of localization and replacement of imported technology.

Regarding investment, SOEs are neither entitled to special mechanisms nor responsible, and have no obligations in investment in scientific, technological development and innovation. Therefore, the regulations and policies on investment of SOEs have not yet well delivered the orientation stated in the Prime Minister's Decision No. 707 / QD-TTg on prioritizing investment in "key science and technology of strategic importance, leading and orienting the building of a knowledge-based economy with high technology content, contributing to enhance the competitiveness of the entire economy. "

3. THE READINESS OF STATE-OWNED ENTERPRISES IN THE INDUSTRY 4.0

3.1 Models on the maturity, readiness of enterprises in IR 4.0

Within the scope of the research group, no specific models have been developed to assess the maturity of SOEs in Industry 4.0. Therefore, in this section, we will present some models of the world on assessing enterprise readiness in Industry 4.0. These models are a very useful reference base for the research team to design an analytical framework for SOEs readiness in Industry 4.0 in Vietnam.

Conceptually, the maturity level of an enterprise with Industry 4.0 can be broadly understood as a state of completeness, holiness and readiness, implying progress in the development process of the enterprise (Schumacher et al, 2016). The models of readiness and maturity will be a useful basis for measuring SOE preparedness in Industry 4.0. Some models of enterprise readiness and maturity in Industry 4.0 have been introduced in the world, including:

Table 3.1: Typical maturity/readiness models of enterprises in IR 4.0

Source: VDMA, IWI & RWTH Aachen 2015, Lanza et al 2016, PwC 2016, Schumacher 2016

Models	Sources	Approach/methods
IMPULS- The readiness for Industry 4.0	VDMA, IWI & RWTH Aachen University (2015)	Assessing 6 components, including 18 indicators to determine the readiness for 4.0 according to 5 levels; obstacles to increase from bottom to high are also analyzed, accompanied by a solution
Empowerment and implementation strategy for Industry 4.0	Lanza et.al (2016)	Assess the maturity of CN 4.0 with a short test and a process of identifying barriers. No detailed method of evaluation will be given
Industry 4.0/ Self assessment on digital operation	PricewaterhouseCoopers (2016)	Online self-evaluation of 6 components; focus on the maturity of the digitalization system, divided into 4 levels of maturity.
Assessing the maturity and availability of manufacturing enterprises in Industry 4.0	Schumacher và đồng sự (2016)	Maturity assessment is done by 9 components, including 62 groups of indicators with different weight indicating importance. The problems are measured in 5 levels from low to high and tested by case analysis.

Among above models, IMPULS- Readiness for Industry 4.0 and PwC's Digital Self-Assessment System (2016) were highly regarded as the most comprehensive models because they based on a sound theoretical framework and published their methodology clearly.

The IMPULS 4.0 model designed by VDMA (German mechanical association), IWI and RWTH Aachen University (2015) is designed to assess the level of industrialization 4.0 of enterprises, built on the basis of the results of consultation with Representatives of German businesses are members of the association through many online seminars, discussions and surveys. PwC's digital self-assessment system (2016) is the most widely used model of Industry 4.0 in practice to date. In 2016, PwC conducted a survey of more than 2,000 experts and company leaders from more than 2,000 businesses in 26 countries across continents.

In Vietnam, MOIT & VASS & UNDP (2018) conducted an assessment of the readiness in accessing to Industry 4.0 of enterprises in 18 industries based on the IMPULS model - VDMA's Industry Readiness 4.0. , IWI and RWTH Aachen University (2015), which carried out an enterprise survey. This is considered to be the first enterprise survey on Industry 4.0 in Vietnam, elaborately designed, large size with 2,659 enterprises that responded to the questionnaire. The use of both quantitative and qualitative analysis methods has found significant results. However, the investigation results of the Ministry of Industry and Trade also acknowledged many limitations as follows:

• Firstly, the IMPULS 4.0 analysis framework is not entirely consistent with the surveys of MOIT, VASS & UNDP. IMPULS 4.0 is designed primarily for manufacturing / mechanical enterprises, but the MOIT, VASS & UNDP survey includes businesses operating in 18 industries - a much broader scope than manufacturing. generating / mechanical. The IMPULS 4.0 method may not be entirely suitable for Vietnamese businesses with a large degree of differentiation, capabilities, and development level than German businesses. The IMPULS 4.0 method is for businesses to assess their own readiness, while the Ministry of Industry and Trade conducts a sample survey to compare businesses.

• Secondly, on how to calculate index scores, component weights, IMPULS 4.0 methodology is not disclosed in detail. Therefore, the surveys of MOIT, VASS & UNDP developed their own scoring method. This calculation may not reflect correctly compared with IMPULS 4.0 method. Although the study attempted to adhere to qualitative guidelines on how the score of VDMA's business readiness in each dimension, it was not possible to calculate the weights corresponding to the components due to time constraints. investigation time and resources. On the other hand, the group also thinks that VDMA's weights are not suitable for the Vietnamese business sector. It can be said that the adjustment of points and weights of MOIT, VASS & UNDP has made the survey results have a big difference compared to the IMPULs 4.0 method.

• Third, MOIT, VASS & UNDP have made many adjustments, increases and removed some questions to "fit with the conditions of Vietnam". Some basic technologies of CN 4.0 expressed in IMPULS 4.0 method were removed for the same reason. MOIT, VASS & UNDP's IMPULS 4.0 methodology of self-formulation and adjustment clearly does not guarantee a solid theoretical basis of this method but is purely based on experience. Therefore, the survey results will be different and difficult to compare with international businesses.

• Fourth, the method of IMPULs 4.0 is to encourage businesses to participate in the survey, to assess their own readiness. Meanwhile, the MOIT, VASS & UNDP investigation is a formal, mandatory government investigation, which can put pressure on state-owned enterprises. The results of the investigation may therefore be biased due to political pressures.

The survey results show that the SOE sector has the highest level of readiness, far exceeding the readiness of both FDI and private sectors. Specifically, there are up to 16% of SOEs at the "basic level" and 1% - "experienced" (in the group "leading" the process of joining Industry 4.0) while this rate in the region FDI is only 3% of the base level, 0% at the experienced level, the private sector: 1% at the base level and 0% at the experienced level. The average point of the readiness of SOEs is 1.44, much higher than the industry average of 0.53 and highest compared to other economic sectors (FDI: 0.6 and private 0.5). . These results suggest that the SOE sector can play a leading role in Industry 4.0.

Research by MOIT, VASS & UNDP explains the outstanding factor of SOEs because the size, level of capital equipment, concentration index and manufacturing sector of "high technology" are the main reasons for this sector. have a higher level of readiness than other regions and thus play a pioneering role in the level of readiness to participate in Industry 4.0. The study also recommends that SOEs take advantage of scale and capital advantages to increase access to Industry 4.0 and increase connect with businesses from other regions.

However, the research of MOIT, VASS & UNDP (2018) has not yet pointed out the limitations, nor recommended specific measures for SOEs to improve their readiness in Industry 4.0. The initial advantages of scale do not necessarily provide a competitive advantage and better preparation for SOEs in Industry 4.0, especially in the context of growing and stronger private sector. Another point to note is that the survey of MOIT, VASS & UNDP has not yet shown the relationship between enterprise readiness in Industry 4.0 and production and business results of enterprises.

The above limitations in the MOIT, VASS & UNDP survey have motivated the research team to choose a different approach to assess in another aspect (possibly closer to reality) in terms of readiness. of SOEs in Vietnam for Industry 4.0.

3.2 Analytical framework

In this study, the readiness of SOEs in Industry 4.0 is assessed through a self-assessment survey of the degree of digitalization of enterprises by the method of PwC (2016) combined with the assessment of digitalization of SOEs in some sectors and fields based on 2016 GSO enterprise survey data.

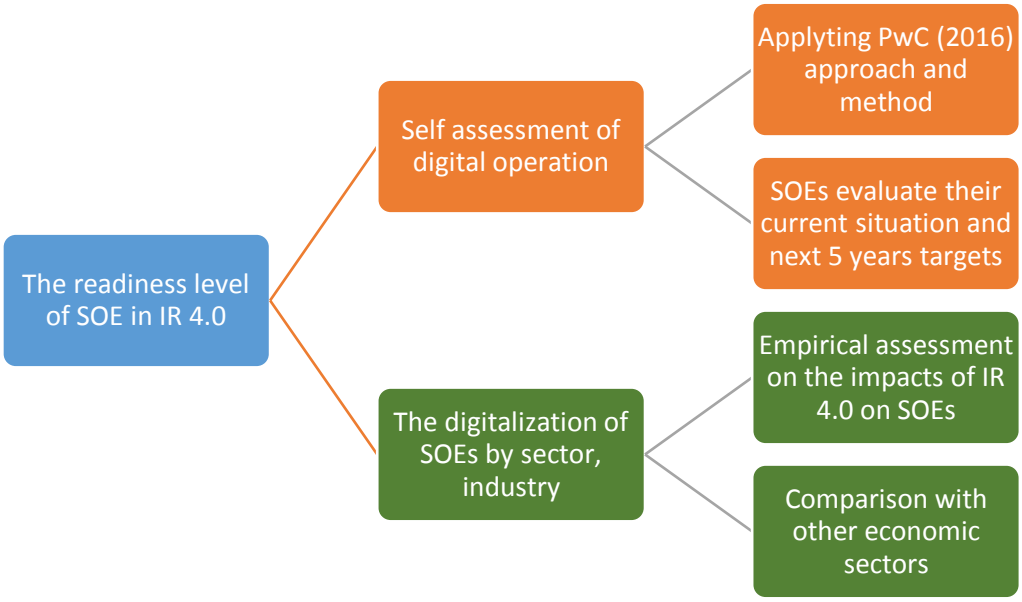
In the first analytical direction, we carry out a self-assessment survey of digital operation based on the method developed by PwC (2016) (hereinafter referred to as the PwC method). The advantage of this method, as stated, is its comprehensiveness and applicability to all types of businesses, in many industries, sectors and in many different countries. In addition, the PwC method also shows current situation as well as the goals of businesses in the future of digitalization.

Due to limited resources and time, the study could only apply the PwC survey on a relatively limited number of SOEs. To overcome this limitation, a quantitative analysis of the digitalization of SOEs based on the results of the 2016 GSO enterprise survey to compare and supplement to the research results. Extracting this data set, the research team compared the digitalization level of SOEs, measured by the use of computers and the internet of enterprises, with other economic sectors in many industries. Taking advantage of the data set, the research team also conducted the test of the impact of digitalization on SOE production and business results.

Finally, combining two analytical methods to outline a more general picture of the state and readiness of SOEs in Industry 4.0. Detailed analysis framework is presented in the below chart.

Figure 3.1: Framework for analyzing the readiness of Vietnamese SOEs in Industry 4.0

Source: Authors

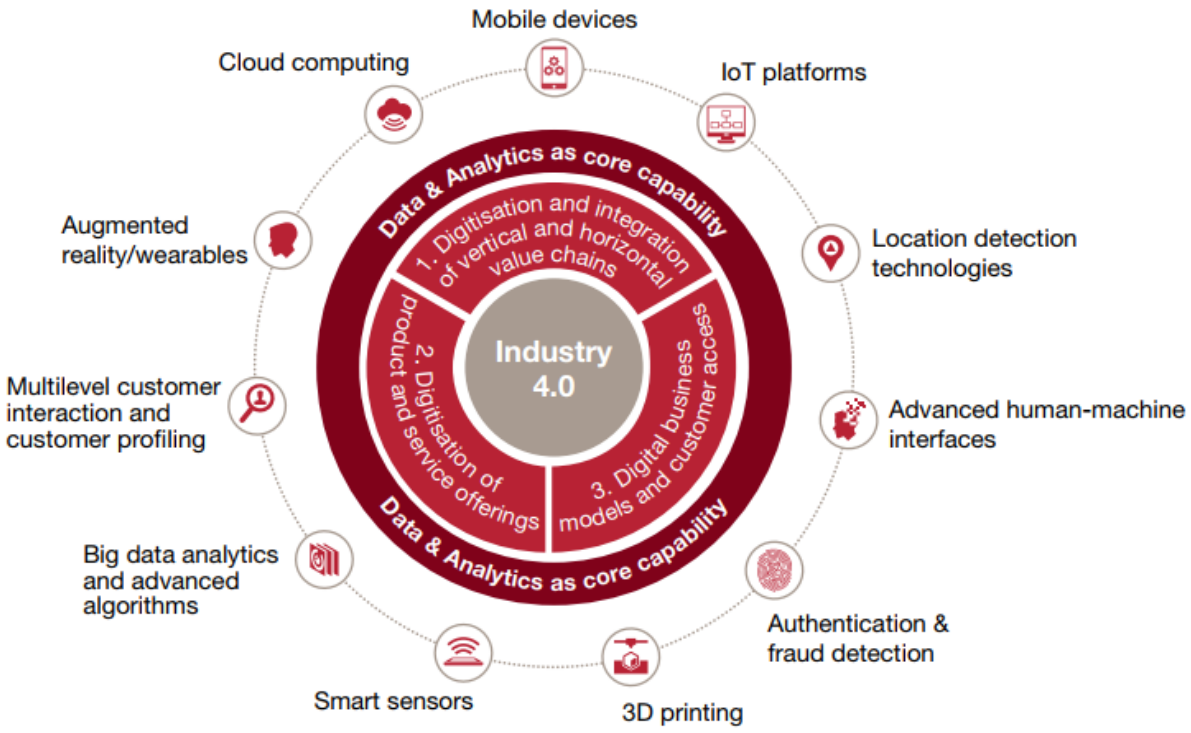


3.3 Applying PwC's digital self-assessment method to assess the readiness of Vietnamese SOEs in Industry 4.0

The model of self-assessment of digital operation of PwC in Industry 4.0 is based on the basic theory that the three driving forces leading businesses to advance in Industry 4.0 include: i) Digitizing and integrating into the value chain horizontal and vertical; ii) Digitize services and products; iii) Business models and digital customer access. These dynamics revolve around the core competency of collecting, analyzing and transmitting data. The ability to collect and analyze data is supported by the introduction of advanced technologies in Industry 4.0, such as cloud computing, virtual reality, mobile devices, IoT platforms, Positioning technology, 3D printing, smart sensors, large data analysis, ... PwC's digital operational level model can be shown as the chart below.

Figure 3.2: IR 4.0 and supporting digital technologies

Source: PwC 2016

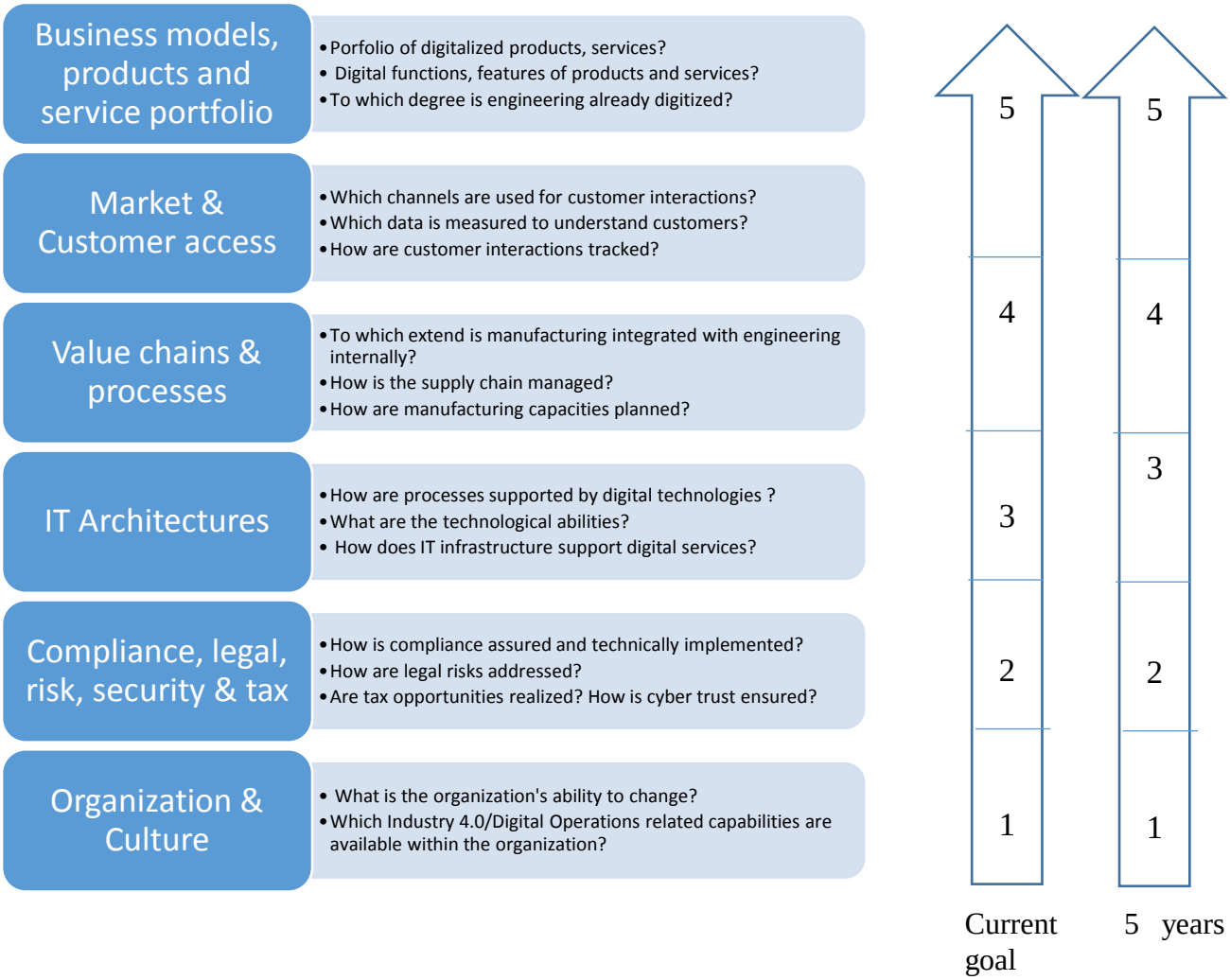


Based on this model, PwC (2016) develops a model to self-assess the level of digital operation in Industry 4.0 to support businesses to understand their position in Industry 4.0 by measuring the current situation and the item. business goals in the next 5 years in 6 pillars, thereby identifying development needs as well as classifying the maturity level of enterprises.

The PwC CN 4.0 self-assessment model of digital operation consists of 6 pillars, corresponding to 33 questions. For each question, the business assesses its STATUS STATUS and GOAL within the next 5 years. Rating on a scale, with 1: minimum and 5: maximum. See the picture below.

Figure 3.3: Pillars and scales to measure the digitalization level of businesses

Source: Pwc (2016)



After summing up the average scores of the six pillars above, enterprises surveyed will be ranked in four levels equivalent to the level of digitalization maturity in Industry 4.0, including:

1. Businesses that start digitizing (The Digital Novice) are businesses that have just started to digitize their operations and business models. The main objective of these businesses is just to start integrating the number of internal activities. The list of products and business services of these enterprises is mainly ordinary physical products, and the level of integration in vertical and horizontal value chains is limited.

2. Enterprises that have integrated vertical numbers are businesses that have added digital features to their products or created digital products and services to do

business. Businesses have also used data to create value and have somewhat integrated digitalization in vertical value chains internally, from resource planning to production machines, or even to the products.

3. Horizontal Collaborators are businesses that have completed most of the digital integration in the internal value chain vertically (from planning to production, sales) and has now focused on collaboration and digital integration with partners, customers, and suppliers. In the process of horizontal digital integration, new businesses form loose relationships with value networks with partners to serve customer requirements.

4. Digitizing champions are businesses that have integrated digitalization in the value chain both vertically and horizontally to a quite important level in their business. The current champion will focus on developing new, break-through business models, products and services that are often driven from data to serve the customer's individual requirements. Collaborative activities and coordination are the essential drivers for creating value.

Details of the evaluation pillars and descriptions of maturity levels are shown in the table below.

Table 3.2: Main pillars and maturity of businesses in Industry 4.0

Source: PwC (2016)

	Digital novice	**Vertical integrator**	**Horizontal collaborator**	**Digital champion**
Business models, product and service portfolio	Newly-digitized solutions and separate applications	Having a portfolio of digital products and services with software, networks (M2M) and data are the key differentiating factors	Collaborate with external partners to provide integrated solutions to customers in the supply chain.	Develop new, destructive creative business models with innovative products and services
Market & customer access	The online displays are separate from actual media channels. Focus on the product instead of the customer.	There are many distribution channels, integrating both online and offline channels, Start implementing data analysis, for example, for personalization	Take a personalized approach to customers and actively interact with other partners in the value chain	Integrating customer experience management in all sales marketing channels

Value chain & process	Digitize and automate some subprocesses	There is vertical digitalization and integration of processes, and data flows within the company	Integrating digitizing processes and data streams with customers and external partners. Use data thoroughly	Improve the digital ecosystem with partners, including self-optimization. Distributed processes can be automated
IT infrastructure	Distributed and separate IT infrastructure	Internal IT infrastructure is consistent	Building general and synchronous IT infrastructure for partners in the same network	Having service bus technology with partners (transmitting information through reliable cloud technology) and securing data exchange
Compliance, legal, tax & risk	According to the traditional way, not yet focused on digitalization	Identification of digital challenges has been identified but has not yet been fully addressed	Coordinate with partners to handle legal risks consistently	Optimize the value chain network to comply with laws, tax obligations and security
Organization & Culture	There is not much coordination yet, the units are quite separate	There is some cooperation between departments in the company but not methodically and consistently	Cross-company cooperation. There is a culture to encourage sharing	Collaboration is an essential driving force for value creation

3.3.1 Survey of self-assessment of digitalization of SOEs

The questionnaire for the survey was built on the basis of the content of PwC questionnaire (see Appendix 1). However, the research team made some adjustments, the difference between these two questionnaires was mainly in the general information of the business. In the questionnaire of this study, information on the characteristics of enterprises such as type of business, level of ownership of the state, number of employees paying insurance, number of subsidiaries was added to be able to implement. show comparisons and statistics in line with the objectives of the study.

Part B of the survey Self-assessment of enterprise's digital operating capacity is kept unchanged from PwC's design to ensure consistency and consistency with the PwC method. Regarding the component scoring method, we also apply the calculation and weight of PwC. Because the PwC survey of digitalization is a global survey, applicable to many countries and many industries, we can simply apply the methods, questions, and scoring method of PwC without further adjustment. As a result, the

results obtained can be compared with the common ground of international businesses of the same size, field and industry.

3.3.2 Sampling

The research team selected a sample for randomized survey. Based on the database of SOEs collected, we conducted a random selection of businesses to send survey questionnaires.

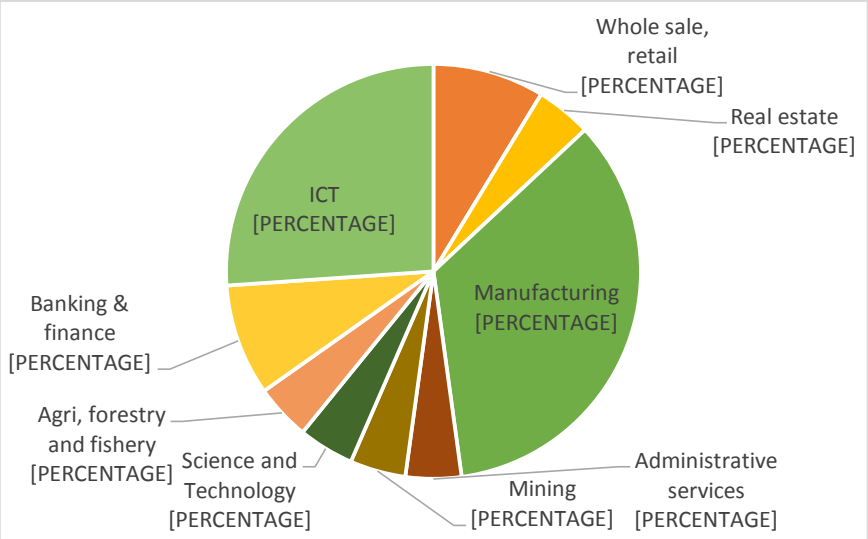
3.3.3 Descriptive statistic

Out of 100 votes sent to businesses, the team collected 23 votes to meet the requirements. The organizational structure of the industry, type of business registration, size and level of state ownership is as follows

a. Industry, sector

The chart below shows that SOEs participating in the survey belong to 9 level 1 industry groups based on VSIC 2007 classification, including: Wholesale and retail; real estate; manufacturing and processing; administrative services; extractive; science and technology; Agriculture forestry seafood; finance, banking, insurance and media information. In particular, the group of enterprises in the processing, manufacturing and information and communication industries accounted for the highest proportion with 35% and 26% respectively. The diversity of industry groups makes the survey results well representative.

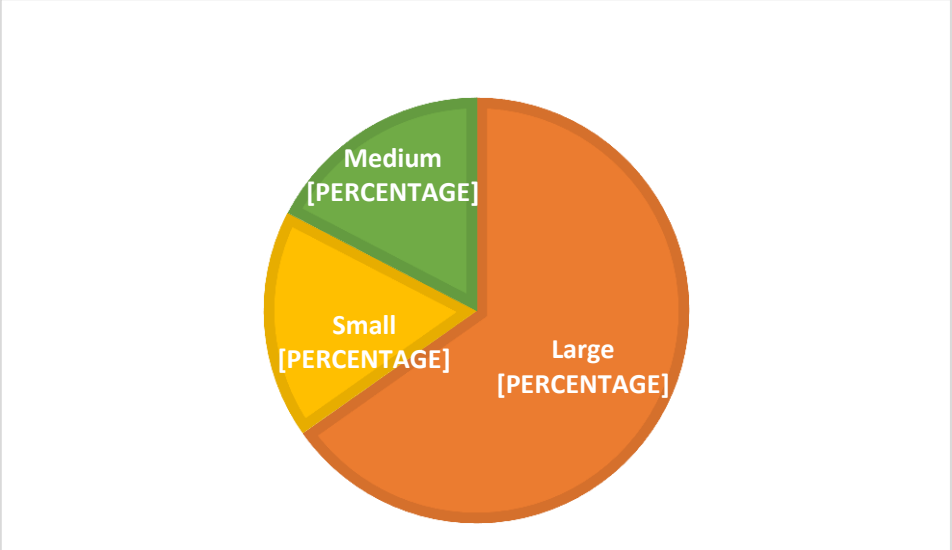
Figure 3.4: Structure of enterprises participating in the survey by type of business



b. Business size

Of the 23 respondents, 65% are large size. Small and medium-sized enterprises have the same number, accounting for about 17.5% (criteria for classification of small and medium-sized enterprises based on Decree 39/2018 / ND-CP detailing a number of articles of the Law on Supporting Small and Medium Enterprises). The overwhelming number of large enterprises reflects the fact that the majority of SOEs today are large size enterprises. This is reaffirmed when analyzing the larger dataset of enterprises by the General Statistics Office (2016).

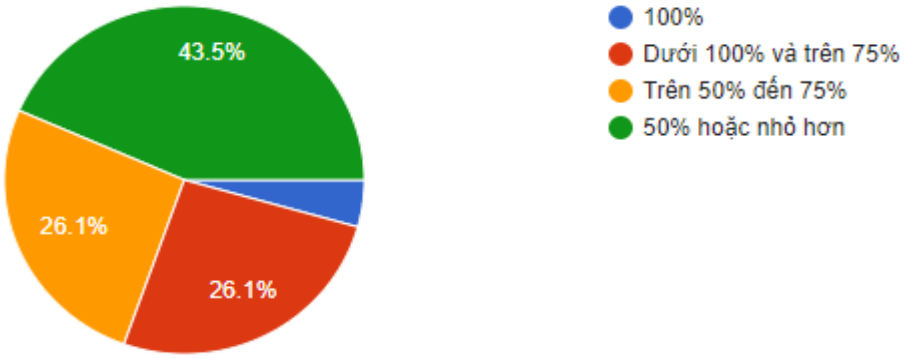
Figure 3.5: SOEs by size



c. State ownership

Our survey is conducted on enterprises with state capital. Survey results show that 43.5% of enterprises participating in the survey are equitized state enterprises with less than 50% of state capital in their charter capital. Only one enterprise has 100% state owned charter capital. The majority of enterprises have state capital from 50% to less than 100% of charter capital.

Figure 3.6: Share of enterprises by state ownership



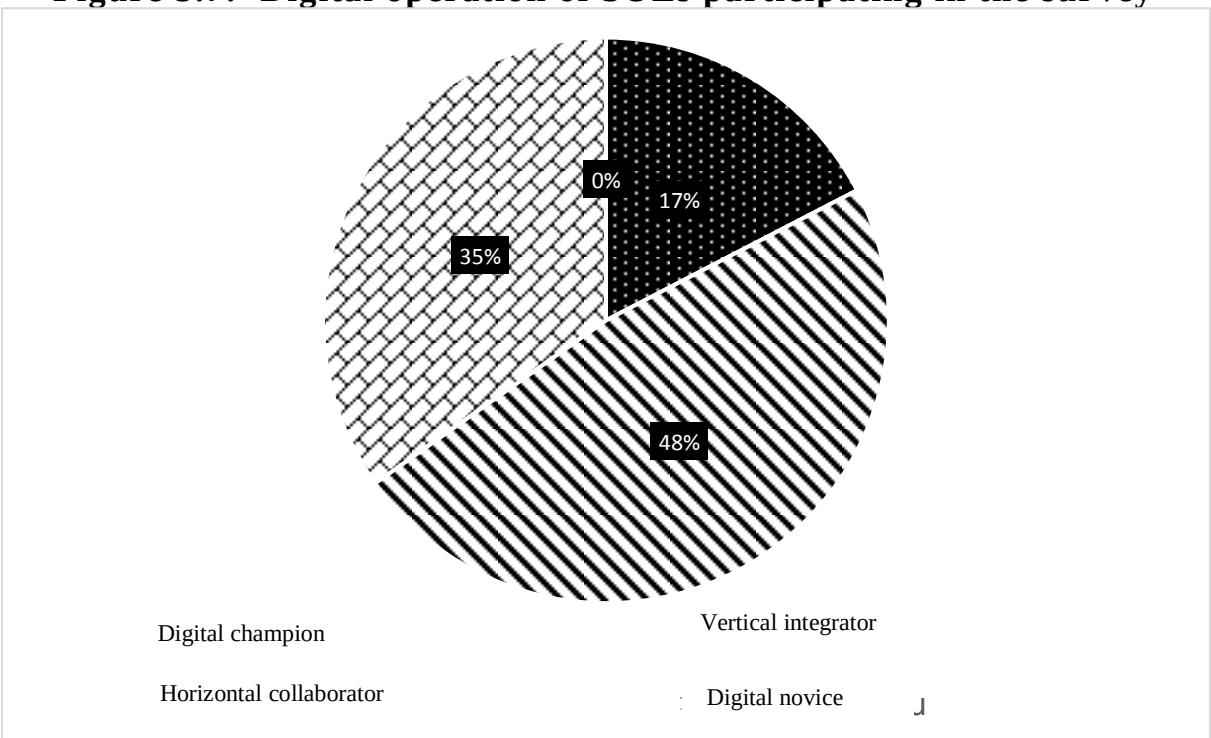
3.3.4 Results of survey

- Business size, industry and state ownership

The figure below shows the level of digitalization of SOEs participating in the survey. None of the survey businesses ranked at the top is digital champion. This means that no SOEs in the survey area have achieved a world-class level of digitizing operations.

Most businesses have just started the process of digitalization within their businesses. More than three-quarters of businesses (83%) are able to operate digitally at the start level, 35% of businesses start digitizing and 48% at the level of internal digitalization. . Only 17% have completed internal digitalization and rose to become a "value chain collaborator", by expanding digital connectivity with external partners.

Figure 3.7: Digital operation of SOEs participating in the survey



Although the status of digitalization of SOEs is at an average level, enterprises set high targets for the next 5 years. The survey results show that the average digitized operation of all businesses is only 2.75 / 5 at the time of the survey but the average digitized target of the target in the next 5 years is 4.45 / 5. This reflects the interest and great expectations of businesses on the path of digitalization to rise to become the market leader in the future.

Figure 3.8: The average score of the digitized operation level of the current SOEs and targets

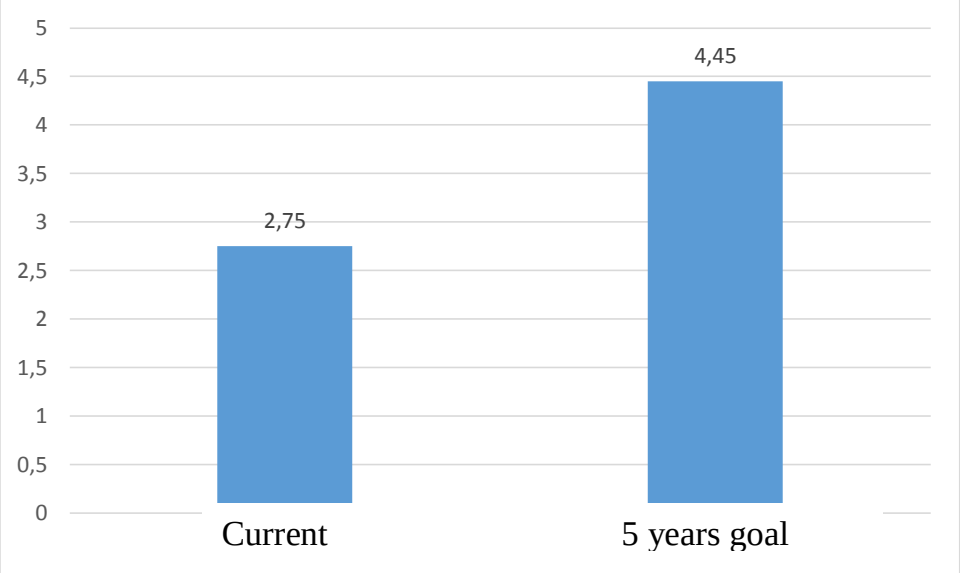


Table 3.3 below shows the average score of digitized operation and ranking of enterprises based on the size, industry and state ownership.

In term of size, large businesses have a high level of digitizing operations that are superior to small and medium-sized businesses. The average score of digitized operation of large enterprises is 3.07 while that of small and medium enterprises is only 2.46 and 1.84. In terms of goals, medium-sized enterprises had the highest average digitized target score, reaching 4.51, followed by large size and small-size enterprises. These results provide an additional proof that scale provides a great advantage for businesses to access and digitize in Industry 4.0. This result is similar to the finding of the Ministry of Industry and Trade (2018) in the survey of the readiness of Vietnamese enterprises in Industry 4.0.

Another interesting point is that medium-sized businesses have high expectations for the possibility of future digitalization, reflected by the highest average digitized target score in the region. This can reflect the expectation of medium-sized enterprises that take advantage of technology and digitalization to rise to become a market leader.

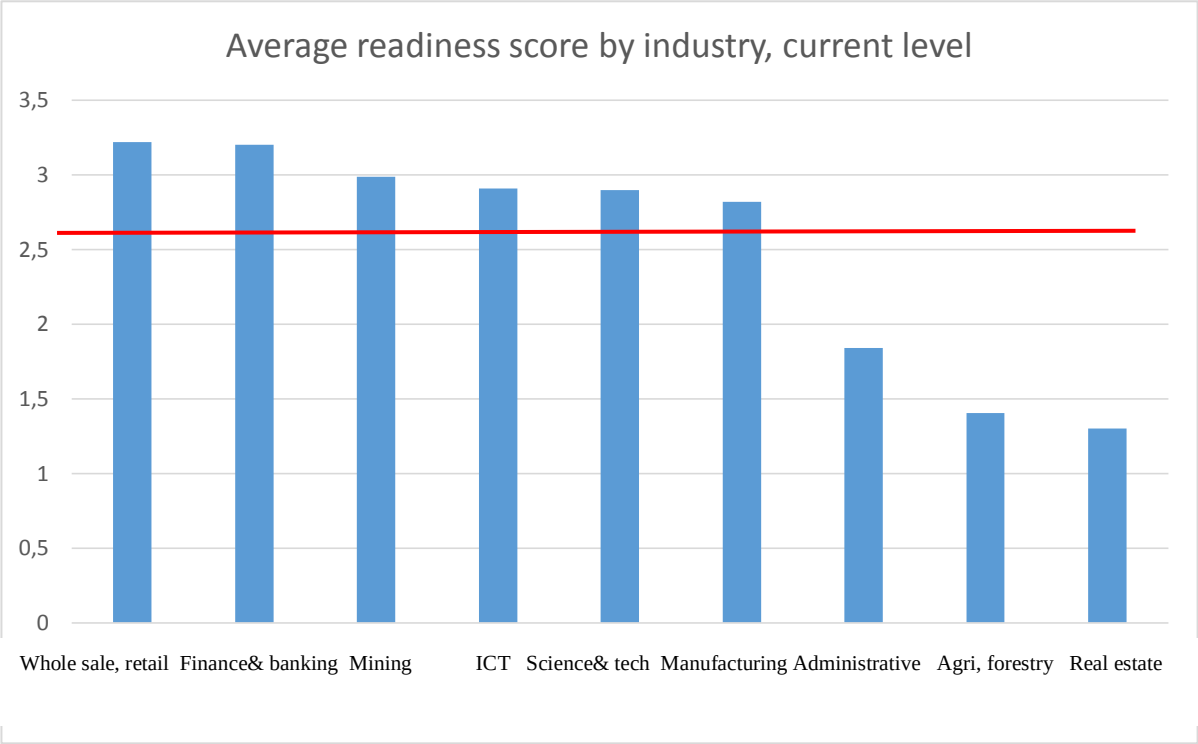
Regarding industries, the top 2 groups of industries with the highest average operating scores are wholesale, retail and finance, banking and insurance. Processing, manufacturing and information and communication industries also had relatively high scores. Meanwhile, the two groups with the lowest level of digital operation are real estate and agriculture, forestry and fishery. However, there is only 1 observation in these professions.

Regarding the goals in the next 5 years, the finance, banking and insurance sectors; S&T are the industries with the highest expectations. Enterprises in these industries have an average target of digitalization of 4.85; 4.84 and 4.7. This may indicate that businesses in these industries have a comparative advantage over other businesses in the development of digital ecosystems or are likely to benefit most from digitalization. Regarding the impact of state ownership, the research analyzes the impact of the proportion of state ownership in charter capital on the digitalization of SOEs. The results show a clear trend that the lower the state ownership rate, the higher the level of digitalization and the goal of digitalization in the next 5 years. The group of enterprises with state ownership of less than 50% achieved the average state of digitalization of up to 3.24, the target of average digitalization is 4.66, the highest among all groups. The group of enterprises with state capital from 50% -75% has the lowest average status of digitalization, reaching 2.26 points. This finding suggests that SOEs after equitization seem to have a stronger digitalization engine and are more aware of the benefits of digitalization. However, the results show that only fully equitized SOEs, when the state ownership rate is no longer dominant (<50%), this trend only takes place in a positive direction.

Table 3.3: The average readiness score and classifies businesses based on size, industry and level of state ownership

	Average readiness score of current level	Average readiness score of 5 years goal	Digital champiton	Horizontal Collaborator	Vertical Integrator	Digital novice	Total
By size							
Large	3.07	4.5	0	4	9	2	15
Medium	2.46	4.51	0	0	2	2	4
Small	1.84	4.2	0	0	0	4	4
Total							23
By sector							
Whole sale, retail	3.22	4.54		1		1	2
Real estate	1.3	3.13				1	1
Manufacturing	2.82	4.41		1	5	2	8
Administrative	1.84	4.63				1	1
Mining	2.99	4.36			1		1
Science, technology	2.90	4.84			1		1
Agri, forestry, fishery	1.41	3.07				1	1
Finance, banking, insurance	3.20	4.85		1	1		2
ICT	2.91	4.70		1	3	2	6
By state ownership							
100%	2.85	4.21	0	0	1	0	1
75% to 100%	2.42	4.13	0	0	3	3	6
50% to 75%	2.26	4.46	0	1	1	4	6
Below 50%	3.24	4.66	0	3	6	1	10

Figure 3.9 average of readiness score by industry



- Analysis of 6 digital pillars

The following section presents the findings detected through the digital operation survey, summarized from 6 component pillars. The results of the average of the current digitized status and digitized target points of the 6 pillars are shown in the radar chart below. The chart shows that, in general, businesses are at an early stage of digitizing, or just starting, with an average of digitized operations on all pillars below 3/5 points. The wide gap between the status quo and the digitalization goal shows that businesses have great ambitions to rise up in Industry 4.0 by improving their digitalization goals. On average, businesses participating in the survey expect to improve their digitalization level by 1.5 times over the next 5 years.

Among the 6 pillars, the first pillar: business models, digital products and services had the lowest average score, reaching 2.55 points and pillar 6: Organization and corporate culture scored the highest: 3.0 points.

Figure: 3.10 average point of the current situation and the 5-year target of surveyed enterprises

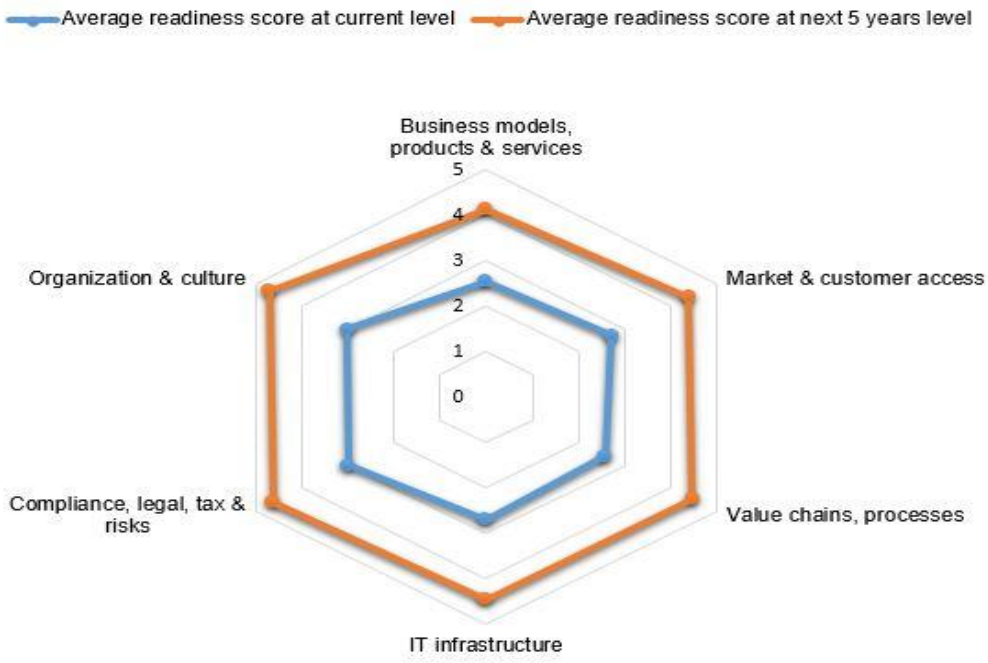


Table 3.4 below details the average score of the pillars by sector, firm size and state ownership.

Table 3.4: Average score of digital operation level of Vietnamese SOEs according to 6 main pillars

	Business models, product and service portfolio	Market & customer access	Value chain & process	IT infrastructure	Compliance, legal, tax & risk	Organization & culture
By size						
Large	2.84	2.91	2.98	3.06	3.34	3.30
Medium	2.21	2.63	1.85	2.46	2.63	3.00
Small	1.79	2.04	1.75	1.54	2.03	1.88
By sector						
Whole sale, retail	2.33	3.25	3.50	3.25	3.50	3.50
Real estate	1.00	1.00	1.00	1.00	2.80	1.00
Manufacturing	2.58	2.67	2.74	2.83	3.04	3.06
Administrative	2.00	2.33	1.80	1.67	1.50	1.75
Mining	1.83	3.00	1.60	2.67	3.83	5.00
Science, technology	3.00	2.67	2.80	3.50	2.67	2.75
Agri, forestry, fishery	1.67	1.83	1.60	1.00	1.33	1.00
Finance, banking, insurance	3.17	3.00	3.13	2.67	3.75	3.50
ICT	2.92	2.94	2.53	2.92	2.97	3.17
By state ownership						
From 75% to 100%	2.31	2.33	2.26	2.45	2.83	2.71
50% to 75%	2.36	2.50	2.14	2.06	2.17	2.33
Below 50%	2.83	3.10	3.05	3.23	3.60	3.60
Total	**2.55**	**2.71**	**2.57**	**2.69**	**2.99**	**3.00**

Regarding the first pillar, the business model, products and services have 6 questions about the business portfolio of digital products and services of the business; the ability to digitize, personalize services, products and processes, and the ability of businesses to collaborate with partners / customers to develop products. The average score of all businesses participating in the survey is 2.55 / 5 - the lowest score in all the pillars. Over the next 5 years, businesses expect to improve the digitalization of this pillar by 1.61 times the current level to reach 4.13 / 5.

Further analysis of the questions in this pillar we found, although up to 78.2% of customers said that the use and analysis of data from customers, products or machines is important in business model of the company but only 43% of businesses surveyed are able to digitize, add applications and digital features to products and services. The ability to personalize products and services of customers also proved to be a major limitation. The survey results show that up to 52% of businesses only produce and trade in homogeneous products that customers cannot personalize. Thus, although businesses are aware of the importance of digital services and products for their business activities, the ability to digitize and personalize products and services is a common weakness.

When disaggregating this pillar by size, industry, ownership rate, the results also show a quite uniform trend. Large size enterprises score significantly higher than small and medium-sized enterprises. Enterprises in the fields of science and technology; Insurance, finance and information and communication got the highest scores, while real estate businesses; Agriculture, forestry and fisheries have the lowest score on services and products. This is also consistent with the reality, specific to these industries. Industries that rely on natural resources and physical capital will have less potential to digitize products and services than industries that rely on technology and services.

Regarding ownership, this pillar also shows that enterprises with less than 50% of state capital have a higher level of digitalization of services and products than enterprises with more than 50% of state capital. State-owned enterprises with a state capital ratio of 50% or more in their charter capital are also better able to digitize and service products than SOEs with state capital accounting for 75% - 100% of their charter capital. Further analysis of the questionnaire we found that, the ability to digitize, personalize products, collaborate with customers, partners to develop, products and services of businesses has less than 50% State capital is better than the group of enterprises where state ownership holds dominant shares. This can be explained by the higher competition pressure on the first group, urging this group of enterprises to innovate their products and cooperate more with the parties than state-controlled enterprises.

Pillar 2: Market and customer access

This pillar consists of 6 component questions to identify the ability to use digital technology in sales, interact with customers, set pricing flexibly, analyze customer data, and collaborate to enhance customer access. line. The current average score of all surveyed enterprises in this pillar is 2.71 / 5. Businesses aim to improve the digitalization of this pillar by 1.62 times the current level to reach 4.39 / 5 by 2024.

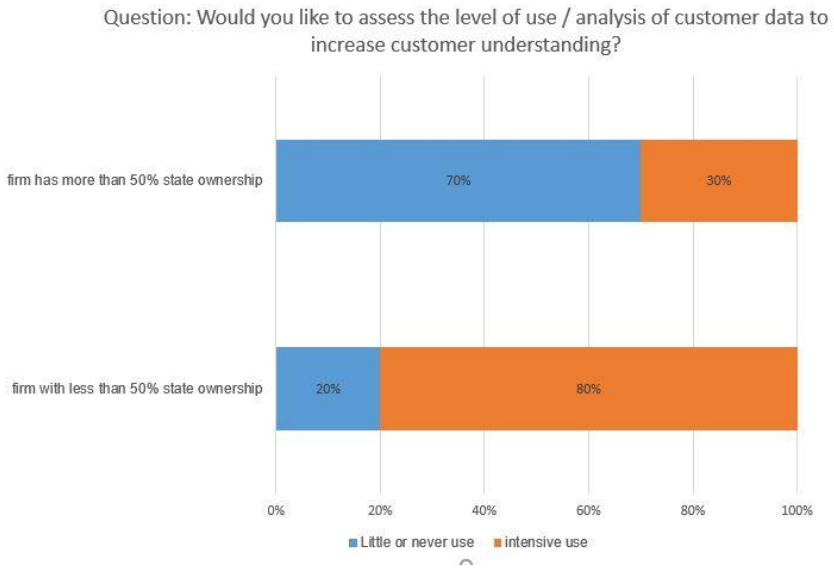
In-depth analysis of the questions in this pillar, the team obtained some interesting findings. The ability to flexibly set prices based on each customer group is the least

likely of the businesses surveyed, reflected in the lowest score of 2.43. The reason for this phenomenon may be due to regulatory barriers, market competition and digitalization weaknesses. Regarding regulatory barriers, enterprises in the field of pharmaceuticals and health care have all stated that their products cannot be flexibly priced according to different customers. This is an example of how industry regulation can impact, reduce personalization motivation, set pricing flexibility for client groups of businesses. In addition, in order to set flexible prices, businesses must also have a product database, customer consumption, which is the weakest point of businesses as shown in the first pillar.

However, flexible pricing is not the highest priority goal of businesses. The two goals that most businesses want to improve are the ability to use, analyze customer data and communicate with customers. Up to 74% of businesses want to maximize the ability of data analysis to understand customers in the next 5 years and 70% of businesses want to improve communication efficiency to increase customer interaction.

Regarding the types of SOEs, the general trend still shows that enterprises with state capital below 50% of chartered capital have significantly higher scores than those with higher state capital. This again reveals the potential impact of market competition on the digitalization capacity of SOEs. Among the enterprises with more than 50% state capital, 70% of businesses currently do not or very little use customer data to enhance customer understanding. Meanwhile, the figure of enterprises with state capital below 50% is only 20%. enterprises with more than 50% state capital, 70% of businesses currently do not or very little use customer data to enhance customer understanding. Meanwhile, the figure of enterprises with state capital below 50% is only 20%.

Figure 3.11: Comparison of customer analysis between two types of SOEs



In terms of size, large enterprises still proved superior with an average score of 2.91, while small and medium enterprises only had a low average score, respectively: 2.63 and 2.04. . By sector, the wholesale, retail (3.24), finance, banking and insurance (3.0) sectors have the highest average scores. Real estate, agriculture, forestry and fishery are the ones with the lowest scores.

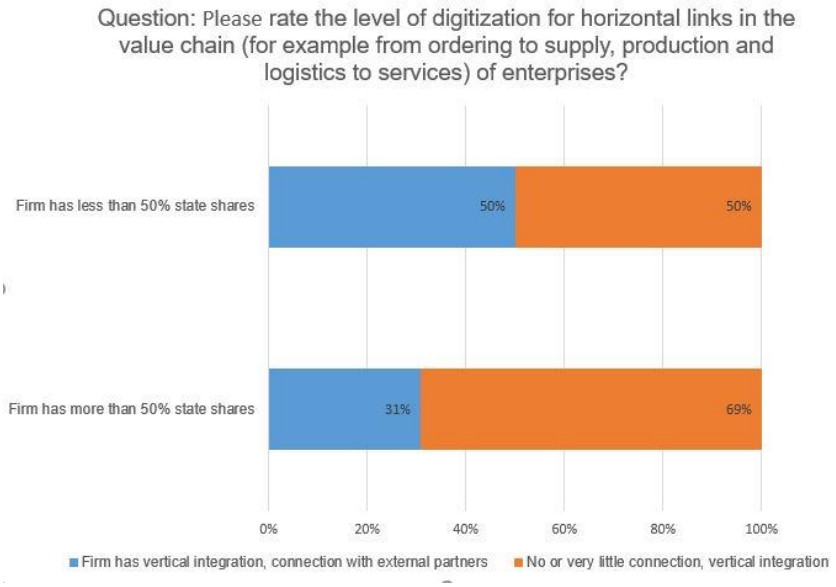
Pillar 3: Value chain and processes

This pillar consists of 5 questions about the degree of digitalization in the vertical value chain of businesses, from product development to production; ability to monitor production in real time, flexibly change production plans; level of application of end-to-end solutions for production planning; the degree of digitalization of equipment, factories and the level of digitalization of processes across the horizontal value chain (from order to supply, production and logistics to service). The average of all businesses in this pillar is 2.57 / 5 and businesses aim to improve the digitalization of value chains and processes to reach 4.47 / 5 by 2024. .

Survey results show that businesses have a good level of digitalization in internal production operations (vertical value chains) but are weaker in terms of data connectivity with external partners (value chains. horizontal). Among 23 surveyed enterprises, there are 7 enterprises, equivalent to 30.4%, capable of monitoring production in real time and adjusting production flexibly according to market fluctuations. However, only 17.4% of enterprises have the ability to integrate and exchange information with suppliers' partners, logistics units and customers.

When comparing the two groups of SOEs, the group with more than 50% state shares and the group with less than 50% of state shares in the charter capital, the survey results show that the general trend is that the enterprises have less state shares. 50% have a higher average score, which represents a better level of internal digitalization and a horizontal value chain for this group. The ability to connect and integrate data with external partners, suppliers, and customers of enterprises where the state does not hold dominant shares is also better than those with state-controlled capital. Up to 50% of enterprises with no state capital dominant ability to create digital links with partners, customers, suppliers, including 1 enterprise capable of creating comprehensive links (5 / 5 points). The corresponding figure in the group of enterprises with more than 50% of state shares is only 31%.

Figure 3.12: Comparing the digitalization level for horizontal links between two types of SOEs



Decomposing by size, we see a clear trend that large size enterprises are able to digitize value chains and processes compared to small and medium-sized enterprises. In particular, this is the pillar that medium businesses have the lowest scores (1.85 / 5), only slightly higher than the average of small businesses (1.75 / 5). This result provides further evidence that the biggest difficulty of medium-sized enterprises is the ability to digitize internal production processes and connect data with partners in the chain.

Regarding trades, wholesale and retail industries; finance and banking led the average score while the mining sector; real estate and agro-forestry and fisheries have the lowest average scores.

Pillar 4: Information technology (IT) infrastructure

The fourth pillar, information technology infrastructure includes 6 questions about the advanced level of the information technology system of the enterprise; MES production operating system; IT department's ability to collect, analyze production data, customers and the importance of new technologies in business and information technology connectivity. Currently businesses surveyed have an average score of 2.69 / 5 in this pillar but aim to improve to reach 4.45 / 5 in the next 5 years.

Feedback from businesses shows that the level of application of production operating systems (MES) to control production processes is quite low. Most businesses only plan production manually without the support of a centralized IT system. Even for the group of enterprises in the processing industry, only 37.5% of enterprises have high application of a production management system.

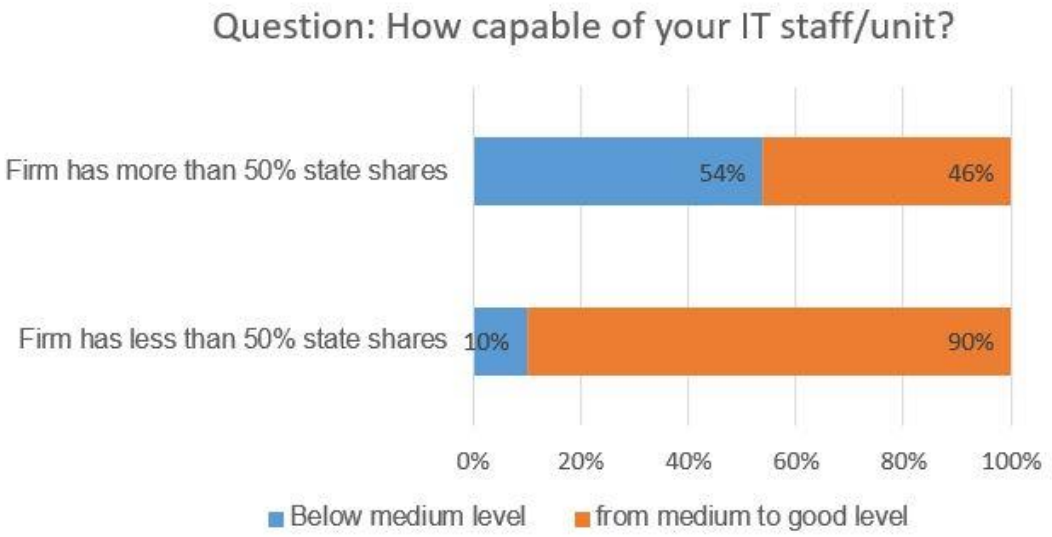
Businesses seem to appreciate the potential of new technologies. 65% of businesses surveyed said that new technologies, such as social networking, mobile, analytics technologies, cloud computing are very important to business. of the business.

Comparison between enterprises with dominant state capital and enterprises with un dominant state capital (<50% of charter capital), the results show that state-owned enterprises do not dominate in charter capital. The proportion continued to lead, with the average score of this pillar of up to 3.23 / 5 far ahead of enterprises with state capital above 50%. In addition, in-depth analysis of component questions suggests that the cause of underdeveloped IT infrastructure in SOEs is probably the competence of the IT department.

Responding to the question: "Could you tell us the ability of the IT department of the business to meet business requirements, ensure progress, quality and cost?", Up to 54% of SOEs State-owned stakes maintain that their IT departments are often below expectations - The performance and quality of their work are not as expected (for example, delayed deployment , inflexible IT processes, etc.), meanwhile, this figure is only 10% in enterprises with state capital in charter capital below 50%. This

difference may stem from the fact that the dominant SOEs do not attract high quality human resources as equitized ones due to uncompetitive wage mechanism. In addition, this group of businesses also invest less in IT infrastructure and are affected by bureaucratic working practices, using paperwork like a state agency.

Figure 3.13: Comparing IT staff/unit performance between two types of SOEs



Regarding industries, enterprises in science, technology, wholesale and retail are leading in the pillar of IT infrastructure. In terms of size, large enterprises still have better results than small and medium enterprises as the general trend. In particular, this is the pillar that small businesses have the lowest average score. This may reveal the reality of small businesses having the most difficulty in building their IT infrastructure.

Pillar 5: Compliance with regulations, laws, risks, security and taxes

This pillar consists of 6 questions on how businesses establish and comply with internal rules, formal laws on digitalization, protection of intellectual property rights, cybersecurity and taxation. Survey results show that the respondents answered an average of 2.99 / 5 and have the goal of improving the digitalization capacity to reach 4.63 points by 2024.

A closer look at the component questions in the survey shows that most businesses do not have their own digital governance rules and regulations. When asked, how complicated the company's own digital regulations are, 47.8% of businesses say that the company does not have or has little regulation on digitalization and there is no governance process. internally for other relevant sections but not digitizing.

The aspect of tax administration for digitized components also emerged as an underdeveloped area of management with 43% of businesses scoring below average, i.e. businesses without or using an approach to digital goods like other physical assets.

This may stem from the fact that digital goods and services do not have a high proportion in the business portfolio of businesses. However, for businesses with a high list of products and services, effective tax administration will help businesses optimize their tax obligations.

Table 3.5: Percentage of enterprises with scores below average in pillar 5

Share of enterprises below average point	
Tax management relating to digital portfolio	43%
Risk management relating to digitalization of products	35%
Compliance with Intellectual Property regulations	22%
Internet, network security	35%
Risk management relating to digital connection with partners, customers	17%

One notable advantage of businesses participating in the survey is that they have paid close attention to compliance with the Intellectual Property Law. Up to 5/23 enterprises with a maximum score of 5/5 confirmed that businesses have established and implemented processes to ensure that intellectual property rights are protected in accordance with the law. Regarding the goals in the next 5 years, the businesses surveyed most importantly are the protection of intellectual property rights and network security. The survey also found that 87% of businesses surveyed want to maximize IP compliance and 82% of businesses want to improve network security protection within the next 5 years.

In terms of ownership ratio, enterprises with a state capital ratio of less than 50% of their charter capital still have better scores than those with more than 50% of state capital as the general trend in other pillars. The average score of enterprises with less than 50% state capital is 3.6, which is the highest average in the pillars of this business sector. Responding to the question "How complicated are your digital regulations? with 5 levels from Level 1: Less complicated- No digitalization rules and no internal governance processes for other relevant parts but no digitalization to Level 5: High complexity- Digital compliance policies and regulations are set for the entire enterprise, 70% of enterprises with state capital in the charter capital below 50% have an average score or higher while only 38% of enterprises Enterprises with state capital in the charter capital of more than 50% achieved similar scores.

By industry, mining and finance, the bank scored the highest in this pillar. Large mills also score higher than small and medium-sized businesses.

Pillar 6: Organization and Corporate Culture

The last pillar consists of 4 questions to assess the level of creating value from data, enterprise resources for Industry 4.0, the awareness and competence of the leadership team as well as the ability to collaborate with organizations. external organizations to

promote Industry 4.0. This is the pillar with the highest average score of all businesses, reaching 3/5 points. In the next 5 years, businesses aim to improve their capacity to raise this pillar score to 4.69 / 5.

Businesses do not have a systematic approach to turning data into value. 30.4% of businesses in the survey said they were only able to create very little value from the data collected. Although businesses can collect a lot of data, there is no systematic approach to take advantage of data to innovate and improve the business model. In addition, resources to promote research and development of new science and technology of Industry 4.0 in enterprises are still very limited. 35% of enterprises responded to the survey by admitting that they lack or do not know the capabilities, resources as well as who is responsible for Industry 4.0 in the enterprise. Of all the businesses surveyed, only one said that they had invested methodically and strategically for Industry 4.0, as evidenced by the fact that businesses had specialized units, departments and divisions. subject subjects, with clear and comprehensive responsibilities to promote and deploy Industry 4.0

However, the results also show a positive trend when leaders and business managers are competent and professional in accordance with the desire to promote Industry 4.0 in enterprises. Only 26% of business leaders surveyed said that they had little support, interest, disregard for Industry 4.0 and almost no digital expertise. 74% of leaders and business managers are above average qualified and interested. 22% of businesses also think that leaders, managers and their staff are fully aware of the importance, content and implications of Industry 4.0.

When comparing the two state-owned enterprises sectors, we see this is the pillar that enterprises with the state capital ratio below 50% of charter capital is the most outstanding than the enterprise sector with state capital on 50% of charter capital. The average score of state-owned enterprises below 50% of charter capital in this pillar is 3.6 / 5, the highest among the pillars.

In addition, in-depth analysis of questions reveals that state-owned enterprises dominate the ability to create value from data, less resources and the ability to promote industry 4.0, leadership. less attention and no appropriate expertise and less cooperation with outside institutes and universities to research and develop new technologies compared to enterprises where the state does not hold the dominant proportion of charter capital (see table below).

Table 3.6: Percentage of enterprises below average score (below 3/5)

	Enterprise has more than 50% state shares	Enterprise has less than 50% state shares
Creating value from data	54%	10%
Resources spent for Industry 4.0	62%	10%
Support and expertises of leader	54%	0%
External cooperation	54%	20%

The lack of vision, skills and awareness of Industry 4.0 is becoming a major challenge for the state-owned enterprises. 100% of leaders, managers and officials in enterprises with less than 50% of state capital in the charter capital all have awareness, expertise from average to very good when it comes to Industry 4.0. Meanwhile, this ratio is only 46% in enterprises where the state holds dominant capital. This figure implies that SOEs leadership and management are inferior to their private sector peers, in defining the vision and roadmap to pursue Industry 4.0. When business leaders lack vision, awareness, businesses without changing culture and lack of training, the transformation ability of SOEs in Industry 4.0 will be difficult to succeed.

In term of size, large size businesses still have superior rankings. This is the pillar with the highest average score of medium-sized businesses. Regarding industry, the general trend still recurred when the banking and finance enterprises; extractive; Information Communication; Science and technology are the fields with high scores.

Comment:

The SOE digitalization survey results provide nine main findings:

- Most businesses have just started the journey of digitalization within their businesses. Only a few state-owned enterprises have completed internal digitalization and reached out to integrate digitalization with external value chains.

- The size of the enterprise, its ownership rate and the industry that affect the level of SOE digitalization Enterprises with less than 50% of state shares, large size enterprises or those in the banking, finance, science and technology, manufacturing and processing sectors tend to have higher digitized operating points than average. jar.

- SOEs show high expectations about improving their digital situation in the next 5 years. Especially medium-sized enterprises, enterprises with less than 50% of state capital in charter capital and enterprises in the banking, finance and telecommunications sectors. Enhancing customer interaction and analyzing customer data is a top priority for businesses.

- Regarding the ability to operate digitizing, businesses are aware of the importance of digital services and products for business but the ability to digitize and personalize products and services is a common weakness. .

- Enterprises do not currently have a systematic approach to turning data into value. Although businesses can collect a lot of data, there is no systematic approach to take advantage of data to innovate and improve the business model.

- Restrictions on the ability to analyze customers makes businesses do not set flexible prices to capture more surplus value. Market barriers, price regulation also limit the ability of enterprises to set flexible pricing.

- The quality of information technology personnel determines the enterprise's ability to digitize operations. SOEs with a high proportion of state ownership appear to be

severely lacking in the IT and IT departments of these SOEs rarely achieve the expected goals.

- In addition, resources to promote research and development of new science and technology of Industry 4.0 in enterprises are still very limited. The lack of vision, skills and awareness of Industry 4.0 is becoming a major challenge for the state-owned enterprises.

- Cooperating with external partners, customers, institutes and schools to research and develop new technologies and new products is an essential requirement to promote the digitalization of value chains of SOEs. However, the level of SOE cooperation with the outside is quite limited, partly due to the absence of cooperation regulations, the ability to protect intellectual property rights as well as risk management for the relationship. online.

3.4 The use of internet, computer in SOEs

The above survey results reveals findings on perceptions and capacities of SOEs in the digitalization of their business operation. Our analysis also provides more insights into the differences, strengths and weaknesses of SOEs in the digitalization in IR4.0.
However, similar to the sample survey conducted by MOIT, our survey on the digital operation of SOEs conducted on only a small sample of SOEs. In addition, the survey subjects did not include enterprises without state capital such as private enterprises, FDI enterprises, so it is not possible to make comparisons. Therefore, survey's results are not solid enough to generalize for the entire business sector.
To overcome this problem, the research team conducted a second analysis of SOE's internet and computer applications based on the 2016 GSO's enterprise census data. The survey provides abundant information about the business system in all industries and provinces, including tax codes, production and business efficiency, costs, etc. extracted from the balance sheet and financial statements. Although the survey data set also has limitations, such as very little information on corporate governance, missing data, etc., this is actually the largest accessible Vietnamese enterprise-level dataset (in terms of sample size).
Taking advantage of the questions available in the enterprise survey on the situation of computer and internet usage, the research team conducted quantitative analysis to explore the impact of computer and internet usage on the business results of enterprises as well as compare the digital capacity between SOEs and enterprises of other economic sectors.

3.4.1 Descriptive statistic

First, in terms of definition, in this analysis we identify SOEs including enterprises with more than 50% of state shares. It should be noted that this definition extends beyond the legal definition of SOEs in Enterprise Law 2014. In the enterprise survey conducted by the General Statistics Office, SOEs, according to our definition, correspond to four types of enterprises: i) Sole-member limited liability company with 100% of the central government, ii) Sole member limited liability company 100 % of local government, iii) Joint stock companies, limited liability companies with more than 50% State capital, iv) State companies. There are also co-operatives in the

survey, but this group is not considered a type of enterprise, according to the Cooperative law. Therefore, we remove all cooperative observations from the dataset.
In addition, for the sake of comparison, we also included the private enterprise and foreign-invested (FDI) sectors for in-depth analysis. Private enterprises include enterprises of categories 6 to 10 in the enterprise survey, specifically including: i) private enterprises, ii) Partnerships, iii) Public companies limited liability companies, limited liability companies with less than 50% state capital, iv) joint stock companies without state capital, v) joint stock companies with state capital less than 50% of charter capital. FDI enterprises include the following types of enterprises: i) 100% foreign capital, ii) state-owned enterprises in joint venture with foreign countries, iii) other enterprises in joint venture with foreign enterprises.
In terms of structure, the table below shows a total of 457240 enterprises in the 2016 survey sample, after excluding cooperatives. Private enterprises accounted for 96.59%, followed by the FDI sector with 2.9% and the lowest proportion was SOEs with 0.52%.

Table 3.7: Enterprises by ownership in 2016

Source: GSO (2017)

	Number of enterprise	Share %
SOEs	2358	0.52
Domestic private	441641	96.59
FDI	13241	2.9
Total	457240	100

In term of size, micro enterprises, which have no more than 10 employees, accounted for the majority, with 71.9% of all businesses. Next, SMEs with employees from 11 to 300, accounted for 23.54% and large enterprises with employees greater than 300 people or turnover of over VND 100 billion, accounted for the smallest proportion, respectively, 4.56%.

Table 3.8: Enterprise by size

Source: GSO (2017)

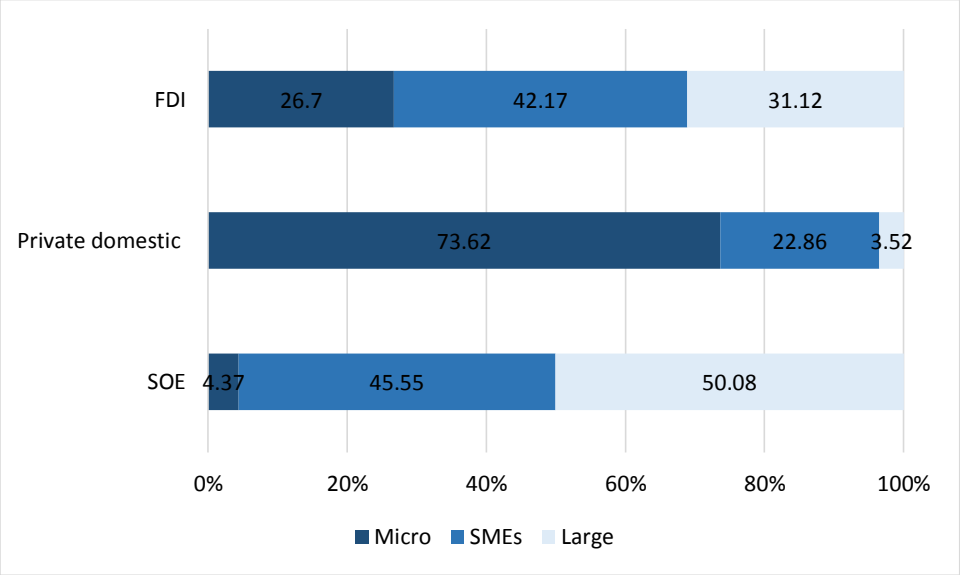
Size	Number	Share
Micro	328777	71.9
SMEs	107633	23.54
Large	20831	4.56
Total	457241	100

The below figure outlines more clearly the size of enterprises by economic sector. Our main interest- SOEs- are mostly large enterprises (50.8%) and SMEs (45.5%). Only 4.36% SOEs are micro enterprises. In contrast to SOE sector, the private enterprise

sector is mainly comprised of micro enterprises (73.62%), small and medium enterprises accounting for 22.86%, and only 3.52% are large enterprises. FDI enterprises had the most uniform structure when micro enterprises accounted for 26.7%, small and medium enterprises accounted for 42.17% and large enterprises accounted for 31.12%. The scale structure above partly shows that the private sector of Vietnam is only growing in number but not competing in scale with other economic sectors.

Figure 3.13: Enterprise by size and ownership

Source: GSO (2017)



Regarding industry, based on the industry VSIC 2017 code in the dataset, we classify enterprises by 20 primary industries. The number and structure of enterprises by industry and ownership are shown in the table below.

Table 3.9: Enterprise by industry and ownership

Source: GSO (2017)

	SOEs		**Private**		**FDI**	
Sectors	***Number***	***Share %***	***Number***	***Share%***	***Number***	***Share %***
Agri, forestry, fishery	324	14	3,562	1	119	0.9
Mining	82	3.48	2,361	0.53	45	0.34
Manufacturing	445	**18.87**	61,337	**13.89**	7,169	**54.15**
Electricity, gas	63	2.67	1,158	0	15	0.11
Water supply, garbage treatment and recycle	176	7.46	1,348	0.31	20	0.15
Construction	249	**10.56**	57,579	**13.04**	657	4.96
Whole sale, retail	312	**13**	180,455	**41**	1,504	**11.36**
Transportation	191	8.1	27,583	6.25	376	2.84
Food, drinks, housing	94	3.99	16,518	3.74	310	2.34

ICT	58	2.46	8,934	2.02	776	5.86
Finance, banking & insurance	47	1.99	1,862	0.42	117	0.88
Real estate	91	3.86	9,852	2.23	417	3.15
Science & Technology	**87**	**3.69**	**39,471**	**8.94**	**1,232**	**9.31**
Administrative services,	50	2.12	16,540	3.75	214	1.62
Education & training	8	0	5,841	1	132	1
Health care & Social Security	3	0.13	1,522	0.34	48	0.36
Entertainment	72	3.05	2,413	0.55	40	0.3
Other services	6	0.25	3,282	0.74	49	0.37
Total	2,358	100	441,635	100	13,240	100

The table above shows that the three industries with the most SOEs are: processing and manufacturing industries; wholesale, retail and construction. Only 3.69% of SOEs whose main business is professional activities, science and technology. Meanwhile, there are 8.94% private enterprises and 9.31% FDI enterprises operating in this field. ***These statistics show that, at least in quantity, SOEs did not work in professional research, science and technology as much as non-SOE sector.***

The proportion of SOEs in some high-tech industries of Industry 4.0 such as processing, manufacturing, information technology and telecommunication were not large. Only 18.87% of SOEs operated in processing and manufacturing while this figure was 54.15% in FDI enterprises. Only 2.46% of SOEs involved in information and communication industry while FDI was 5.86%.

Meanwhile, in the financial, banking and real estate sectors, SOEs accounted for higher shares. Specifically, there was 3.86% of SOEs operating in real estate business while only 2.23% of private enterprises and 3.15% of FDI enterprises in this sector. In the finance, banking and insurance industries, the same trend was observed, with 1.99% of SOEs operated in this sector while only 0.42% of private enterprises and 0.88% of FDI enterprises did. This data suggests that ***in terms of industrial structure, a larger share of SOEs did business in high-profit and risky areas than non-SOE sector did.***

Moreover, many SOEs operated in the real estate industry, which is a very low digitized sector as our survey found in the previous section.

3.4.2 The application of computer, internet in SOEs

Due to limitations of the survey data set, we cannot measure the level of digitalization of businesses in detail. However, the General Statistics Office's enterprise survey data set has some questions about computer and internet applications that can indirectly represent for digitalization level of business. In this section, we will analyze the digitalization level of Vietnamese SOEs, expressed by the level of computer and internet application.

SOEs have a higher level of computer and internet access than private and FDI firms, however, the frequency of using computers and internet is lower. The table below shows that SOEs are slightly better than the private ones in their ability to own computers and internet and have higher chance of having website. Almost 100% of SOEs have computers, 98.69% have internet access and 61.28% have their own websites. Private enterprises and FDI enterprises also have very high rates of owning computers and internet, from 93.2% or more, but they rarely have their own websites

like SOEs. Only 28.04% of private enterprises and 42.18% of FDI enterprises have their own websites.

Table 3.10: Proportion of enterprises having computers, internet and websites by ownership (%)

Source: GSO (2017)

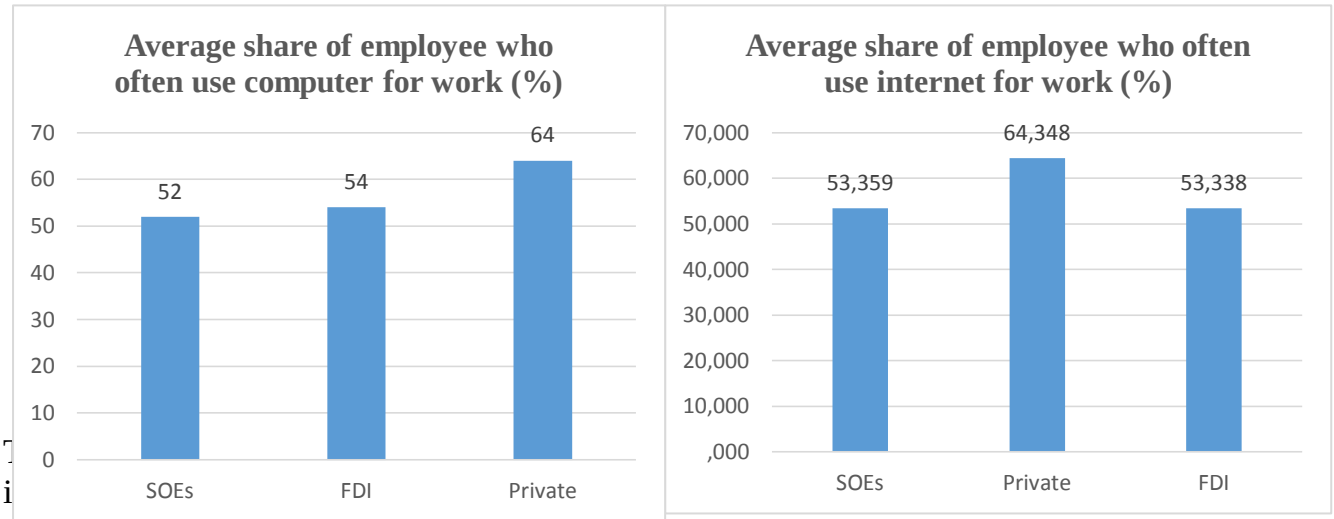
	Computer	Internet	website
SOEs	99.49	98.69	61.28
Private enterprise	94.44	93.19	28.04
FDI	98.53	96.52	42.18
Total	94.58	93.32	28.62

The higher ownership rates of computers, internet and websites show the advantages of SOEs IT infrastructure compared to other sectors. However, SOE computer and internet usage is lower than the other two. Specifically, only 52% of employees in the SOE sector often use computers at work, while this proportion is 54% for the FDI sector and 64% in the private sector. Regarding the percentage of employees who regularly use the internet at work, there are 53.36% in SOEs, this is 64.35% in private enterprises and 53.34% in FDI enterprises.

The difference in computer and internet usage of different business areas may due to differences in industrial structure. Enterprises operated in processing, manufacturing, wholesale and retail industries, might have a lower proportion of employees using computers and internet than one operated in services, administration, science, technology, etc. We then compare the internet and computer usage rates of different types of businesses in each industry to isolate industrial impacts.

Figure 3.14: Percentage of employees who regularly use computers and the internet in the work of economic sectors

Source: GSO (2017)



information and telecommunications; finance, banking, insurance; science and

technology; education and training have a much higher percentage of workers using computers and the internet than low-tech industries, such as agriculture, forestry and fisheries; food, drinks, housing or manufacturing.

Table 3.11: Percentage of employees who regularly use computers and the Internet by type of enterprise and industry

Source: GSO (2017)

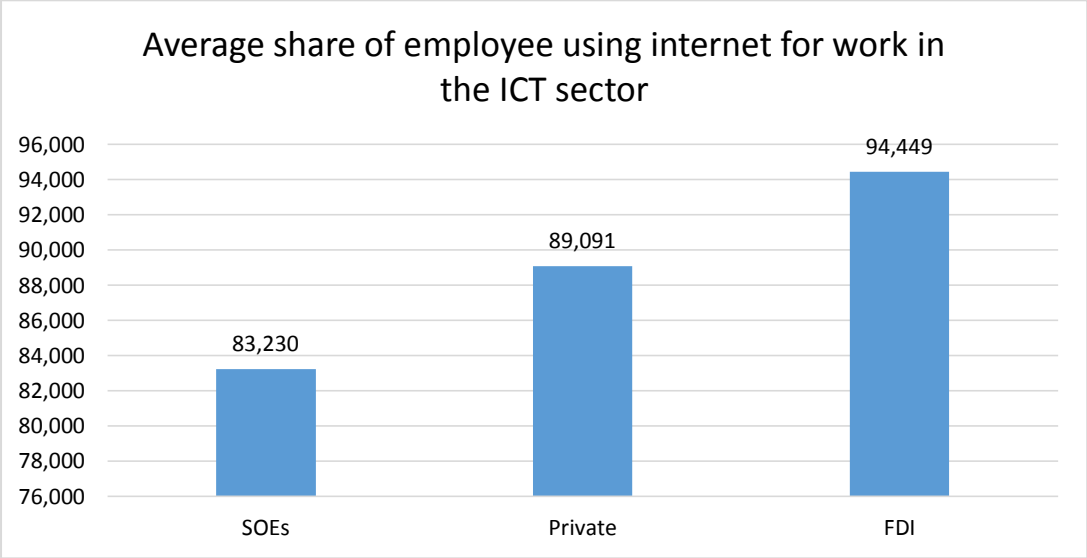
	SOE		Private		FDI	
	Share of labor using PC	Share of labor using internet	Share of labor using PC	Share of labor using internet	Share of labor using PC	Share of labor using internet
Agri, forestry, fishery	40	42	51	53	39	40
Mining	40	43	41	43	63	64
Manufacturing	36	37	45	46	29	29
Electricity, gas	62	63	47	50	55	57
Water supply, garbage treatment and recycle	35	35	47	49	56	54
Construction	49	50	55	56	72	72
Whole sale, retail	67	69	67	67	85	84
Transportation	60	62	58	60	81	79
Food, drinks, housing	44	47	52	53	53	55
ICT	82	83	90	89	96	94
Finance, banking & insurance	96	93	83	83	96	91
Real estate	73	73	79	78	78	76
Science & Technology	82	79	85	84	93	91
Administrative services,	59	59	71	72	80	80
Education & training	79	80	82	81	83	84
Health care & social security	54	54	72	72	79	78
Entertainment	72	73	63	65	56	60
Other	56	52	64	65	53	57
Home made services			59	66		

To clarify the difference between SOEs and non-SOEs in the average labor force using computers and internet, we conducted a t-test in each industries to find statistical differences.

Firstly, in the information and telecommunication industry, the average rate of SOEs using internet is only 83.23%, the lowest among 3 economic sectors. T-test shows that we can reject the assumption that the average rate of labor force using internet of SOEs is higher or equal to that of non-state sector with the statistical significance of 5%. In other words, the proportion of employee using internet for work in SOE, which operated in the telecommunication industry, was statistically lower than that of the FDI and private sector.

Figure 3.15: SOEs use internet less in information and telecommunication industry than other enterprises

Source: GSO (2017)



Note that this result does not disprove the achievements of the large SOEs in the telecommunications industry. Taking advantage of the inherent advantages from capital, infrastructure and market knowledge, large economic groups in the IT and telecommunications industry have made investments, research and development to enhance their digital capacity, in order to enjoy and success in Industry 4.0. One of the typical examples is Viettel Group, a state-owned economic group pursuing the goal of creating a digital society and becoming a pioneer in Industry 4.0. See the box below.

Box 3.1. Viettel declares to pursue the goal: to create digital society

Source: Compiled from viettelelecom

At the 30th anniversary of Viettel's establishment, June 1, 2019, Major General Le Dang Dung - Acting Chairman and CEO of Military Industry and Telecommunications Group affirmed that the vision of this SOE is to become a joint venture. leading in Industry 4.0 and creating a smart, digital society: 'Entering 2019, Viettel will convert numbers in two things: one is to convert numbers for the Group itself, the entire internal process of Viettel people must be digitized; The second is consulting and supporting organizations and units in Vietnam to convert successfully.

Viettel must take the lead and carry out the mission committed to the Government: Become a pioneer in the 4.0 Industrial Revolution. '

Up to now, Viettel has integrated 5G wave infrastructure, making Vietnam in the list of 4 earliest 5G testing countries in the world. Viettel's 5G mobile network connection speed reaches from 1.5 to 1.7 Gb, equivalent to the speed of commercial optical cables. Also according to this group, thanks to the advancement of Viettel, Vietnam can go with the world when mastering and applying new technologies in the field of telecommunications, creating conditions for the development of high-tech fields.

In addition, Viettel has signed a smart city cooperation agreement with 23 provinces / cities across the country. The model of smart operating center has been piloted in many localities, helping to connect population data, public administration, transportation, health, education ... combined with big data analysis to show the The problem arises locally. Traffic congestion is solved by analyzing human density data. Security and order are improved thanks to cameras and sensor systems.

That is why Viettel invests in a leading and wide 4G infrastructure in the world, ready for both 5G infrastructure. Viettel will spend 1,000 billion for the Venture Capital Fund to cooperate with technology companies, join hands with the Government to create a digital society.

Table 3.12 shows the results of t-test of the difference between the average rate of employees using internet and PCs of different types of enterprises by industries. The results show that the group of non-state enterprises (including private and FDI enterprises) had a higher average rate of labor using internet and computers for work than SOEs did in 9/17 industries, including: information and telecommunication; agriculture forestry seafood; processing and manufacturing; water supply and waste disposal; science and technology; food, drink and accommodation; real estate and administrative services. Therefore, it can be conclude that the efficiency of using computers and internet in SOEs is lower than that of non-state enterprises in 9 sectors.

SOEs only had a higher proportion of labor using internet, pc for work in three sectors, including finance & banking& insurance, electricity and entertainment. Thus, SOEs have higher efficiency in using computers and internet than non-state enterprises in these 3 sectors. This result is consistent with the actual observations when in the electricity industry, EVN has made efforts to accelerate it's digitalization (see box below). The financial sector, insurance banks are also sectors that SOEs operate effectively under pressure of fierce competition and pressure from international organizations.

Box 3.2. Digital transformation process of EVN

Source: CMSC (2019)

Attending the seminar "Breakthrough solutions to accelerate the digital transformation process - ICT infrastructure development and platform technology" at ICT Summit 2019, EVN Deputy General Director Vo Quang Lam presented the transformation process. EVN number:

Currently, 100% of EVN's units have used the E-Office system to solve the problem. EVN has also implemented digital signing of the Group. Not only "spreading" technology, digital transformation is also done in depth by EVN thanks to efforts to change technology habits and change the way of executing work of employees. Currently, 95% of documents coming and going within the Group are circulated electronically.

Contribute to creating a digital economy

The digital transformation has not only been successfully implemented by EVN in the Group, but also created a positive spillover effect in society. In 2013, in the field of business - customer service, EVN was the first unit in the country to issue large size electronic invoices.

In 2018, EVN's electricity services were equivalent to public services at level 4 - the highest level. Customer transactions with EVN, from the first step of service request, to contracting and payment, are done online based on technology.

In recent years, the diversification of electricity payment channels has also been strongly implemented by EVN, including online electricity payment through automatic debt deduction, internet banking, mobile banking, electric wallets. ... At the customer care centers of Electricity, EVN has also diversified its ways of serving customers via website, email, webchat, fanpage, Customer care App on mobile devices, etc. Especially, EVN has Successful chatbot application - using artificial intelligence (AI) to advise customers.

Currently, EVN is focusing on implementing the Project of Research, Development and Technology Application of Industry 4.0 for production and business activities. EVN has determined and strived to become a digital enterprise based on the application of digital technologies, information technology and technology of Industry 4.0 to the operation fields, making EVN a strong corporation. sustainable and efficient development; become the leading regional corporation.

In addition, there were 5 sectors where SOEs and non-state enterprises were not statistically different, including retail, mining, transportation, healthcare and education.

The average percentage of workers using the internet and PC can be regarded as an indirect measure of digital operation. The testing results show that SOEs in most industries were not as digitalized as other economic sectors.

Table 3.12: Testing of statistical differences between the average percentage of labor using computers and Internet between SOEs and non-state enterprises in some industries

Source: GSO (2017)

Note:*** statistically significance at 1%, ** statistically significance at 5%, * statistically significance at 10%

Sectors	Average share of labor using internet for work %		Average share of labor using PC for work %	
	Non SOE	SOE	Non SOE	SOE
ICT	89.52**	83.22	90.47***	81.78
Agri, forestry, fishery	52.33***	42.36	50.51***	40.09
Manufacturing	44.45***	36.74	43.17***	36.09
Whole sale, retail	67.59	68.72	67	67.45
Finance, banking, insurance	83.61	93.31***	84.17	95.63***
Science & technology	84.43**	79.44	85.61*	82.3
Mining	43.77	42.71	41.58	40.17
Electricity, gas, stream air	50.2	63.26***	46.91	62.32***
Water supply, sewerage, waste management	48.69***	34.9	47.48***	34.54
Construction	55.74***	50.13	54.85***	49.21
Transportation	60.39	61.57	58.04	60.2
Accommodation and Food	53.49**	46.88	52.17***	44.04
Real estate	78.25*	73.16	79.22**	72.55
Administrative services	72.04***	59.44	71.45**	59.4
Education & training	81.4	80	81.61	79.23
Health care	71.83	53.67	72.1	53.67
Entertainment	64.43	72.71***	63.3	72.05***

3.4.3 The impact of digitalization on business performance of enterprises

SOEs used internet and PCs with lower efficiency than non-state enterprises in some industries. If we consider the use of the internet and PC as a measure of digitalization, it can be said that SOEs were less digitized than non-state enterprises in many industries.

But another question is what does the digitalization impact on businesses? Does an improvement of digital operation help businesses to enhance production and business efficiency?

In this section, we conducted an analysis based on econometric model to answer the above question. To assess the impact of digitalization on businesse performance, we adopted the approach of Pham and Nguyen (2014).

Data

The research team continued to exploit the 2016 GSO enterprise survey data set to carry out this analysis. We combined components of dataset based on business ID to form a full set of data, including information about the business, financial performance and information related to the use of internet and PC for work.

In addition, the data is cleansed by filtering out abnormal observations and outliers, for example: businesses with zero sales or labor, outliers of profits, debt ratios, fixed assets. The final dataset contains 450,326 observations, representing 450,326 businesses.

- *Modeling*

Applying the approach of Pham The Anh and Nguyen Duc Hung (2014), we built a model to evaluate the impact of digital operations on business performance of enterprises.

First, we assume that firm i uses two inputs: Capital (Ki) and Labor (Li) with a certain set of technologies or technological capacities (Ai) to produce goods and services. (Yi). The firm's output (Yi) can be described using the basic Cobb-Douglas production function below:

$$Y_i = A_i K_i^{\beta 1} L_i^{\beta 2} \text{ or } lnY_i = lnA_i + \beta_1 lnK_i + \beta_2 lnL_i + v_i \quad (1)$$

In which, β1 and β2 are the corresponding coefficients, showing the elasticity of Yi output with the capital and labor inputs. vi is the random error in the model, which is assumed to have a mean of zero and a fixed variance.

Ai is the technological capacity of the enterprise assumed to depend on a group of factors that reflect firm's characteristics, business owner's capability and the digital operation ability of the business. Factors affecting the factor productivity of an enterprise can be described using the following equation:

$$lnA_i = \beta_0 + \kappa C_{ji} + \varphi Z_{ji} + \sum j \alpha_{ji} SH_{ji} + e_i \quad (2)$$

In equation (2) SHji represents the impact of the j digitized operating element on the technological capacity of firm i; Cji is a vector of variables that control the influence of governance factors and characteristics of the business, for example, ownership type, size of business, business lines, capacity of the business owner, etc. ; vector Zi controls the influence of other factors such as economic regions and local policies;

Finally, ei is the measuring error and is considered as the effect of random productivity shocks with a mean of zero and a constant variance. Combining (2) and (1), we obtain the aggregated model represented as follows:

$$lnY_i = \beta_0 + + \beta_1 lnK_i + \beta_2 lnL_i + \kappa C_{ji} + \varphi Z_{ji} + \sum j \alpha_{ji} SH_{ji} + \varepsilon_i \quad (3)$$

Model (3) can be estimated using cross section or panel data. Although estimating the model (3) with panel data is better because it allows control of unobservable factors which change over time. However, due to limited data access, we conducted a model (3) using cross section data. Before and after tests are performed to ensure the selected model is well fit (passing test of multi-colinearity, autocorrelation and heteroskedasticity).

- *Variable selection*

- Dependent variable: in this study, the dependent variable is firm's business performance measured by total revenue of enterprise's production and business activities.

- Explanatory variables:

The two important inputs are labor and capital which are represented by total number of employees at the end of the year and the average fixed assets of the year. All of these variables use nominal values (in logarithm).

Regarding variables representing the digitalization capacity of enterprise SHj, we select the percentage of employees who regularly use computers (tyle_pc) and the percentage of employees who regularly use the internet at work (tyle_int). Because these two variables are strongly correlated, they are separately put in different models.

Regarding variables that represent the management capacity and firm's characteristics Cj, we select ownership type, business line, manager's gender, manager's qualifications and financial leverage. The first four of these variables are dummy. Business lines are classified by sub-category 1 in VSIC2007, in which agriculture, forestry and fishery are taken as the base to compare with other industries. The financial leverage ratio is calculated by total debt divided by total equity. Regarding other factors (Zi), dummy variables represent 6 economic regions. The Northern Delta region is a baseline for comparison with other regions.

Descriptive statistics

After cleaning, the final data sample had 450326 observations, corresponding to 450326 enterprises. The descriptive statistics of variables are shown in the below table.

Table 3.13: Descriptive statistics used variables

Source: GSO (2017)

Variable	Description	Number of observation	Mean	St dev	Min	Max
Dependent variable						
lnrev	Log of revenue	393370	7.74	2.30	-2.30	19.94
Independent variables						
lnL	Log of total employee	450234	1.84	1.30	0.00	11.26
lnK	Log of fixed asset	234348	7.11	2.01	-0.51	18.54
r_liability	Liability ratio	414896	0.43	1.08	-177.43	186.47
Ownership						
SOEs	SOE: 1	450325	0.01	0.07	0	1
Private	Private: 2	450325	0.97	0.18	0	1
FDI	FDI: 3	450325	0.03	0.17	0	1
tdcmgd	Education level of director: 0: Lower than bachelor, 1: higher than bachelor	450314	0.64	0.48	0	1
gioitinh	Director gender					
Nữ	Female: 0	450317	0.27	0.44	0	1
Nam	Male: 1	450317	0.73	0.44		
tyle_pc	Share of labor regularly using PC for work	436969	63.06	34.53	0	100
tyle_int	Share of labor regularly using internet for work	434852	63.74	34.81	0	100
indus	Sector					
agriculture		450326	0.01	0.09	0	1
mining		450326	0.01	0.07	0	1
manufactu~g		450326	0.15	0.36	0	1
Electrici..		450326	0.00	0.05	0	1
water sup..		450326	0.00	0.06	0	1
construct~n		450326	0.13	0.34	0	1
wholesale..		450326	0.40	0.49	0	1
transport~n		450326	0.06	0.24	0	1
Foods &ho..		450326	0.04	0.19	0	1
Telecommu~n		450326	0.02	0.14	0	1
Finance&b~g		450326	0.00	0.07	0	1
Real estate		450326	0.02	0.15	0	1
Research&~t		450326	0.09	0.28	0	1
Administr..		450326	0.04	0.19	0	1
Education		450326	0.01	0.11	0	1
Health &s..		450326	0.00	0.06	0	1
Entertain~t		450326	0.01	0.07	0	1
Other ser..		450326	0.01	0.08	0	1
household..		450326	0.00	0.01	0	1
region	Economic regions					
Red river..	Red river delta	450326	0.33	0.47	0	1
Northern ..	Northern & moutainous area	450326	0.04	0.20	0	1
North cen..	North & South central	450326	0.13	0.34	0	1
Central H..	Central highland	450326	0.03	0.16	0	1
South East	South East area	450326	0.39	0.49	0	1
Mekong Ri..	Mekong river delta	450326	0.08	0.27	0	1

- *Results of estimations and discussion*

Table 3.14 presents the estimated results of 6 regression models that show the impact of digitalization on Vietnamese enterprise's business performance based on 2016 GSO enterprise census data. Out of 6 presented models, the first 3 models evaluated the impact of internet usage at work and the next 3 models evaluate the impact of computer usage at work on net sales. Model 2 and model 5 tested the effects of digitalization on SOEs by adding interaction variables and model 3 and 6 tested for non-linear effects of digitalization by adding squared variables.

Regarding the fit, the adjusted R2 coefficients of six models ranged from 58.4 to 58.5%, indicating that there were about 60% of the variation of the dependent variable explained by those models. Due to heteroskedasticity, we estimated the coefficients using heteroskedasticity-consistent standard errors to improve the accuracy of p (p-value) values. Some necessary tests were performed and did not detect autocorrelation between independent variables (see annex). After cleaning up abnormal observations, final sample included 210567 observations in the first 3 models and 211886 observations in last three models. All coefficients of main variables were statistically significant at 1%. The estimations indicate following results:

First of all, after controlling for all other factors, the characteristics of the firm (such as labor size, fixed assets and debt ratio) have an effect that is consistent with our assumptions. The positive and significant coefficient at 1% of labor (natural base logarithm of labor-lnL) and fixed assets (natural base logarithm of fixed asset value-lnK) shows that the bigger the size of labor, capital (assets) of an enterprise, the greater its revenue. The coefficient of the labor variable is very large, implying that most Vietnamese enterprises are still labor-intensive. The ratio of debt /equity (r_liability) also shows a positive correlation with revenue. This is consistent with the fact that businesses with access to loans will be able to expand production and business and thereby increase sales.

Business owner's capability represented by two dummy variables, including gender and qualification. The negative coefficient and the statistical significance at the 1% level of gender variable "Male" implies that male owners had lower revenue than female-owned businesses controlling for all other factors. In addition, businesses with directors with a university degree or higher also had higher revenues than the oe without a bachelor degree.

Secondly, in terms of ownership type, the model results (1) and (4) have not shown a reliable basis to determine whether SOEs have low or higher revenues than non-state enterprises. In models 2, 3, 5, 6, the negative and significant coefficient at 1% of the SOE variable indicates that SOEs had lower revenues than private enterprises if they had absolutely no employees using computers and internet regularly at work. However, in reality, statistics show that SOEs used internet and computers on average 52 to 53%.

Thirdly, in terms of digital operations, businesses were better off if they had higher digital operation. Business had higher sales if they had higher percentage of employees who regularly use the internet and computers at work. After controlling for all sectors, business characteristics, estimation models 1 and 4 show that workers who regularly use the internet and/or computers was significantly positively correlated with revenue.

In particular, the estimation results show that the impact of increasing digitalization on SOEs is higher than that of non-state enterprises. The marginal effect of internet and computer usage on SOEs is expressed by the coefficient β of the SOE interaction variables * tyle_int and SOEs * tyle_pc in models 2 and 5. These coefficients are all statistically significant at 1%.

The positive correlation between the use of computer and internet and revenue can come from the relationship between digitalization and labor productivity. As businesses increase digitalization capacity, labor productivity also increases and boosts up revenue growth. In addition, increasing the ability to use the internet also helps firm to expand the ability to access new markets, thereby expanding production scale and revenue.

Fourth, the results show that the relationship between digitalization and revenue growth does not seem to be a linear relationship. Increasing the use of computers and internet can help businesses to improve revenue rapidly in the early stages, but when the usage level is close to 100%, it is likely that the impact on sales will be lower. Excessive use of the internet and computers labor can lead to a dispersion of focus on production, business or a loss of time spent on specialized activities. In other words, the marginal effect of increasing use of computers and the internet on productivity and revenue in enterprises could be diminishing.

To test this relationship, we add the variables $tyle\_pc^2$ and $tyle\_int^2$ to test the nonlinear relationship between the degree of digitalization and revenue in models 3 and 6. The estimated results show that the coefficients of the variables tyle_pc2 and tyle_int2 are negative and statistically significant at 1% significance level, implying that the marginal effect of increasing digitalization on revenue is diminishing. At the threshold of 75% of computer usage and 76% of internet usage, revenue starts to decline with a small amount.

Fifth, different industries and regions had different revenue levels. When taking enterprises in agriculture, forestry and fishery as a basis for comparison, the majority of enterprises in other sectors have higher revenue, except for some industries such as accommodation, health care, education, entertainment and other services. When comparing firms in the Red River Delta region as a benchmark, firms in the Northern Uplands, Central and Central Highlands regions have lower revenues while those in the Southeast and the South. Mekong River has higher revenue.

Table 3.14: Model's estimations

Dependent var	Description	(1)	(2)	(3)	(4)	(5)	(6)
Lnrev	Log of revenue	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
LnK	Log of fixed asset	0.256***	0.256***	0.255***	0.256***	0.256***	0.254***
		(0.00221)	(0.00221)	(0.00221)	(0.00220)	(0.00220)	(0.00220)
LnL	Log of total employee	0.917***	0.917***	0.923***	0.918***	0.918***	0.927***
		(0.00369)	(0.00369)	(0.00371)	(0.00369)	(0.00369)	(0.00372)
r_liability	Liability ratio	0.328***	0.328***	0.328***	0.329***	0.329***	0.329***
		(0.0328)	(0.0328)	(0.0328)	(0.0328)	(0.0328)	(0.0327)
gioitinh	Gender of director: Male	-0.0643***	-0.0643***	-0.0649***	-0.0652***	-0.0652***	-0.0658***
		(0.00720)	(0.00720)	(0.00720)	(0.00718)	(0.00718)	(0.00717)
tdcmgd	Education level of director: Higher than bachelor	0.0334***	0.0342***	0.0353***	0.0281***	0.0289***	0.0288***
		(0.00661)	(0.00661)	(0.00660)	(0.00662)	(0.00662)	(0.00661)
DNNN	Firm ownership: SOE	0.0195	-0.266***	-0.270***	0.0155	-0.281***	-0.372***
		(0.0299)	(0.0504)	(0.0503)	(0.0299)	(0.0504)	(0.0884)
tyle_int	Average share of labor using internet for work	0.00286***	0.00280***	0.0113***			
		(0.000103)	(0.000103)	(0.000424)			
DNNN*tyle_int	Interaction term		0.00540***	0.00521***			
			(0.000882)	(0.000881)			
tyle_int^2	Square of tyle_int			-7.37e-05***			
				(3.64e-06)			
tyle_pc	Average share of labor using internet for work				0.00309***	0.00303***	0.0127***
					(0.000107)	(0.000107)	(0.000433)
DNNN*tyle_pc	Interaction term					0.00570***	0.00990**
						(0.000925)	(0.00422)
tyle_pc^2	Square of tyle_pc						-8.39e-05***
							(3.74e-06)
Sectoral dummies		YES	YES	YES	YES	YES	YES
Regional dummies		YES	YES	YES	YES	YES	YES
Constant		3.146***	3.162***	2.998***	3.151***	3.169***	2.986***
		(0.0468)	(0.0468)	(0.0474)	(0.0467)	(0.0467)	(0.0473)
Observations		210,567	210,567	210,567	211,886	211,886	211,886
R^2		0.584	0.584	0.585	0.584	0.584	0.585

Robust standard errors in parentheses

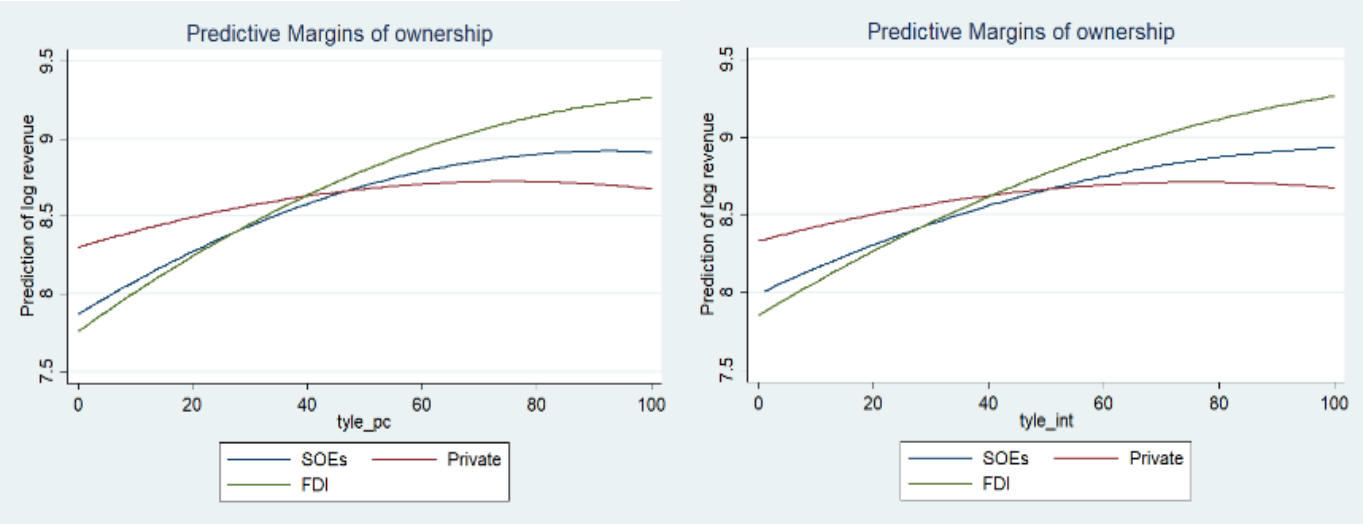
*** p<0.01, ** p<0.05, * p<0.1

After estimating the model, we proceeded to use the results of model 6 to outline the graphs of the difference between the impact of PC and internet usage on revenue growth by ownership types, business lines.

The figure below shows that the proportion of labor using the internet generally has a positive effect on revenue growth of all types of businesses. However, the impact of the ratio of labor using the internet to revenue growth of FDI enterprises is the highest, followed by SOEs. The impact on private sector revenue is positive but not significant. The simulation line has a concave shape, which shows the revenue growth decreases with increasing percentage of labor using computer.

Figure 3.16: Prediction of the impact of the proportion of labor using the internet on revenue growth of different types of businesses

Source: Author's simulation

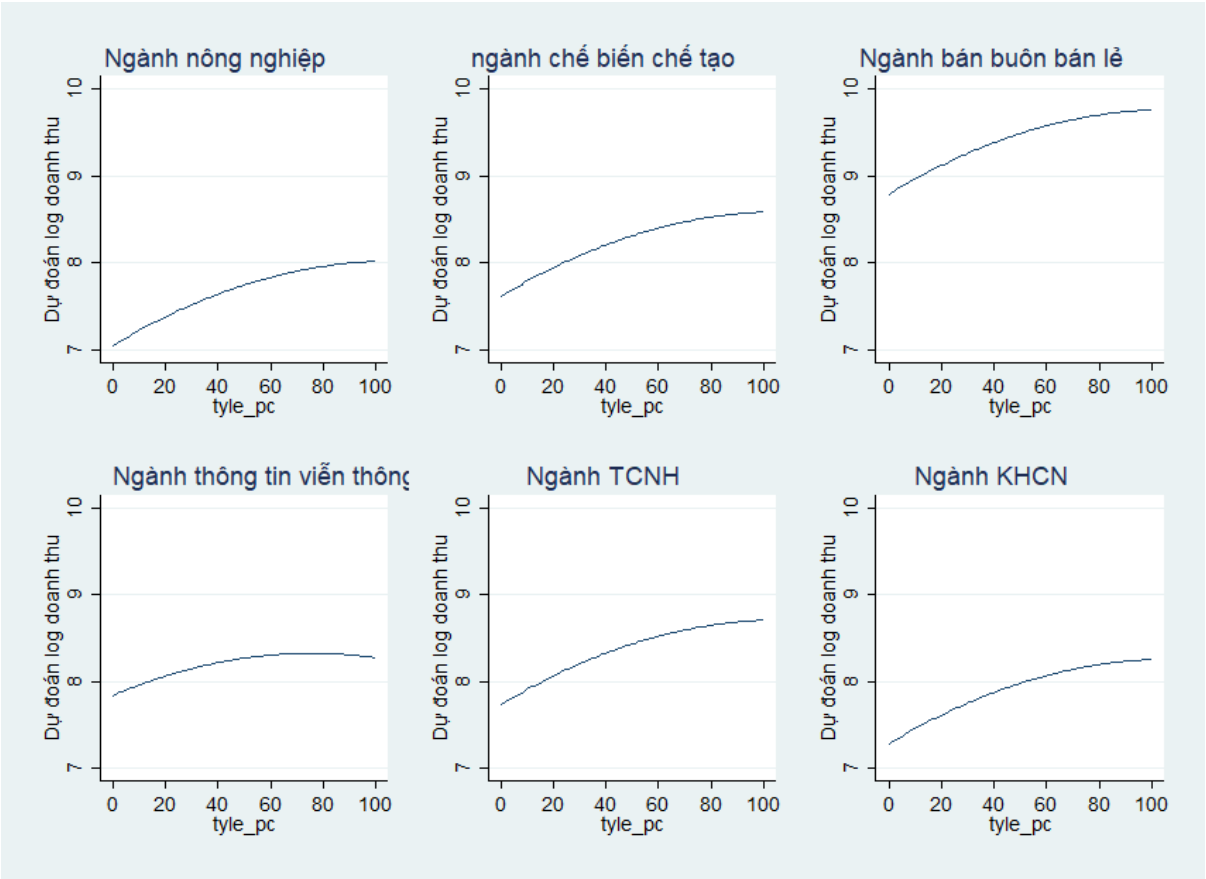


State-owned enterprises of different industries are affected differently by strengthening their digitalization capacities. The figure below simulates the impact of increasing the proportion of labor using PCs (computers) and revenue growth of SOEs in different industries. The 6 sectors used for comparison include: (i) agriculture; (ii) processing and manufacturing; (iii) retail wholesale; (iv) telecommunication information (v) finance and banking; and (vi) science and technology. In which, the wholesale and retail industry has the highest turnover, represented by the curve at the highest position. Agriculture has the lowest turnover.

The slope of the revenue curves reflects the impact of the proportion of PC-employed workers (computers) on revenue growth of enterprises in the industry. Agriculture, processing, manufacturing, and wholesale and retail trade are more affected, represented by steeper curves, while businesses in telecommunications, finance, banking and science and technology have less impact. This may be because enterprises of information, telecommunication, finance, banking, science and technology industries have already used intensively computers and internet in their

work, so the marginal impact of the increase in computers, The internet is low. Meanwhile, in agriculture, manufacturing, processing and wholesale, retail, revenue grows relatively faster with the same increase in the proportion of labors using PCs at work.

Figure 3.17: Prediction of the impact of using computers on revenue of some industries



Comment: We exploit econometric models to explore the usage of computers and internet in SOEs and the impact on business performance (revenue growth). The four main findings are as follows:

- In terms of quantity, SOEs had a ratio of activities in the fields of science and technology; processing and manufacturing; information and telecommunications are quite low while many SOEs operated in high profit and risky areas such as real estate. The absence of businesses in the fundamental areas, such as science and technology would certainly make it difficult for SOEs to upgrade their digitalization capabilities.

- SOEs digitalization capacity was poorer than private sector in many industries. Among 20 industries, sectors, SOEs only surpassed the private sector in 3 sectors: finance and banking; electricity, steam, gas and entertainment. This result is somewhat in contrast to the Industry 4.0 preparedness survey conducted by the Ministry of Industry and Trade in 2018.

- Digital operating efficiency, expressed by the percentage of employees who regularly use computers and the internet at work, are positively correlated with the production and business efficiency of enterprises, measured by total sales. Enhancing the ability to operate digitally can effectively improve the turnover of SOEs, an average increase of 1% of internet users will increase 0.82% of revenue and an increase of 1% of employed labor Using PC will boost revenue by 0.87%. Compared to non-state enterprises, the impact of digital operating efficiency on SOEs is higher. Improving digitized operational efficiency can help businesses improve labor productivity, expand markets and thereby increase sales.

State-owned enterprises of different industries are affected differently by strengthening their digitalization capacities. SOEs of agriculture, forestry and fishery sectors; processing and manufacturing; retail, wholesale benefit more from digital operations while SOEs in finance, banking and science and technology benefit less.

4. RECOMMENDATIONS, SOLUTIONS TO PROMOTE SOES TO THRIVE IN INDUSTRY 4.0

4.1 Summary of results

This study conducted a summary and review of the legal documents, policies and laws on the role of SOEs in S&T development. In addition, the study also applied the PwC's digital operation framework, combined with an empirical analysis on the impact of digitalization and SOE's performance.

Analysis of the role, mission and goals of SOEs in promoting the development of S&T and Industry 4.0, shed light on following issues:

- Although SOE is expected to play a key role in the economy to become a driving force for growth and lead other economic sectors, this sector still has a relatively weak role in S&T activitites.

- SOE's passive participation in S&T research activities in the period 2011-2016 may due to the fact that this sector has no clear and specific scientific and technological goals; limitations and weaknesses of corporate governance; lack of flexible financial mechanism to make investment and development; lack of regulations and sanctions to motivate SOEs to cooperate, transfer technology, support other economic sectors to create innovation ecosystems and lack of solutions to restructure SOE sector toward innovation with a strong focus on S&T.

- Legal regulations and policies on SOE's investment did not institutionalize direction stated in Decision 707/QD-Ttg on prioritizing investment in "science and technology; strategic sectors and industries, leading and orienting the development of knowledge economy, with high technology content, contributing to enhance the competitiveness of the whole economy". Excepting state business groups, SOEs generally do not have enough resources to invest in R&D and innovation.

The accessment on the readiness of SOEs in Industry 4.0 based on the PwC method highlights some following issues:

- SOEs will face challenges to grow and develop in Industry 4.0 because SOEs have a moderately low level of digital operation. Most SOEs have just started the digital journey and have not completed vertical integration. Few SOEs have reached out to digitize external components of its value chain to achieve horizontal collaborator.

- Six biggest challenges for SOEs in the digital journey, including: First, the ability to digitize and personalize products and services is limited. Second, SOEs do not have a systematic approach to generate values from data. Although SOEs can collect many data, there is no systematic approach to take advantage of data to innovate and improve business models. Third, SOEs lack the ability to set flexible prices due to limitation of customer analysis and regulatory constraints, which prevent freedom of pricing. Fourth, SOEs with high levels of state ownership severely lack talents and

experts in IT departments. Fifthly, resources to promote R&D of nw technology of Industry 4.0 are still very limited. Finally, the cooperation between SOEs and external partners is quite limited, partly due to the absence of cooperative regulations, the ability to protect intellectual property rights as well as risk management mechanism for the online risks.

- The size, state ownership and the industry are determining factors that affect the level of digitalization. Enterprises with less than 50% state ownership, large size enterprises or in highly competitive industries like banking and finance, science and technology, manufacturing and processing tend to have higher digital operating scores than average level. This provides additional evidence to support equitization and to increase competitive pressure on SOEs.

- SOEs show high expectations about improving their digital capability in the next 5 years, especially medium-sized enterprises and those with less than 50% state capital and those of the banking, finance and telecommunications sectors. Enhancing customer interaction and analyzing customer data is the top priority for most of surveyed SOEs.

In the final section, the empirical analysis on the impact of digitalization on business performance, exploited 2016 GSO Enterprise Survey to reveal some findings:

- SOEs are facing great opportunities to improve productivity, production and business efficiency if investment is made to enhance their digital operations. Enhancing the digital operation ability asscociates with a significant improvement in revenue. Estimation shows that an average increase of 1% employee using internet for working would increase 0.82% revenue and 1% increase in employee using PC for working would boost up revenue by 0.87%.

- Improving digital operation capability by increasing the use of computers and internet for working is a good way but not enough. It has only a great effect in a number of sectors, such as agriculture, manufacturing, wholesale and retail trade. Meanwhile, the impact on SOEs' revenue in telecommunications, finance, banking and science and technology industries is not significant.

- In terms of quantity, SOEs, which operate in the fields of science and technology, telecommunication and manufacturing, is quite low compare to non-SOE sector. However, in risky sectors such as real estate, SOEs account for the largest share.

- Most of SOEs are not as competitive as the private sector in digitalization. Among 20 industries and sectors, SOEs only outperforme the private sector in digitalization in three sectors: finance & banking, gas production and distribution, and entertainment.

4.2 Policy recommendations

4.2.1 For the government

The above results partly illustrate the position of SOEs in scientific and technological innovation in the period of 2011-2016. The results highlight the fact that Vietnamese SOEs have not yet performed the leading role in technology, science and innovation as expected. Excepting some large SOEs such as Viettel, EVN and large state-owned banks which have invested in researching and developing new products and services of Industry 4.0, in general, SOEs are only at the beginning of the digitalization journey.Given their limited capacity and weaknesses, it is difficult for Vietnamese SOEs to seize opportunities and cope up with major challenges of the "creative destruction" of Industry 4.0.

Based on study's findings, we propose a number of policy solutions to support SOEs to improve their readiness, adaptation and progress in Industry 4.0.

4.2.1.1 Detailing and implementing a solution stated in the Resolution No.52-NQ/TW of the Politburo on a number of guidelines and policies to actively participate in the IR4.0: " It is necessary to establish mechanism for SOEs to make investments in technological R&D, venture capital and into innovative start-ups". Specifically:

- To promulgate the national strategy on Industry 4.0, including contents related to specific mechanisms and policies for SOE sector in the IR4.0, especially in promoting the leading role in developing scientific and technological capacity; formulating strategies, plans on investment in developing and applying science and technology. Policies need to be designed to facilitate R&D activities of SOE sector.

- The CMSC, on the basis of its functions and tasks, reviews and amends regulations on corporate governance; promulgate regulations and instructions toward creating incentives and flexibility in investment, business of SOEs which operate in new technology fields; apply best practices of private sector on corporate governance and enhance the accountability of SOE's managers.

4.2.1.2 Repositioning the role and goals of SOEs in Industry 4.0

a. SOEs supporting roles

The role of SOE should be repositioned adopting the approach of innovation ecosystem model.

Under the approach of innovation ecosystem model, SOEs will play as an important supportive link in the national innovation ecosystem. SOEs will play a key role in connecting other economic sectors, domestically and internationally, to turn Vietnam into a hub of technology and innovation. SOEs can play important roles in industries that support innovation such as infrastructure development, social security, cultural exchange, health care, education, inclusive development which bring opportunities for vulnerable, minority groups, disabled people, women and young talents.

However, in key industries and technologies of Industry 4.0, SOEs would not necessarily bear a leading role. The private sector can take the lead because it is more dynamic and can accept higher risks.

b. Setting specific targets for Industry 4.0

According to OECD's recommendations on best practices of corporate governance (2010), the first thing that the state owner need to do is to set specific goals in order to ensure effective monitor and evaluation of SOE's performance. Setting clear goals, which is the basis for monitoring and evaluation, will ensure the transparency and accountability of relating parties.

In the context of Industry 4.0, the setting of specific, clear and quantitative goals to serve as a basis for assessing SOE contributions in Industry 4.0, should be prioritized. The goals for SOEs in Industry 4.0 include not only the goals of innovation, science and technology but should also include the goals of sustainable, inclusive, and innovative development of innovation ecosystems.

To evaluate the performance of SOEs, we propose to evaluate and classify SOEs based on an inclusive and sustainable development framework, including 5 pillars:

- *Production and business performance*: including current financial indicators (ROA, ROE, debt ratio, leverage ratio) and indicators: labor productivity (added value / labor / year), labor productivity growth rate, cost of business administration.

- *Social performance* measured by indicators: Average salary, labor growth rate, cost of social responsibility implementation, sustainable development, environmental protection standards ...

- *Trade performance* or import-export capacity measured by the ratio of export to total revenue, total value of import-export turnover, export growth rate.

- *Innovation performance* includes the following criteria: R&D expenditures/total revenue; number of patents, inventions and technology improvements on sales; number of research projects in coordination with external partners, research institutes, universities; digitized operational level index, broadband internet usage rate, automation of important manufacturing steps/process, digital integration and collaboration with customers and trading partners, etc.

- *Green growth*, including the following criteria: Energy saving, CO2 emission reduction, water use reduction, waste water treatment rate, etc.

These pillars should be assessed according to different weights based on the size, industry, type of state-owned enterprises and goals, targets assigned by state owner. State owners such as CMSC, ministries, provincial people committee can refer to the below table to set targets for SOEs under their management.

Table 4.1: Setting up goals for SOEs in the manufacturing sector based on sustainable, inclusive pillars

Pillar	Criteria	Goal for 2025
Innovation	R&D expense/revenue (%)	1.7%
	Number of patent/ VND billion of revenue	1.1
	Projects, cooperation with university, think-tank	20
	Digital operation score	4/5
	Share of employee using high speed internet for work (%)	82%
	Automation of important manufacturing steps/process	64%
Business performance	ROA	3-5%
	ROE	10%-15%
	Debt/equity ratio	<3
	Annual growth of added value	5%
	Annual growth of labor productivity (%)	10%
Green growth	Reduction of energy consumption compare to 2015/industrial added value (%)	34%
	Reduction of CO2 emission compare to 2015/ industrial added value (%)	40%
	Reduction of water usage compare to 2015/ industrial added value (%)	41%
	Utilization of industrial solid waste	79%
Trade performance	Annual growth of export	5%-10%
	Share of high tech products/ export value	>20%
	Diversification of export markets	High
Social performance	Creation of jobs for vulnerable groups, disable people and young talents	3-5%
	Number of female in the board of director	>30%
	Annual sustainable development report	Yes
	CSR expense/total revenue	0.5%

In addition, regarding some strategic technologies of Industry 4.0, it is necessary to set clear goals for SOEs in respective fields, sectors to absorb and master the use of these technologies and then gradually proceed to develop and upgrade that technology to international or regional level according to a reasonable path.

Advanced technologies of Industry 4.0 may not yet appear, so policies should encourage technological development and innovation. Current technologies should not be forced to use in industries by all economic sectors because it could lead to the lock in effect, which is harmful for innovation. Instead, competition should be encouraged to improve and invent technologies that best suit the market.

4.2.1.3 Continue to restructure SOEs, accelerating the equitization of SOEs in priority industries in Industry 4.0

The study suggests to accelerate the equitization of SOEs in all sectors and fields, including prioritized sectors of Industry 4.0.

It is necessary to increase the threshold of share for external shareholders in order to produce positive effects on production, business and innovation performance of equitized enterprises. In addition, policies should be designed to attract strategic shareholders with technological, financial, brand and market capabilities, especially foreign strategic shareholders.

The Government also needs to remove policy barriers in order to attract strategic shareholders and foreign shareholders with technological capabilities. In details: to set up clear selection criteria and ensure transparency; to renovate the enterprise valuation mechanism and selling price of shares to strategic investors; to improve publicity and transparency in the equitization process; to increase the ownership threshold and give effective rights for strategic shareholders to get involve in corporate governance and improve corporate governance, enhance competitiveness of SOE sector (CIEM, 2017).

In addition, results show that there are still many SOEs operating in high-risk sectors such as real estate. These SOEs have a low level of digitalization and do not contribute to the development of science and technology in Industry 4.0, so it is advisable to thoroughly divest from businesses and real estate projects to reallocate capital for scientific and technological R&D.

4.2.1.4 Promote business environment reform and ensure fair competition

The study proposes to enhance the reform of business environment, promote fair and healthy competition in all sectors, especially priotized sectors, industries of Industry 4.0.

In industries and sectors, where SOEs have a dominant position, such as electricity, telecommunications, insurance, chemical production, etc. the government should take measures to promote competition by removing entry barriers, technical barriers; creating incentives for private and FDI enterprises to enter the market and compete equally.

4.2.1.5 Modernizing, digitizing governance and supervision of state owners

The state owner who wants to promote SOEs to be innovative, creative and successful in Industry 4.0 should firstly renovate their own management capabilities through modernization, digitalization of the monitoring, evaluation and management system. To accomplish this goal, the study recommends some following solutions:

- To develop, manage and operate the national data system on SOEs

Ownership agencies shall review and assess the current state of the total value of assets and capital invested in enterprises under their management; building databases and management information systems for businesses.

To build a real time e-database of all enterprises with state capital automatically link and updated with each ownership agency’s database; the database should be updated at least every 3 months and must contain the following information:

• Business name & ownership representative agency

• Equity structure (including state equity).

• Basic financial indicators of the enterprise (extracted from the Balance Sheet and annual financial statement).

• Goals, objectives assigned by the ownership agency or shareholders in each period, including business, social, innovation performance and indicators.

• Company internal regulations, code of conducts

The national data system on SOEs should be made public and transparent and widely shared among ministries, the media, researchers and consultants.

- Modernizing management and monitoring tools

In the management and supervision of enterprises, the owner representative agency should apply modern corporate governance mechanisms, tools to monitor closely, effectively enteprise's financial status, even daily and hourly updates.

• A technical solution is to build and operate management information center that monitors the State capital flows invested in enterprises, especially through an online management information system (MIS), which connects with each enterprises to collect relevant data. The system should automatically evaluate and analyse financial, bussiness performance, compare it with assigned targets and report regularly to the ownership agency. All factors, including business plan, goals, budget, performance and project progress must be monitored on the same database collected from the business in order to ensure monitoring conducted on regular, transparent basis.

• Ownership agencies should recruit and establish a specialized team of analysts and experts so that the ownership agency can make timely and reasonable decisions. The team should carry out analysis to warn, manage the risk of ineffective projects, which cause the loss of state capital.

• It is recommended to develop and operate a system of measuring and evaluating the effective operation of enterprise. On that basis, rewards and punishment should be made for each enterprise and appointed managers in order to ensure effective operations .

• The guidlines for SOEs should be made to deliver clearly state owner's goals on business, corporate social responsibility, innovation, budget management, and accounting standards.

• It is also recommend to conduct a customer satisfaction assessment with SOE's service provision and customer feedbacks must be well presented in SOE performance evaluation report.

• Enhancing the implementation of monitoring and preventing corruption through effective and modern measures of corruption (see Korean experiences).

• A set of indicators for corporate governance reforms should be introduced to encourage SOEs to implement corporate governance innovation initiatives and learn from international best practices.

In order to build a modern, comprehensive and effective management, monitoring and evaluation system of SOEs, we can learn Korean experience in designing mechanisms, systems, and tests for SOE. Based on KIPF (2019), the study proposes the application of an effective SOE management, monitoring and evaluation system according to the following framework:

Table 4.2: Proposing a modern effective management, monitoring and evaluation system for SOEs

System	Objective	Monitoring tools, method	Implementation
Pre-feasibility testing system of establishing new SOEs	Preventing unreasonable establishment of new SOEs, reviewing the appropriate size and needs, the impact of financial support on new SOEs	If the minister / ministries wants to set up new SOEs, they must pass the test Examine three contents: the necessity and effectiveness of the new organization, its performance and the suitability of the financial plan	The SOE Innovation Committee approved the plan proposal The Ministry of Planning and Investment and the Ministry of Finance review the proposed plans and announce the results
Performance checking system	Check the SOE's suitability in shipping; reduce, transfer and merge unnecessary or unnecessary functions of SOEs	Examining the necessity of the functions and tasks under the current socio-economic conditions and requiring SOE restructuring; Check whether it is necessary to transfer SOEs to localities or to other SOEs; Check whether or not to equitize SOEs; Check whether SOE restructuring is required (merger, dissolution, transfer)	The Ministry of Planning and Investment shall coordinate with the specialized ministries
Human	Prevent duplication of	Organization and quota for	SOEs comply

resource and organizational management system	task function; maintaining the SOE scale at a reasonable level; creating a mechanism for sharing and coordinating personnel when there is a fluctuation due to military service, maternity leave; ensure fair and transparent treatment of labor; objectively assessing the competence and results of the director; make use of human resources from disadvantaged groups, disabled people, women and science and technology talents; guaranteed	SOEs Human resource management of SOEs Wage system Open contracts and career positions High-level human resource management	with the SOE governance guidelines of the Ministry of Planning and Investment
Budget management system and accounting system	Publicity, transparency and standardization of the financial and accounting situation of SOEs	Instructions for budgeting and implementation Separate accounting system for SOEs Accounting rules for SOEs	The Committee for State Capital Management at Enterprises and the Ministry of Planning and Investment and the Ministry of Finance issue regulations and instructions
Financial management system	Publicity, transparency and standardization of the financial situation, efficient use of the budget, and reduction of public debt	Debt reduction plan Medium and long-term financial management plans	The Ministry of Planning and Investment and the Ministry of Finance guide and promulgate regulations SOEs with total assets of 2 trillion won must make medium and long-term financial plans to submit to the Government and National Assembly
Survey	Promote SOE	Survey customer	All SOEs and

customer satisfaction	governance based on the customer as the center	satisfaction	semi-public organizations providing direct services to the public must conduct this survey at least once a year. The results are published and reflected in the performance evaluation of SOEs Enterprises with Category C results must have an improvement plan
Anti-corruption policy and consolidation measures	Preventing corruption, creating a good moral foundation for the community	Salary, budget and personnel policies Consolidated measures measure internal and external corruption Measurement processes Use the feedback results of corruption measurement Assess anti-corruption policy	Central Inspection Committee, Government Inspectorate, related agencies
SOE governance innovation	Improve management efficiency and quality of public services	Guidance on management innovation for SOEs Three directives on SOE governance reform Organizational innovation index in 2017 Institutional innovation index in 2018 Evaluating the results of institutional governance innovation in 2018	The Ministry of Planning and Investment and the Ministry of Finance issue instructions The SOEs and these organizations carry out the governance reform plan according to the tasks in the guidance

4.2.1.6 Policies to promote SOEs to improve their digital operations

It is necessary to have policies to encourage SOEs to carry out the digitalization process to avoid falling behind and to achieve advanced digital operation. By 2025, we should set targets as 70% of SOEs would achieve horizontal collaborator and 10% achieve digital champion according to PwC self assessment of digital operation.

A number of solutions that could help SOEs to improve their digital operations:

- To continue arranging and restructuring SOEs, including equitization and diversification of ownership for small and medium-sized SOEs. State ownership agencies should only keep significant shares in strategic SOEs, which operate in prioritized sectors of Industry 4.0.

- Focusing on renovating SOE business model towards modernization, application of information technology in corporate governance and business activities of SOEs (increasing digital features into products, personalizing products, ...). To accomplish this goal, large SOEs managed by CMSC, can develop, apply real-time management systems, update important information on management, investment, production, business, finance, etc.

- Promoting SOEs to enhance data connectivity with external partners by encouraging SOEs to cooperate with universities, research institutes and private enterprises to conduct joint research of technological innovation and new technical products in prioritized industries.

- Making policies to encourage, support, motivate enterprises to invest in information technology; MES production operating system; applications of cloud technology, big data ...

- Applying a more flexible wage mechanisms, associated with labor productivity and market price for SOEs to attract high-quality talents in information technology.

4.2.1.7 Additional supportive policies

In addition to above recommendations, the study highly recommends supportive policies for all types of enterprises to enable them to perform a quantum leap in Industry 4.0. Some supportive policy proposals are as follows:

Firstly, we focus on improving information systems for all businesses to support domestic businesses to access policy information, market opportunity, legal framework, FTA agreements, technological exhibitions, etc. The Government can finance to connect these systems or select the best information system to develop, such as the business support portal system of the Ministry of Planning and Investment or some enterprise associations.

Secondly, the Government should soon complete and promulgate a proposal to develop strategic prioritized sectors in Industry 4.0 including a comprehensive assessment of the strategic importance of Industry 4.0 and action plans. In addition to issuing strategies, the actual implementation should also be promoted to avoid weak, ineffective enforcement. The implementation of policies and strategies on Industry 4.0 needs to be organized systematically and through an effective agency.

Thirdly, the Government should promote the development of e-commerce, especially cross-border e-commerce; building and completing the legal basis for different types of e-commerce business, sharing economy, digital business models; Strengthening the protection of intellectual property rights, ensuring network information security. The national project on sharing economy should be effectively implemented.

Fourthly, efforts should be made to raise awareness of businesses about Industry 4.0 through communication campaigns, seminars, training courses for businesses. Programs to improve capacity and awareness for businesses need to be highly realistic and practical. Training programs on Industry 4.0 should not only base on theory or textbooks. Experts, practitioners with plenty of experiences can deliver knowledge and inspire people much better and more effectively.

Fifthly, Government should encourage universities and vocational training systems to train workers in prioritized sectors of Industry 4.0 to improve resilience and reduce the risk of job loss in IR4.0. Skills training programs for employees should focus on computer skills, information technology and foreign languages, especially information technology skills for women.

Sixthly, Government should revisit and develop an appropriate strategy to attract FDI enterprises into prioritized sectors in Industry 4.0, actively attract FDI projects with the application of modern technologies and processes. In addition, local government should reduce FDI projects into low-value stages.

Seventh, Government should encourage businesses to invest in sustainable development by setting environmental protection standards in line with the standards of developed markets; designing "green" tax incentives for businesses that perform well in environmental protection; inspecting and ensuring that enterprises strictly comply with security requirements labor safety; promoting trade union activities in a substantive way, ensuring workers' rights.

4.2.2 Solutions for SOEs

The study proposes six groups of solutions for SOEs to improve their digital operations to adapt, advance and achieve success in Industry 4.0. Six solutions group corresponds to six pillars of pwc's digital operation analysis framework. SOEs, after performing self-assessment of digitalization capacity, can identify pillars with low scores and implement the solutions introduced here to improve, score, rank and capacity.

4.2.2.1 Improve business models, products and digital services

- Developing digital applications, integrating digital features into smart products and services of enterprises, for example: integrating RFIT technology, opening online applications on appstore, google play ...

- Develop digital formats for products such as QR codes, to conduct connections with online payment networks and e-wallets.

- Integrating information collection functions, automatic product status updates to have intelligent maintenance and alerts and recommendations.

- Develop products, services, events that customers can make personalized according to their interests. Increasing customer loyalty for products and services through promotions and after-sales services for products and services sold.

- Collecting ideas, surveying customers and partners about products and services. Actively exchanging information with partners and units. Create reciprocal communities, such as facebook groups, forums to engage and share customer support to improve the experience of using products and services of the business.

4.2.2.2 Promote market expansion and reach customers with digital technology

- Building a system of customer database on consumer behaviors of customers, systematic classification and storage

- Develop flexible pricing policies for each customer base on affordability, characteristics and customer behavior to improve the value of surplus earned.

- Diversify sales and expansion channels, combining both traditional sales channels and e-commerce channels. Take advantage of domestic e-commerce platforms (tiki, sendo, lazada ...) and international (amazon, alibab) to access the wider market.

- Diversify the interaction channels with customers: Facebook, google ads, sales website, forums, fairs. Use a variety of digital tools to increase customer interaction (Example: Using social networks to collect customer ideas to develop products).

- Develop online sales applications, invest in upgrading smart sales devices for salespeople to increase productivity, reduce redundant personnel and increase sales efficiency. Online sales applications that connect customers and product updates in real time. Integrate the ability to create personalized products and execute customized, flexible orders.

- Promote initiatives to share and exchange customer information with partners in the value chain such as banks, credit houses, shipping units, exporters, etc.

4.2.2.3 Upgrade value chains and digitize internal production processes

- Digitizing internal production processes by applying control software and applications, for example, processing and manufacturing enterprises can apply direct control programs of machinery. through CAD models, ERP and MES integration.

- Upgrade machines and production processes to enable real-time monitoring of production processes and the ability to flexibly change production schedules.

- For businesses in the manufacturing, processing and manufacturing industries, it is necessary to invest in developing an integrated end-to-end planning system - including real-time information on planning and planning. guide the process from sales forecast, production to logistics and logistics of Enterprises.

- Building intelligent and digitized factories of production equipment of enterprises with sensors, Internet of things; digital-based monitoring, control, optimization and automation.

- Integrating information of logistics service providers into internal IT systems.

4.2.2.4 Upgrading information technology infrastructure

- Invest in upgrading IT infrastructure to meet new requirements of 4.0 technology, IoT development research, big data analysis, ... and build a roadmap and budget to upgrade technologies. technology, infrastructure development or lease purchase to improve access to the world's most advanced technologies in the field

- Building centralized IT infrastructure system, capable of collecting, synthesizing and analyzing real-time data on production, products and customer data to monitor, control and optimize too Manufacturing process and flexibility vary according to market conditions.

- Actively experiment and leverage new digital technologies to build and develop new business models or increase the effectiveness of making business decisions.

- Attract talents in the IT field, especially human resources capable of responding flexibly to new requirements and new changes in Industry 4.0. Improve interaction between sales department and IT.

- Increasing the proportion of labor using broadband internet and fiber optic cables in the enterprise.

- Establishing common technology platforms, websites, personal pages, mobile applications that customers, distributors and partners of enterprises can easily access to check information, products and applications, order, monitor transaction status, answer questions ...

4.2.2.5 Completing regulations on digitalization, security and network security of enterprises.

- Developing specific digital management regulations and rules for businesses to ensure that digital or related components are strictly managed, safe, and minimize risks.

- Strictly protecting the intellectual property rights

- Developing a special section on digital risk management to assess the risks of digitizing production processes and risks from digital products. This category should be published along with the annual business report.

- Taking advantage of the state's priorities and supports in investing in upgrading technology and production science and technology in Industry 4.0. Manage digital assets, locations and settings for digital assets (licenses, patents, intellectual property rights, etc.) to receive government incentives, taxes, and grants.

- Establish a network security mechanism to cover production activities, and implement measures to protect production from cyber threats, such as installing services, anti-virus and hacker packages and network attacks.

- Ensure partners in the value chain, customers understand the regulations and digital policies of the business and respect the implementation

4.2.2.6 Building an innovation culture in the enterprise

- For large size enterprises, especially in the fields of finance, banking, science and technology, and telecommunications, specialized units, departments and divisions should be established with clear and comprehensive responsibilities to promote and deploy IR4.0

- Organize training courses for senior management of businesses to improve awareness of the importance, content and implications of Industry 4.0. The Board of Directors needs to outline the vision and roadmap to pursue Industry 4.0. In addition, enterprises can research and develop strategies suitable for their industries and conditions to integrate 4.0 objectives, technologies and processes gradually into production and business.

- Actively participate in building an open connection platform in Industry 4.0 so that many parties can participate in research and contributions; actively seek partners, research institutes and universities to participate in cooperation, research and development of smart technologies, products and services.

References

5. BCG (2018) "Industry 4.0 and impacts on Vietnam" Báo cáo tham vấn của tập đoàn BCG cho Bộ Kế hoạch và đầu tư
6. Bowers, M.R., Martin, C.L., Luker, A., 1990. Trading places: employees as customers, customers as employees. Journal of Services Marketing, 4 (2), 55-69.
7. CIEM. (2018). "Báo cáo Tác động của công nghiệp 4.0 tới ngành dệt may Việt Nam".
8. Cosmiqo (2018) "Why IR4.0 is important" presented by Dr Koh Niak Wu, Cosmiqo International Pte ltd
9. Girma, Sourafel, Yundan Gong and Holger Görg. (2009). "What Determines Innovation Activity in Chinese State-owned Enterprises? The Role of Foreign Direct Investment."
10. IMPULS Stifftung, IWI & RWTH Aachen University (2015). IMPULS - Industrie 4.0 Readiness, Impuls-Stiftung des VDMA, Aachen-Köln, 2015
11. ISDP (Institute for Security and Development Policy). 2018. "Made in China 2025: Backgrounder", June 2018, www.isdp.eu
12. Jian Cheng GUAN, Richard C.M. YAM, Esther P.Y. Tang, Antonio K.W. Lau, 2009, "Innovation strategy and performance during economic transition: Evidences in Beijing, China", Research Policy,Volume 38, Issue 5, 2009,Pages 802-812,ISSN 0048-7333,
13. Kasper, and Streit. (1999) New institutional economics. Northampton, the US & Cheltenham, the UK: Edward Elgar Publisher
14. KIPF (Korea Institute for Public Finance). 2019. "The Management System of SOEs and QGOs in Korea" Edited by Jongwon Choi, chaegi Kwack, and Youngjae Ra, YooChan Kim Publisher, March 2019
15. Luthra & Mangla (2018) Evaluating challenges to Industry 4.0 initatives for supply chain sustainability in emerging economies. Process Safety and environmental protection 117 (2018) 168-179
16. MOIT& VASS & UNDP (Bộ Công thương, Viện Hàn Lâm khoa học xã hội Việt Nam và Chương trình phát triển Liên hợp Quốc tại Việt Nam) (2018). "Báo cáo đánh giá sự sẵn sàng tiếp cận cuộc cách mạng công nghiệp lần thứ tư của các doanh nghiệp thuộc các ngành công nghiệp ở Việt Nam:kết quả phân tích số liệu điều tra khảo sát". Tháng 8/2018
17. Nelson, R.R. (ed.), 1993. National Innovation Systems: a Comparative Analysis, Oxford University Press, Oxford.
18. OECD (2015), Data-Driven Innovation: Big Data for Growth and Well-Being, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264229358-en
19. OECD (2017), OECD Digital Economy Outlook 2017, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264276284-en
20. OECD/ERIA (2018), SME Policy Index: ASEAN 2018: Boosting Competitiveness and Inclusive Growth, SME Policy Index, OECD Publishing, Paris/ERIA, Jakarta,https://doi.org/10.1787/9789264305328-en.
21. Prahalad, C.K., Ramaswamy, V., 2004. Co-creation experiences: the next practice in value creation. Journal of Interactive Marketing, 18 (3), 5-14
22. Pwc (PricewaterhouseCoopers) (2016). The Industry 4.0/Digital Operations Self Assessment, 2016
23. Pham, T. A., & Nguyen, D. H. (2014). The impacts of business environment institutions on business performance of Vietnamese enterprise. Spring Economic Forum. Hanoi, Vietnam: Vietnam Economic Commitee of the Congress.
24. Phòng thương mại Hoa Kỳ (2017) "Made in China 2025: Global ambition built on local protection" US Chamber of Commerce, Washington DC

25. Schumachera Andreas, Erol and Sihn (2016). A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises, Changeable, Agile, Reconfigurable & Virtual Production Conference 2016, Procedia CIRP 52 (2016), 161-166
26. Schumpeter, J. 1942. Capitalism, Socialism, and Democracy. New York: Harper & Bros. Trefler, D. 2004. The long and short of the Canada–U.S. Free Trade Agreement. American Economic Review 94, 870–95.
27. Schwab, K. (2016). The Fourth Industrial Revolution. World Economic Forum.
28. The economist, 2017, "The rise of super star", special report, available online at: http://www.economist.com/sites/default/files/20160917_companies.pdf, Last accessed: 13h11pm GMT +7 22/08/2019
29. Tran, T. B., Crafton, R., & Kompas, T. (2009). Institutions matter: The case of Vietnam. The Journal of Socio-Economics, 38, 1-12.
30. UNIDO. (2017). Accelerating clean energy through Industry 4.0: manufacturing the next revolution. Vienna, Austria.
31. Worldbank & Bộ Kế hoạch và đầu tư (2016) "Báo cáo Việt Nam 2035- Hướng tới Thịnh vượng, sáng tạo, công bằng và dân chủ", NXB Hồng Đức
32. WorldBank (2018) Tương lai việc làm việt nam: khai thác xu hướng lớn cho sự phát triển thịnh vượng hơn. Ngân hàng Quốc tế Tái thiết và Phát triển/Nhóm Ngân hàng Thế giới, Washington, DC, USA

Appendix

Appendix I. questionnaire for self-assessment on digital operation

English version available at: https://i40-self-assessment.pwc.de/i40/landing/

Thông tin chung

Tên Công ty:.....

Ngành, lĩnh vực kinh doanh chính:……

Địa chỉ trụ sở chính của doanh nghiệp:

Huyện/quận, Tỉnh/thành phố:.....

Hình thức đăng ký kinh doanh của doanh nghiệp là:

☐ Công ty TNHH MTV ☐Công ty hợp danh

☐ Công ty cổ phần ☐ Hình thức khác, nêu rõ:……..

Doanh nghiệp có phải là công ty con của một doanh nghiệp khác không? ☐Có ☐Không

Doanh nghiệp có bao nhiêu công ty con (sở hữu trên 50% vốn điều lệ) và bao nhiêu công ty liên kết (sở hữu dưới 50% vốn điều lệ)?

……..công ty con ……..công ty liên kết

Doanh thu năm 2018:

☐Dưới 3 tỷ đồng ☐50 tỷ đồng đến 100 tỷ đồng

☐3 tỷ đồng đến 10 tỷ đồng ☐100 tỷ đồng đến 200 tỷ đồng

☐10 tỷ đồng đến dưới 50 tỷ đồng ☐200 tỷ đồng đến 300 tỷ đồng

☐Trên 300 tỷ đồng

Tổng số lao động cuối năm 2018: …… người, trong đó số lao động đóng bảo hiểm:…….. người.

Hiện tại, tỷ lệ cổ phần nhà nước tại doanh nghiệp là bao nhiêu ?

☐100% ☐ Dưới 100% và trên 75%

☐ Trên 50% đến 75% ☐ 50% hoặc nhỏ hơn

Tự đánh giá năng lực vận hành số hóa của doanh nghiệp

Bảng tự đánh giá bao gồm 33 câu hỏi, tương ứng 6 hạng mục. Với mỗi câu hỏi, xin quý vị vui lòng tự đánh giá HIỆN TRẠNG năng lực của doanh nghiệp và MỤC TIÊU trong vòng 5 năm tới. Đánh giá theo thang đo mức độ, với 1: mức tối thiểu và 5: mức tối đa.

Ví dụ: Doanh nghiệp ứng dụng các kênh truyền thông số để quảng cáo sản phẩm ở mức độ nào?

Mức 1: Không dùng các kênh truyền thông số để quảng cáo sản phẩm, chỉ dùng các kênh quảng cáo truyền thống: in catalogue quảng cáo, tham gia hội chợ, triển lãm…

Mức 5: Sử dụng nhiều kênh truyền thông số để quảng cáo sản phẩm, ví dụ: google ads, quảng cáo trên mạng xã hội, truyền hình, các trang báo điện tử…

HIỆN TRẠNG	1	2	③	4	5
MỤC TIÊU	1	2	3	4	⑤

1. Mô hình kinh doanh, danh mục sản phẩm, dịch vụ

1.1 Quý vị đánh giá như thế nào về mức độ đóng góp của các sản phẩm số, dịch vụ số trong toàn bộ giá trị tạo ra của tất cả các sản phẩm của Doanh nghiệp?

Mức 1: Không có đóng góp gì. Toàn bộ giá trị tạo ra từ kinh doanh các sản phẩm vật chất và các dịch vụ liên quan tới sản phẩm vật chất (ví dụ: bảo trì, bảo dưỡng máy móc)

Mức 5: Đóng góp chính. Toàn bộ giá trị tạo ra từ kinh doanh các sản phẩm, dịch vụ số và nhượng quyền sở hữu trí tuệ (Ví dụ: các giải pháp bảo dưỡng, bảo trì dựa vào công nghệ đám mây, nhượng quyền kinh doanh các sản phẩm in 3D)

HIỆN TRẠNG	1	2	3	4	5

MỤC TIÊU	1	2	3	4	5

1.2 Các sản phẩm thông thường của doanh nghiệp được số hóa đến mức độ nào? (Ví dụ: Ứng dụng công nghệ RFID để nhận diện sản phẩm, tích hợp cảm biến, kết nối Internet vạn vật, sản phẩm thông minh,…)?

Mức 1: Hoàn toàn không có số hóa. Danh mục sản phẩm đang kinh doanh chỉ bao gồm các sản phẩm thuần túy vật chất (ví dụ: các máy móc cơ khí không có tính năng số hoặc không kết nối mạng)

Mức 5: Hoàn toàn số hóa. Các sản phẩm, dịch vụ số đóng vai trò chính trong danh mục sản phẩm, các sản phẩm vật chất chỉ đóng vai trò trung gian (ví dụ: "app store"- cửa hàng các ứng dụng số cung cấp các tính năng bổ trợ cho máy móc)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

1.3 Khách hàng có thể cá nhân hóa các sản phẩm họ mua đến mức độ nào?

Mức 1: Hoàn toàn không thể. Các sản phẩm không thể cá nhân hóa được (Ví dụ: Sản xuất hàng loạt sản phẩm đồng nhất)

Mức 5: Có thể cá nhân hóa hoàn toàn- Các sản phẩm có thể được khách hàng cá nhân hóa hoàn toàn (ví dụ: Khách hàng có thể tự thiết kế, thay đổi tùy chỉnh dù chỉ mua 1 sản phẩm)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

1.4 Xin Ông/Bà cho biết mức độ số hóa trong các khâu, công đoạn trong vòng đời sản phẩm? (Ví dụ: Số hóa và kết hợp các khâu lập kế hoạch, thiết kế, chế tác, sản xuất, kinh doanh và tái chế)

Mức 1: Khả năng số hóa và kết hợp thấp- Chỉ áp dụng các công nghệ số riêng lẻ, tách biệt ở một số khâu trong vòng đời sản phẩm (Ví dụ: Không hợp nhất việc chế tạo và sản xuất sản phẩm)

Mức 5: Khả năng số hóa và kết hợp rất cao- Tất cả các công đoạn trong vòng đời sản phẩm đều được số hóa hoàn toàn (Ví dụ: Có thể kiểm tra được khả năng sản xuất sản phẩm thông qua mô phỏng máy tính các mẫu sản phẩm)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

1.5 Theo Ông/Bà, việc sử dụng và phân tích dữ liệu từ khách hàng, sản phẩm hoặc máy móc quan trọng đến mức độ nào trong mô hình kinh doanh của Doanh nghiệp?

Mức 1: Không quan trọng- Mô hình kinh doanh hiện tại không cần phân tích dữ liệu

Mức 5: Tối quan trọng- Dữ liệu chính là nguồn chủ yếu tạo ra giá trị trong mô hình kinh doanh hiện tại (Ví dụ: Dữ liệu về hiệu năng của máy móc được dùng để tính toán các khoản chi phí)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

1.6 Trong quá trình phát triển sản phẩm và dịch vụ, mức độ cộng tác của công ty với các đối tác, nhà cung ứng và khách hàng của Doanh nghiệp Ông/Bà như thế nào?

Mức 1: Không hợp tác- Việc phát triển sản phẩm được thực hiện nội bộ và không hề có trao đổi thông tin với các đối tác, nhà cung ứng hoặc khách hàng

Mức 5: Hợp tác chặt chẽ- Việc hợp tác phát triển sản phẩm cùng các đối tác đã thành quy trình chặt chẽ trong chuỗi giá trị và được công khai, minh bạch cho khách hàng.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

2. Thị trường và tiếp cận khách hàng

2.1 Xin Ông/Bà cho biết mức độ đa dạng của các kênh bán hàng?

Mức 1: Chỉ dùng một kênh duy nhất- bán hàng kiểu truyền thống (ví dụ: các gian hàng tại địa phương)
Mức 5: Bán hàng thông qua nhiều kênh – tích hợp các kênh bán hàng thông thường và bán hàng số, trực tuyến (Ví dụ: cửa hàng, đại lý, website bán hàng, các nền tảng thương mại điện tử,v.v..)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

2.2 Xin cho biết Doanh nghiệp Ông/bà đã sử dụng, kết hợp các kênh truyền thông ở mức độ nào để tăng tương tác với khách hàng, ví dụ: sử dụng website, blog, diễn đàn, các nền tảng mạng xã hội để truyền tin, nhận phản hồi và quản lý khiếu nại?
Mức 1: Truyền thông một chiều- Chỉ sử dụng các kênh truyền thông truyền thống để trao đổi thông tin (ví dụ: website của doanh nghiệp, bản tin điện tử)
Mức 5: Truyền thông tương tác rất cao- Sử dụng rất nhiều công cụ số để tăng tương tác với khách hàng (Ví dụ: Sử dụng mạng xã hội để thu thập ý kiến khách hàng để phát triển sản phẩm)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

2.3 Xin Ông/Bà cho biết các công nghệ số có khả năng hỗ trợ việc bán hàng ở mức độ nào? (Ví dụ: có thiết bị di động hỗ trợ; khả năng truy cập hệ thống mọi lúc, mọi nơi; khả năng khách hàng có thể thực hiện toàn bộ quy trình mua bán tại chỗ)
Mức 1: Bán hàng kiểu truyền thống- Người bán hoạt động ngoại tuyến (offline) mà không truy cập hệ thống (Ví dụ: Chỉ sử dụng văn bản, giấy tờ "cứng")
Mức 5: Bán hàng kiểu số hóa- Lực lượng bán hàng được hỗ trợ bởi các thiết bị điện tử, số hóa và có thể truy cập vào tất cả các quy trình, hệ thống liên quan vào mọi thời điểm (Hệ thống kết nối khách hàng và cập nhật sản phẩm theo thời gian thực; khả năng tạo các sản phẩm cá nhân hóa và thực hiện các đơn hàng tùy biến, linh hoạt v.v..)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

2.4 Xin Ông/Bà đánh giá khả năng đặt giá khác nhau cho các nhóm khách hàng khác nhau (ví dụ: đặt giá sản phẩm, dịch vụ dựa trên uy tín, mức độ sẵn lòng chi trả của khách hàng)?
Mức 1: Đặt giá cố định- Giá cho mọi sản phẩm và dịch vụ đều cố định (Ví dụ: sản phẩm có giá cố định, niêm yết trên catalogues)
Mức 5: Đặt giá linh hoạt- có hệ thống tự động tính toán giá cả, chiết khấu, v.v.. một cách rất linh hoạt theo thời gian thực (Ví dụ: Giá phụ thuộc vào tiềm năng, uy tín của khách hàng, lịch sử giao dịch và tính liên quan của các đơn hàng v.v..)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

2.5 Xin Ông/Bà đánh giá mức độ sử dụng/phân tích dữ liệu khách hàng để gia tăng hiểu biết về khách hàng? (Ví dụ: có các gói sản phẩm, dịch vụ thiết kế cho từng cá nhân dựa trên điều kiện của họ, các sở thích, mối quan tâm, địa điểm, xếp hạng tín nhiệm; sử dụng dữ liệu để thiết kế và chế tạo sản phẩm mới v.v..)?
Mức 1: Ít sử dụng dữ liệu- Thông tin lưu trữ phân tán, ít được sắp xếp, thiếu tính hệ thống, chỉ do một phòng ban duy nhất quản lý và cũng không được phân tích sâu (Ví dụ: lưu trữ các giao dịch trong file excel)
Mức 5: Sử dụng dữ liệu triệt để- thu thập thông tin triệt để tại tất cả các đầu mối, sau đó đưa vào một hệ thống tích hợp để giám sát, kiểm tra và cải thiện, tối ưu hóa các sản phẩm, giao dịch và trải nghiệm của khách hàng.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

2.6 Xin Ông/Bà đánh giá mức độ hợp tác với các đối tác để tăng cường tiếp cận khách hàng (Ví dụ: trao đổi thông tin, hiểu biết về khách hàng, cùng tham gia các hoạt động marketing, quảng bá với các đối tác v.v.)

Mức 1: Không có- Không cộng tác với đối tác nhằm tăng cường tiếp cận khách hàng (ví dụ: mỗi bên có dữ liệu khách hàng riêng biệt và cũng không hợp tác để marketing hoặc bán hàng)

Mức 5: Hợp tác chặt chẽ và hợp nhất để cùng tiếp cận khách hàng- Dữ liệu khách hàng được sao lưu hoàn toàn trong hệ thống của đối tác (ví dụ: khách hàng có tài khoản chung trong hai hệ thống và có thể sử dụng thông tin khách hàng của đối tác)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

3. Chuỗi giá trị và các quy trình

3.1 Ông/Bà *đánh giá mức độ số hóa trong các liên kết dọc của chuỗi giá trị (từ khâu phát triển sản phẩm đến sản xuất) của doanh nghiệp như thế nào ?*

Mức 1: Hoàn toàn không số hóa- Không có trao đổi thông tin tự động ở các khâu trong chuỗi (ví dụ: Các chương trình vận hành máy móc được thiết lập dựa trên các kế hoạch trên giấy)

Mức 5: Hoàn toàn số hóa- Dòng thông tin vận hành liên tục trong chuỗi giá trị (ví dụ: Điều khiển trực tiếp máy móc thông qua các mô hình CAD[14], tích hợp hệ thống ERP[15] và MES[16])

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

3.2 Ông/Bà đánh giá khả năng giám sát tình trạng sản xuất và khả năng thay đổi kế hoạch sản xuất, kinh doanh theo các biến động thị trường?

Mức 1: Không có khả năng- Sản xuất hàng loạt theo quy mô lớn và không giám sát chi tiết được tình trạng sản xuất. Không có khả năng thay đổi sản xuất theo các biến động thị trường.

Mức 5: Khả năng cao- Có thể theo dõi thời gian thực đối với quy trình sản xuất và có khả năng thay đổi lịch trình sản xuất một cách linh hoạt

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

3.3 Xin Ông/Bà cho biết mức độ áp dụng các giải pháp công nghệ xuyên suốt (end-to-end) để lập kế hoạch và định hướng quy trình từ dự báo bán hàng, sản xuất đến kho vận và logistics của Doanh nghiệp?

Mức 1: Các quy trình lập kế hoạch riêng lẻ- Không có hỗ trợ của công nghệ thông tin và cũng không hợp nhất được các quy trình trong chuỗi giá trị (ví dụ: Lập kế hoạch dựa vào kinh nghiệm quá khứ)

Mức 5: Có hệ thống lập kế hoạch xuyên suốt (end to end) tích hợp- bao gồm thông tin theo thời gian thực trong toàn bộ chuỗi giá trị (Ví dụ: Dự báo bán hàng sẽ có ảnh hưởng trực tiếp tới kế hoạch sản xuất)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

3.4 Xin Ông/Bà cho biết mức độ số hóa của các thiết bị sản xuất của doanh nghiệp mình? (gắn cảm biến, kết nối Internet vạn vật; giám sát, điều khiển, tối ưu hóa và tự động hóa dựa trên kỹ thuật số)

[14] CAD: Computer aided design: thiết kế bằng máy tính

[15] ERP: enterprise resource planning system: hệ thống hoạch định tài nguyên doanh nghiệp

[16] MES: Manufacturing Execution System- hệ thống điều hành sản xuất

Mức 1: Các nhà máy thuần túy cơ học- các thiết bị sản xuất hoàn toàn không có liên kết với hệ thống công nghệ thông tin và không thể thu thập được các thông tin theo thời gian thực
Mức 5: Các nhà máy hoàn toàn số hóa- Các thiết bị sản xuất được kết nối, có thể truy cập và thông tin thực được thu thập để tạo lập các mô phỏng nhà máy ảo.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

3.5 Xin Ông/Bà đánh giá mức độ số hóa đối với các liên kết ngang trong chuỗi giá trị (Ví dụ từ đặt hàng đến cung ứng, từ sản xuất và logistic tới dịch vụ) của Doanh nghiệp
Mức 1: Không có số hóa- Không có việc trao đổi thông tin tự động trong các liên kết ngang của của chuỗi giá trị (Ví dụ: Không có kết nối với bộ phận IT của các nhà cung ứng)
Mức 5: Hoàn toàn số hóa- Các dòng thông tin luân chuyển thường xuyên trong các liên kết dọc của chuỗi giá trị (ví dụ: hợp nhất thông tin của các nhà cung ứng dịch vụ logistic vào hệ thống IT nội bộ)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

4. Hạ tầng công nghệ thông tin (IT)
4.1 Hạ tầng IT của doanh nghiệp Ông/Bà có đáp ứng các yêu cầu số hóa và CN 4.0?
Mức 1: Không đáp ứng. Hạ tầng IT không đáp ứng những yêu cầu của CN 4.0 (ví dụ: IoT, phân tích dữ liệu sản xuất, v.v…) và cũng không dễ dàng để thay đổi, nâng cấp để thích ứng với các yêu cầu mới.
Mức 5: Đáp ứng hoàn hảo- Hạ tầng IT đã đáp ứng các yêu cầu một cách rõ ràng, ngoài ra có lộ trình để có thể nâng cấp nhằm đáp ứng các nhu cầu mới trong tương lai

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

4.2 Doanh nghiệp Ông/bà có sử dụng hệ thống điều hành sản xuất MES (manufacturing execution system) hoặc các hệ thống tương tự để điều khiển các quy trình sản xuất không?
Mức 1: Không sử dụng- Lập kế hoạch sản xuất được làm thủ công mà không có hỗ trợ của hệ thống IT trung tâm.
Mức 5: Sử dụng triệt để- Hệ thống MES hoặc các hệ thống tương tự được dùng để lập các kế hoạch ngắn hạn (Xác định hiệu năng, tối ưu hóa, lên lịch trình sản xuất, v.v..), các hệ thống được tích hợp tốt với ERP và hệ thống nền (shop floor system) để cho phép tích hợp dọc các khâu trong chuỗi giá trị.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

4.3 Xin Ông/Bà cho biết mức độ hoàn thiện của Hệ thống hạ tầng IT và dữ liệu trong việc thu thập, tổng hợp và phân tích các dữ liệu thời gian thực về sản xuất, sản phẩm và dữ liệu khách hàng của Doanh nghiệp?
Mức 1: Khả năng thấp- Không có hệ thống tập trung để phân tích dữ liệu, các phân tích riêng lẻ, thiếu kết nối toàn cục
Mức 5: Hoàn thiện- Có khả năng phân tích dữ liệu tiên tiến (gần như) theo thời gian thực để giám sát, điều khiển và tối ưu hóa quá trình sản xuất và các thiết bị thông minh

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

4.4 Theo Ông/Bà, các công nghệ mới ví dụ như mạng xã hội, di động, các công nghệ phân tích, điện toán đám mây có vai trò như thế nào trong kinh doanh?

Mức 1: Không quan trọng- Doanh nghiệp ít đầu tư vào công nghệ mới và công nghệ cũng ít tác động tới chiến lược kinh doanh (Ví dụ: chỉ sử dụng mạng xã hội bởi vì mọi người cảm nhận rằng đó là việc cần làm)

Mức 5: Rất quan trọng- Việc thử nghiệm và tận dụng các công nghệ số mới có tầm quan trọng lớn để đưa ra các quyết định kinh doanh (Ví dụ: mạng xã hội, cả nội bộ lẫn bên ngoài, có thể giúp phát hiện các khuynh hướng, tâm lý của khách hàng và xây dựng ra các nền tảng chia sẻ tri thức nội bộ)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

4.5 Xin Ông/Bà cho biết khả năng đáp ứng của Bộ phận IT của doanh nghiệp đối với các yêu cầu kinh doanh, đảm bảo tiến độ, chất lượng và chi phí?

Mức 1: Thường xuyên không đạt được kỳ vọng- Các hoạt động và chất lượng công việc của bộ phận này không được như kỳ vọng (ví dụ: Triển khai công việc bị chậm trễ, các quy trình IT không linh hoạt, v.v..)

Mức 5: Luôn đáp ứng các kỳ vọng- Bộ phận IT có khả năng phản ứng linh hoạt với các yêu cầu mới, thay đổi. Bộ phận kinh doanh và IT được kết nối hoàn hảo.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

4.6 Sự kết nối công nghệ thông tin với khách hàng, nhà phân phối và các đối tác của doanh nghiệp đạt mức độ nào?

Mức 1: Hoàn toàn không có kết nối- Doanh nghiệp chỉ có các hệ thống IT khép kín, không cho phép người ngoài truy cập.

Mức 5: Hoàn toàn kết nối- Có các giao diện, nền tảng chung cho tất cả các hệ thống IT liên quan, cho phép trao đổi dữ liệu liền mạch và an toàn (Ví dụ: khách hàng có thể truy cập được tình trạng đặt hàng, giao hàng; các nhà cung ứng nắm được các thông tin về kho bãi)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

5. Tuân thủ quy định, luật pháp, rủi ro, an ninh và thuế

5.1 Các quy định về số hóa của doanh nghiệp Ông/Bà phức tạp đến mức độ nào?

Mức 1: Ít phức tạp- Không có quy định về số hóa và cũng không có quy trình quản trị nội bộ cho những phần liên quan khác nhưng không thực hiện số hóa.

Mức 5: Độ phức tạp cao- Các Chính sách, quy định tuân thủ số hóa được đặt ra cho toàn bộ doanh nghiệp

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

5.2 Xin Ông/Bà cho biết mức độ bảo vệ quyền sở hữu trí tuệ đối với các sản phẩm và dịch vụ số của doanh nghiệp mình và mức độ vi phạm quyền sở hữu trí tuệ của các bên khác?

Mức 1: Bảo vệ kém- Việc bảo vệ quyền sở hữu trí tuệ của doanh nghiệp chỉ được thực hiện tùy trường hợp và vẫn có vi phạm quyền sở hữu trí tuệ của các doanh nghiệp khác.

Mức 5: Bảo vệ chắc chắn- Doanh nghiệp đã thiết lập và thực hiện các quy trình cẩn thận để đảm bảo rằng quyền sở hữu trí tuệ được bảo vệ theo đúng quy định pháp luật

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

5.3 Trong quản trị rủi ro, doanh nghiệp Ông/Bà có đánh giá rủi ro của việc số hóa quy trình sản xuất và rủi ro từ các sản phẩm số không?

Mức 1: Không đánh giá- Quản trị rủi ro hiện chưa đánh giá các rủi ro liên quan đến số hóa sản xuất và danh mục các sản phẩm số

Mức 5: Đánh giá cẩn trọng- Quản trị rủi ro đánh giá cẩn trọng các rủi ro liên quan đến việc số hóa sản xuất và các sản phẩm số.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

5.4 Xin Ông/Bà cho biết, các tài sản số trong chuỗi giá trị có được quản lý hiệu quả trên khía cạnh thuế? (ví dụ chọn địa điểm đăng ký sở hữu trí tuệ để tránh thuế)

Mức 1: Hoàn toàn không có- Thực hiện quản lý tài sản số giống như các tài sản vật chất khác

Mức 5: Đầy đủ- Việc quản lý các tài sản số, địa điểm và những thiết đặt cho các tài sản số (licenses, patents, quyền sở hữu trí tuệ, v.v..) được thực hiện để tối ưu hóa nghĩa vụ thuế.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

5.5 Xin Ông/Bà đánh giá vấn đề an ninh mạng của doanh nghiệp trong hoạt động sản xuất kinh doanh như thế nào?

Mức 1: Không coi trọng- Sản xuất không cân nhắc các vấn đề an ninh mạng, mà chỉ tập trung vào an toàn thông thường

Mức 5: Rất coi trọng- Có cơ chế đảm bảo an ninh mạng bao trùm hoạt động sản xuất, và thực hiện các biện pháp để bảo vệ sản xuất khỏi các mối nguy trên mạng.

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

5.6 Xin Ông/Bà cho biết mức độ tuân thủ các quy định về số hóa và quản trị rủi ro các đối tác và khách hàng liên quan tới doanh nghiệp?

Mức 1: Không liên quan gì- Quản trị rủi ro chỉ thực hiện nội bộ doanh nghiệp và không dính dáng gì đến các đối tác dịch vụ hoặc khách hàng

Mức 5: Liên quan chặt chẽ- Quản trị rủi ro được định nghĩa một cách toàn diện và điều chỉnh liên tục bởi các đối tác và khách hàng liên quan

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

6. Tổ chức và Văn hóa doanh nghiệp

6.1 Ông/Bà đánh giá như thế nào về khả năng tạo ra giá trị từ dữ liệu?

Mức 1: Hạn chế- Thu thập nhiều dữ liệu nhưng không có cách tiếp cận hệ thống nào để tận dụng dữ liệu nhằm đổi mới, cải thiện mô hình kinh doanh.

Mức 5: Hoàn thiện- Có cách tiếp cận hệ thống để khai thác dữ liệu nhằm tối ưu hóa hoạt động và sáng tạo các mô hình kinh doanh mới (ví dụ: có đội ngũ chuyên khai thác, phân tích dữ liệu, có các nhà khoa học dữ liệu v.v..)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

6.2 Đánh giá của Ông/Bà về khả năng và nguồn lực của doanh nghiệp nhằm thúc đẩy CN4.0 (Ví dụ: khả năng phân tích dữ liệu, Internet vạn vật, CPS, HMI, an ninh sản xuất, digital PLM, v.v.)?

Mức 1: Rất hạn chế: Thiếu hoặc không rõ khả năng, nguồn lực cũng như không rõ ai chịu trách nhiệm liên quan đến Công nghiệp 4.0.

Mức 5: Đầy đủ: Có các đơn vị, phòng, ban được chuyên môn hóa, có trách nhiệm rõ ràng, bao quát để thúc đẩy và triển khai CN4.0

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

6.3 Xin Ông/Bà cho biết mức độ ủng hộ và trình độ chuyên môn của các lãnh đạo, người quản lý và cán bộ liên quan đến CN 4.0 tại doanh nghiệp?

Mức 1: Có ít sự ủng hộ, quan tâm- Cán bộ, quản lý, lãnh đạo không coi trọng CN 4.0 và hầu như không có chuyên môn về kỹ thuật số

Mức 5: Rất quan tâm, ủng hộ- Tất cả các quản lý, lãnh đạo có nhận thức đầy đủ về tầm quan trọng, nội dung và các hàm ý của CN 4.0 (Ví dụ: Hội đồng quản trị có tầm nhìn và lộ trình để theo đuổi CN 4.0)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

6.4 Mức độ hợp tác của Doanh nghiệp Ông/Bà với các tổ chức bên ngoài (viện nghiên cứu, hiệp hội ngành, nhà cung ứng hay khách hàng) về CN4.0 ?

Mức 1: Không hợp tác: CN 4.0 là chủ đề nghiên cứu trong nội bộ doanh nghiệp và các kết quả chỉ gói gọn trong doanh nghiệp mà không chia sẻ với các tổ chức bên ngoài

Mức 5: Cởi mở hợp tác: Các sáng kiến, đổi mới của CN4.0 được thúc đẩy trong một nền tảng kết nối cởi mở để nhiều bên cùng tham gia nghiên cứu, đóng góp (Ví dụ: tạo môi trường "Nhà máy thông minh", mở cửa cho khách hàng tham quan các phòng thí nghiệm)

HIỆN TRẠNG	1	2	3	4	5
MỤC TIÊU	1	2	3	4	5

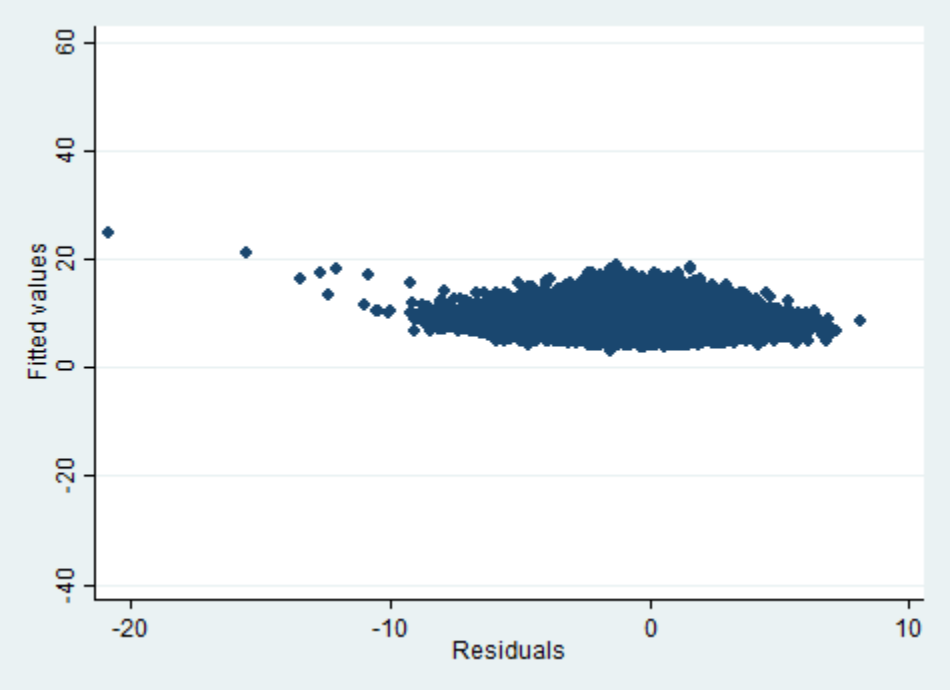
XIN TRÂN TRỌNG CẢM ƠN SỰ HỢP TÁC VÀ GIÚP ĐỠ CỦA ÔNG/BÀ!

II. Appendix 2 – Model post testimations

A. Correlation matrix

	lnrev	lnL	lnK	owners~p	r_liab~y	tdcmgd	gioitinh	tyle_pc	tyle_int	indus	region
lnrev	1										
lnL	0.6472	1									
lnK	0.5365	0.5869	1								
ownership	0.1317	0.1684	0.1558	1							
r_liability	0.1965	0.0998	0.0764	0.0374	1						
tdcmgd	0.0491	0.0696	0.0699	0.0509	0.0149	1					
gioitinh	0.0269	0.0889	0.0637	0.0515	-0.0028	0.0347	1				
tyle_pc	-0.1985	-0.3389	-0.2259	-0.0383	-0.0276	0.2175	-0.0321	1			
tyle_int	-0.1810	-0.3080	-0.2116	-0.0422	-0.0236	0.1987	-0.0288	0.8920	1		
indus	-0.2306	-0.2034	-0.1841	-0.0644	-0.0309	0.1457	-0.0564	0.2882	0.2713	1	
region	-0.0294	-0.1183	-0.0111	0.0242	-0.0335	-0.090	-0.0570	-0.026	-0.058	-0.018	1

B. Scatter graph of residuals and fitted values



Graph shows heteroskedasticity

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Biên tập:
CHU QUANG KHÁNH

In tại Công ty Cổ phần In & Phát triển Thương mại Nhật Minh
Số lượng 100 cuốn, khổ: 19 x 27cm
Giấy phép xuất bản số: 1092-2020/CXBIPH/61-22/TN
Mã ISBN: 978-604-9951-03-9
Quyết định số: 573/QĐ-NXBTN cấp ngày 6/4/2020
In xong và nộp lưu chiểu quý II năm 2020