

Industrial Revolution 4.0 in Some Countries Experiences and Lessons for Vietnam

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Abstract: The world has experienced 3 Industrial Revolutions. Right now, we are at the beginning of the 4th Industrial Revolution. 4.0 Revolution is based on the digital revolution, characterized by the increasingly popular internet and mobile, by smaller and more powerful semiconductors at cheaper price and by Artificial Intelligence. Digital technologies with computer hardware, software and networks are becoming more and more complex, more integrated, thus transforming society. Faced with the unprecedented impact of the 4.0 Revolution, depending on the size of the economy and the level of technology, countries around the world have policies to adapt, catch up and take advantage of the achievements of the revolution. This revolution serves the sustainable development of our country. This article summarizes the policies of some countries such as Germany, the United States, Japan, Singapore, Republic of Korea, India, China, Taiwan, ... under the impact of the 4.0 Revolution; thereby drawing lessons for Vietnam in the process of implementing the 4.0 Revolution to avoid negative impacts, take advantage of the pre-eminence of the revolution in socio-economic development.

Key words: The 4th Industrial Revolution, revolution 4.0, industry 4.0, digitization, high technology.

1. Introduction

The development of humanity has been greatly influenced over the past three centuries by the changes from the Industrial Revolutions.

The first Industrial Revolution took place in the early 18th century because of the achievements in mechanization with the introduction of the steam engine.

The second Industrial Revolution appeared from the late 19th-early 20th century with the invention of electric engines and assembly lines to create large-scale production.

The third Industrial Revolution [2] began in the 70s of the 20th century, characterized by the use of electronic equipment and information technology to automate production. This revolution is characterized by a combination of technologies that help to erase the

boundaries between the fields of physics, digitalization and biology. It is the result of outstanding progress in computers and information technology.

The fourth Industrial Revolution, Industry 4.0, is fundamentally different from the 3.0 Industrial Revolution: higher production automation thanks to customized and flexible technologies. Machines work independently, communicating with each other to make decisions without (or very little) human involvement. The machines self-collect, process, self-adjust, analyse and make decisions by themselves.

In other words, Industry 4.0 creates self-regulating, self-aware and customizable production. Humans, instead of controlling machines are now indirectly interfaced with them via Internet of Things (IoT) or Internet of People (IoP).

Countries in the world, depending on their level of development and practice, have different perceptions

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and policy countermeasures to take advantage of the Industry 4.0 trend. Reality shows that there are two groups: countries leading in technology such as Germany, the United States, Japan, Singapore, Republic of Korea and a series of countries focusing on technology application such as India, China, Taiwan ... The countries in the second group rely on their existing strengths to implement and focus resources on a number of priority areas.

2. The Impact of Industrial Revolution 4.0 on the Face of the World

For manufacturers, the 4th Industrial Revolution sees the introduction of advanced technologies that help create new products and services, increase production efficiency, and promotes innovation and development of the industry in the long run: reduced transportation and communication costs, more efficient supply chains and minimised trade costs.

For consumers, the 4th Industrial Revolution promises to change the method of consumption and time to access products. Activities such as consuming and using basic services can be done remotely. In addition, consumers have access to more transparent product information due to the pressure to maintain a competitive advantage among manufacturers.

One example is in the era of the 4th Industrial Revolution that the textile industry could be fully automated (from automatically scanning the human body for measurements, to the final product). The car assembly industry will also be fully automated.

For organisations and businesses operating with robot workers there will be of course issues that have to be solved legally, such as the legitimacy of transactions performed entirely or in large part by automation as replacement for people.

For the authorities, digital infrastructure technology and equipment enables two-way interaction between people and government. While increasing the power of supervision and leadership, and regulating the economy, thus, will enhance and accelerate

transparency and integration. The 4th Industrial Revolution will help strengthen national security under the effective support of technology if the state management system is flexible enough to manage and cooperate closely with businesses and citizens.

However, this revolution also has the potential to disrupt the balance of the labour market. As robots and automation take the throne, the amount of surplus workers will increase. On the other hand, the rich-poor gap will widen between those providing financial capital and knowledge capital (inventors, shareholders and investors) and those who depend on labour (workers). In that view, the 4th Industrial Revolution can create a decline in income for the majority of the population in developed countries when the need for highly qualified human resources increases and the demand for manpower drops. Historically, the Industrial Revolutions have also deepened social inequality, leading to a series of major economic and political upheavals including tax adjustments and social security.

Another scenario is that organizations and enterprises may not have enough capacity to adopt new technologies or law enforcement find it difficult to fully recruit new technology managers as national security issues become increasingly complex with a combination of traditional and non-traditional elements (such as cyber warfare, biological weapons).

3. Industry 4.0 Promotion Policies in Some Countries

3.1 Europe

In Europe, most of the Western European countries as well as the European Union Parliament have developed strategies to promote Industry 4.0 based on digitization and connectivity (see Fig. 1).

3.2 Germany

The “Industry 4.0” (Industrie 4.0) program was first mentioned in the “High-tech Strategic Action Plan” approved by the German Government in 2012. In the

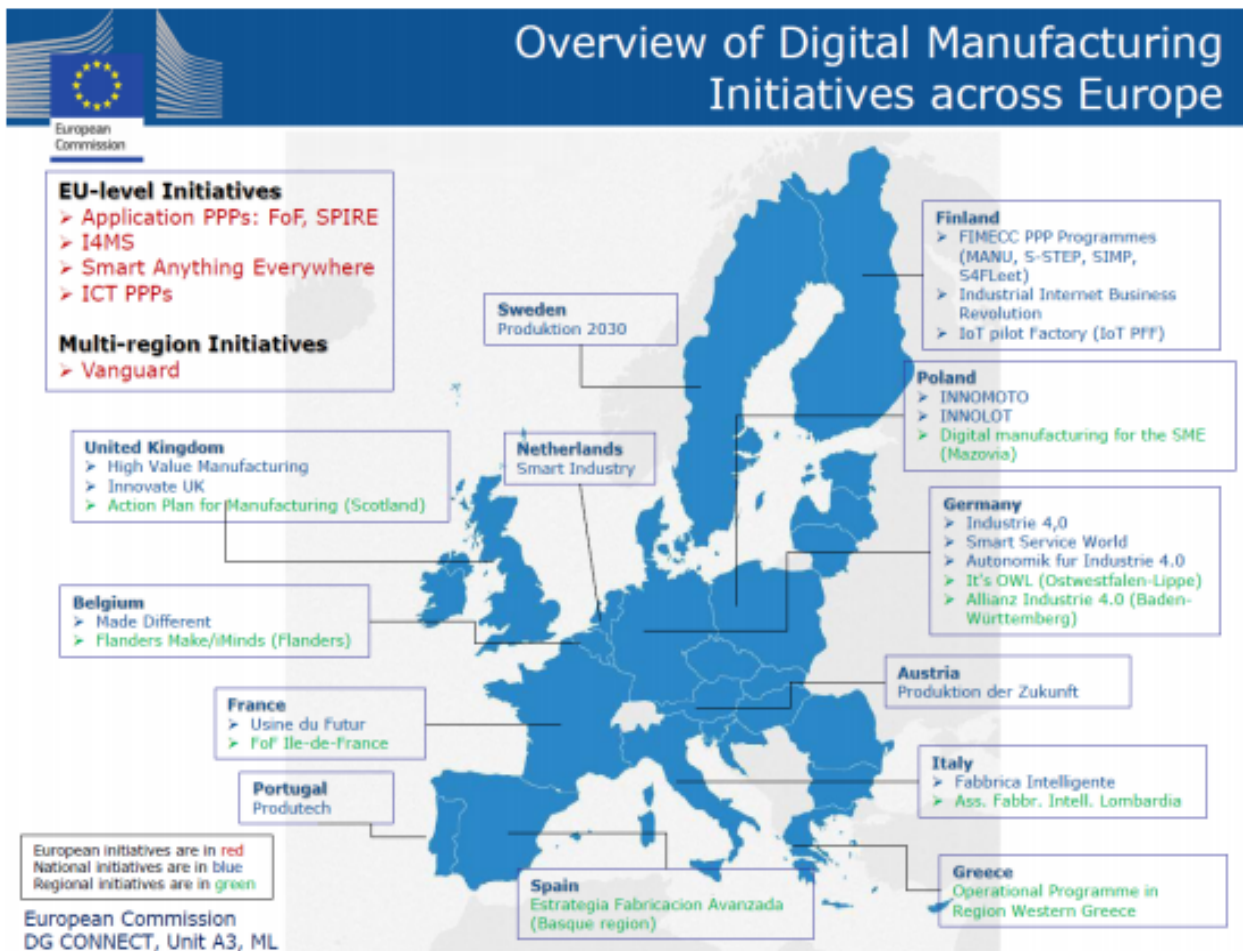


Fig. 1 Industry 4.0 promotion programs in Europe.

Source: Roland Berger.

context of global production, the market share of Western European countries decreased from 35% in 1991 to 25% in 2011 while the share of emerging economies in Asia (Asia minus Japan) increased from 8% in 1991 to 31% in 2011 (Fig. 2). The German Government stated that “globalization is making Germany gradually lose its price competitive advantage in the manufacturing of industrial products”. Therefore, “Germany needs to increase the content of service packages and high-tech solutions in its traditional mechanical industrial products and thereby sell at higher prices”.

That reason led the German Government to develop Industry 4.0 to create a coherent policy framework to maintain Germany’s industrial competitiveness [3].

After launching Industry 4.0, Germany has been looking to attract foreign labour, especially in the high-tech sector, to achieve its goal. This fact has created rapid movement in political decisions. Germany has been gradually expanding its immigration policy for non-EU citizens, especially for high-tech professionals. Many programs to support young businesses in the high-tech sector have been implemented by the German government to promote the economic development under Industry 4.0. Germany has also been focusing its budget on research and development to serve Industry 4.0 and considers this the focus of the national research and development program over the next 10 years. At the same time, Germany also has a policy of learning from the US. For example the

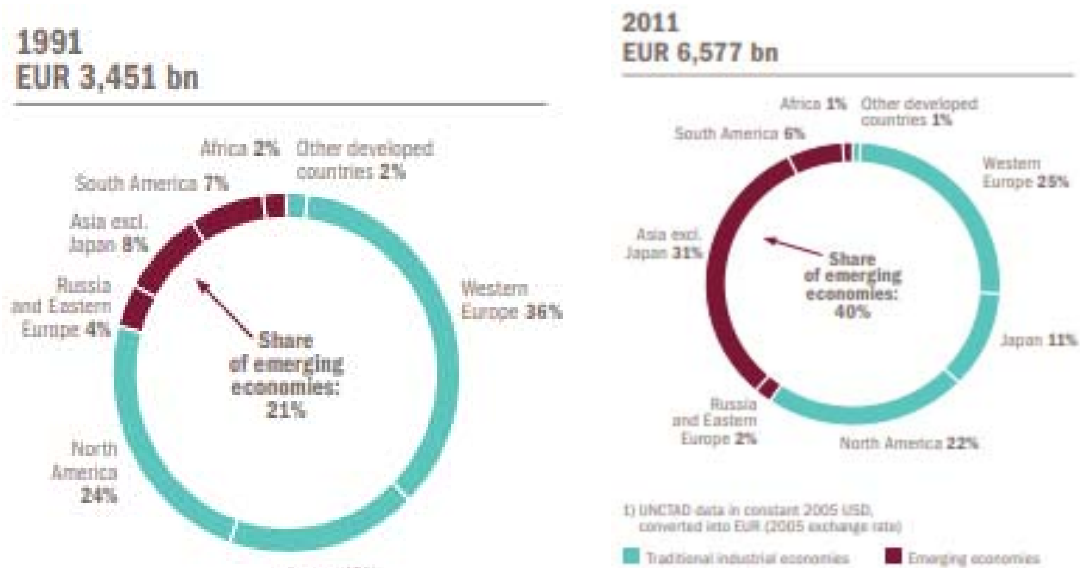


Fig. 2 Market share of global production [4].

German Silicon Valley Accelerator Program, under the management of the German Ministry of Economy and Technology, allows 10 innovative start-ups to move to San Francisco, state of California, United States, within one year.

3.3 USA

In 2011, President Obama announced the program “Advanced Manufacturing Partnership (AMP)”. This is an effort of the US government to improve the quality of products and the competitiveness of American goods on a global scale. Then, the White House announced the Advanced Manufacturing Cooperation Program 2.0 (AMP 2.0), with the aim of boosting advanced American manufacturing. The main contents were: (i) ensuring advanced production research to meet technology availability requirements; (ii) strengthening information flows from federal organizations to be promptly shared with the production sector. And a series of national initiatives and programs were established in which there must be two prominent groups of initiatives: (i) The National Network for Manufacturing Innovation (NNMI) including 45 production technology innovation research institutes with financial support of up to 1

billion USD, in order to promote the development and application of breakthrough technologies to create new products that are globally competitive and (ii) other initiatives that support production and facilitate the introduction and use of new production technologies including the Genetic Testing Reference Materials Coordination Program (GeT-RM), National Robotics Initiative Program, National Nano Technology Program, and “American Entrepreneurship” Program.

In parallel with policies aimed at meeting the needs of economic development, the US Government also focuses on national security policies, including the International Cyber Strategy to prepare global reach, not just in the United States.

3.3.1 “Internet Industry Community” Initiative by General Electric

The term “Industrial Internet” (Industrial Internet) or Industrial Internet of Things (IIoT) was coined by General Electric Company (GE) in 2012. Then, in 2014, GE together with AT&T, Cisco, IBM and Intel, created the non-profit “Industrial Internet Consortium (IIC)” to connect the organizations and technologies needed to drive the growth of the Internet Industry by defining, integrating and promoting best practices [4].

Today IIC has about 170 members, most of whom are private companies and academic institutions worldwide. While Industry 4.0 focuses on manufacturing, Internet Industry focuses on all areas.

3.4 Japan

The promotion of the application of new technologies in Japanese manufacturing has emerged since 2008. The Institute of Advanced Industrial Science and Technology (AIST) builds the Advanced Manufacturing Research Institute, made up of a selection of research groups that focused on knowledge exchange and developing joint projects. Then, with the assessment that the era led by Industry 4.0 [6] is an era of explosive development of many industries such as robotics and Artificial Intelligence, the Japanese considered the fundamental development of a highly qualified human resource, as an important preparation in accordance with the new development requirements. In early June 2016, the Japanese government officially approved a new educational program for high school students. In particular, all middle school students of public schools in Japan will be required to learn programming from the beginning. In addition to developing human resources, continuing to succeed from the policy of the State intervening deeply in the formation and development of enterprises, the Japanese government is encouraging Japanese citizens to create business start-ups and self-employment.

The policy of encouraging start-up with a series of financial capital support, management skills support, creating opportunities to access new high-level technology capabilities, introducing highly qualified human resources ... is the solutions that Japan supports for grantees to benefit and develop.

3.5 Republic of Korea

Korea's strategies and policies to promote Industry 4.0 are mainly based on the successes of the country's Information & Communication Technologies (ICT)

industry over the past three decades. Implementation of preparations for Industry 4.0 of Korea is actively deployed from corporations and research institutes. For example, Hyundai Motor is slowly moving to re-start development of self-driving cars; KITECH Institute with the support of the Ministry of Industry, Trade and Energy and the Ministry of Science and Technology has also set up the project of Advanced Manufacturing System (KAMS) to develop new production technologies and processes.

3.6 India

India shares the same vision with some developed countries such as the US, Germany, and Japan on the aim towards Industry 4.0. The Government of India wants domestic and international manufacturing investors to manufacture their products in India, making India the manufacturing hub of the world. This orientation has been notified internationally by the Indian government representative in 2015 at the Hannover Messe. India aims to include new technologies in manufacturing initiatives, smart cities and infrastructure, as well as new concepts in manufacturing and business as part of a national initiative "Digital India".

In preparation for the implementation of the manufacturing center cluster, Prime Minister Narendra Modi announced the "Make in India" initiative on September 25, 2014. This is a national initiative with the following main objectives: (i) attracting foreign investment; (ii) promoting innovation; (iii) skills enhancement; (iv) protection of intellectual property rights; (v) construction of world-class infrastructure.

3.7 China

In China, the 12th five-year plan (2011-2015) considered Industry 4.0 as one of the seven emerging issues supported by the Chinese government and identified five priority areas: modern equipment, automotive, steel, petrochemical and shipbuilding. In 2015, China officially announced the national strategy

“Made in China 2025” [5] which focuses on promoting production innovation with emerging production technologies, with 10 key areas including: information technology (IT); numerical control tools and robots; aerospace equipment; marine engineering equipment and high-tech vessels; railway equipment; energy saving and new energy; electrical equipment; new materials; biomedical and medical devices; agricultural machinery. “Made in China 2025” is also expected to compete with “Make in India” in attracting foreign investment.

3.8 Singapore

Singapore’s drive to promote new manufacturing technologies is reflected in part of the 10-year in 2015 (smart country) master plan related to ICT with focus on the strong development of biotechnology, and is accelerated with the program Singapore-Smart Nation [2]. Although Singapore has not said too much or put out a strategy on Industry 4.0 or advanced manufacturing, it can be seen that the country has made proper preparations over the past 20 years. Singapore has created the best business environment in the world, attracts the world’s top IT and biotechnology talent, has a thorough e-Government system and is currently implementing a series of large intelligent systems such as self-driving cars, smart buildings, smart villages, infrastructure ready for the IoT at all intersections, all crossroads This country can intuitively classify as the leading countries for the technologies for Industry 4.0. despite a small population but with a solid infrastructure, quality human resources with high skills and a flexible labour structure, advanced policies and governance capabilities, a price-support business environment, value added and innovative activities, and the available technology directions.

3.9 Thailand

Thailand has defined the country’s development roadmap through 3 phases from agriculture, light industry to heavy industry and is now heading to

phase 4, based on 3 pillars: productivity growth, comprehensive growth and green growth. In terms of nature, Thailand has not announced a strategy to promote Industry 4.0, but development orientation Thailand 4.0 has shown the national orientation in identifying 4 priority technology areas: (i) ICT; (ii) nanotechnology; (iii) biotechnology and (iv) materials, energy and environmental technology.

4. Lessons Learned for Vietnam in Industry 4.0

In Vietnam, there is no specific strategy to promote Industry 4.0 or advanced manufacturing based on digitization and connectivity. However, in each relevant field, there are directions and strategies as disclosure policies, specifically: Directive No. 50-CT/TW, dated on March 4, 2005 of the Secretariat on accelerating the development and application of biotechnology for the national industrialization and modernization, Vietnam ICT development strategy to 2010 and orientation to 2020; Strategy for the development of Science and Technology for the period 2011-2020 with the identification of priority fields including: ICT, biotechnology, new material technology, machine manufacturing technology—automation; and the Industrial Development Policy is under interpretation.

However, from the experience of some of the countries described above, Vietnam needs:

- Firstly, overcoming the ideology of fear of innovation, the fear of shifting production to smart, digital production because of fear of social changes due to unemployment. This is what developed economies take for granted (either innovate or die), but in Vietnam, this issue should be of primary concern to most domestic companies. It should also be emphasized that business is at the heart of the national innovation system.
- Second, concretizing strategic directions into programs (such as the US, Germany, China and other countries) to focus on key investment in research and

implementation for 4.0 infrastructure-related issues such as Big Data, Digitalization, IoT, IoP Connection, Smart Production (smart production), Internet Connecting Services (IoS), etc.

- Third, fully mobilizing (to threshold) resources for the effective implementation of the above planned programs. It is important to pay attention to the effectiveness of programs by limiting the goals (technologies and products that prioritize development, innovation) to avoid spreading resources.

- Fourth, building a start-up ecosystem to encourage innovation and creativity and form a system of start-up businesses, especially in high-tech fields such as automation technology, information technology biotechnology, etc.

- Fifth, training and retraining human resources for the implementation of the Revolution 4.0. Revolution 4.0 will not accept cheap labour as a priority advantage. Therefore, the training and re-training of human resources in the direction of the development of Revolution 4.0 is very necessary for our country. It is no coincidence that in the native Silicon Valley of the United States, formerly a complex of textile and apparel companies, is now a network of high-tech enterprises.

5. Conclusion

Industry 4.0, like any revolution, is an irreversible trend. The whole world is in that process and Vietnam can not stay on the side line. The experience of 10

countries selected as the above case study clearly shows that. Whether it is a developed or developing country, it is aiming to take advantage of the 4.0 Revolution for its sustainable development goals. To do that, these countries all plan policy solutions to promote industrial development 4.0 by building specific and advanced NC-TK programs, mobilizing resources up to threshold for effective implementation. Vietnam is a latecomer, but a follower also has strengths: it is the choice to avoid mistakes and the right to “stand on the shoulders of giants”—the right to exploit the results of the predecessors. With a tectonic government shifting from a commanding role to conduct a coordinated role by the policy system, Vietnam will have a position in the 4.0 revolution and in a few specific areas that can rise ahead.

References

- [1] Hermann, M., Pentek, T., and Otto, B. 2015. “Design Principles for Industrie 4.0 Scenarios.” Working paper.
- [2] <https://vi.wikipedia>.
- [3] Roland Berger. “Only One-Tenth of Germany’s High-Tech Strategy, Deloitte, Industry 4.0.” <https://www.automation.com/en-us/articles/2014-1/industry-40-only-one-tenth-of-germanys-high-tech-s>.
- [4] <https://www.rolandberger.com>.
- [5] OECD. 2016. *Main Science and Technology Indicators*.
- [6] 2016. *Policy Department A: Economic and Scientific Policy, Study for the ITRE Committee*. February 2016.
- [7] Roland Berger. 2014. *Think Act Industry 4.0*.
- [8] Smart Nation and Digital Government Office. “Transforming Singapore through Technology.” <https://www.smartnation.gov.sg/>.