Impact of the fourth industrial revolution on the sustainability of Vietnam's economic development

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Abstract. The article explores the impact of the fourth industrial revolution on the sustainability of Vietnam's economic development. The focus is on the implementation of Industry 4.0 in Vietnam. The main indicators characterizing the fourth industrial revolution are analyzed in comparison with the "four new Asian tigers" - Malaysia, Indonesia, Thailand, and the Philippines. Based on the identification of the Industry 4.0 advantages and disadvantages in Vietnam, various aspects of its impact on the national economy are evaluated. The necessity of continuing the implementation of Industry 4.0 on the basis of overcoming the identified shortcomings of the process of its implementation in Vietnam is substantiated.

1. Introduction

The concept of Industry 4.0 has become very popular today and is often mentioned in political program documents in many countries around the world. The majority of countries try to achieve sustainable development, but industrial revolution 4.0 has affected the economy, society and environment primarily in developing countries [1]. On the one hand, industry 4.0 leads to positive changes in sustainable economic development. Revolution 4.0 provides for a breakthrough in the economic growth due to better productive capacity and resource saving [2]. As science and technology develop, production tends to shift towards the green economy. Digital information technologies have a positive effect by improving management, administration and operating efficiency for the management of the economy, society and environment leading to time, labor and financial savings.

At the same time, Industry 4.0 has created many economic, social and environmental problems. Adverse effects of revolution 4.0 include social and labor inequality, unequal access to public services for senior citizens [3], ethical degradation, aggravating problems related to sustainability of industrial enterprises of different technological levels [4], invasion of privacy, information security and state secret threats. Globalization and international integration are spreading more and more and many technical barriers arise for less-developed countries. Countries which will correctly assess their potential and make development plans to implement Industry 4.0 will be able to grow rapidly, otherwise they will lag behind, which will be hardly amendable.

According to the Global Competitiveness Report 2017-2018, Vietnam is ranked 55th (out of 137 countries) based on its global competitiveness index [5]. The abundance of human resources and the big domestic market (the country is ranked 31st out of 137 countries based on those indicators) are, on
the one hand, beneficial for the growth and expansion of the national economy but, on the other hand, are harmful for sustainability. Vietnam faces such problems as high demand for energy, depletion of natural resources and pollution of the environment. Industrial revolution 4.0 is the only way to the sustainable development of Vietnam. Decision No. 432 / QD-TTg of the Prime Minister of Vietnam on the approval of the Sustainable Development Strategy of Vietnam for 2011-2020 announces sustainable development as an important strategic objective of the Communist Party of Vietnam [6].

This paper aims to analyze the status of the Industry 4.0 concept implementation in Vietnam, evaluate its impact on Vietnam’s economic sustainable development, identify advantages and disadvantages of the Industry 4.0 development and give recommendations on how to improve the Industry 4.0 implementation process.

2. Methods

The research is based on the analysis of Vietnam’s Industry 4.0 indicators and their comparison with the indicators of the “four new Asian tigers: Malaysia, Indonesia, Thailand and the Philippines according to two international reports: Insight report the Global Competitiveness Report 2017-2018 [14] и Readiness for the Future of Production Report 2018 [12]. SPSS correlation analysis methods were applied to assess the impact of Industry 4.0 on Vietnam’s economic sustainable development. Figures were mainly taken from the website of the General Statistics Office of Vietnam (https://www.gso.gov.vn). The following websites were used as additional sources: PwC’s Asia Pacific network (https://www.pwc.com/vn/vn/publications/vietnam-publications/industry40.html), The Viet Nam Provincial Governance and Public Administration Performance Index (http://papi.org.vn/eng/).

2.1. Status of the fourth industrial revolution in Vietnam

There are four industrial revolutions in human history, which have had a heavy impact on the economy [7]. Vietnam has gone through the second industrial revolution, construction of technological and social infrastructure, and the third industrial revolution, development of information technologies, automation and the Internet all over the country. In addition, Vietnam is actively implementing the fourth industrial revolution based on cyberphysical production systems and merging of the real and virtual worlds. The fourth industrial revolution has the following advantages in Vietnam:

Government pays special attention to Industry 4.0. It is evident as government supports the development of IT infrastructure and focuses on digital technologies, intellectual agriculture and tourism. Government investments in informatization and communication increased by 60% from 2005 to 2017 (from 9,003 billion dong to 14,277 billion dong) [8]. It should be noted that government investments in professional, scientific and technological activities have increased by 700% for 12 years. While government investments in education increased by 360%. In addition, government invested a lot in the public sector IT infrastructure. The Vietnamese government thus actively supports innovations to promote Industry 4.0 in Vietnam.

In May 2017, the Prime Minister of Vietnam singed Instruction No. 16/CC-TTg “On Strengthening Access to the Fourth Industrial Revolution in Vietnam”. The Instruction sets forth the basic powers of public authorities when implementing the fourth industrial revolution [10]. The National Committee on Information Technology of Vietnam is responsible for consulting on strategic development and improvement of methods to create favorable conditions for the fourth industrial revolution in Vietnam. Vietnam thus has legal documents related to the implementation of industrial revolution 4.0 and provides for the decentralization of public authority powers in this respect.

Vietnam is highly determined to implement the fourth industrial revolution and Vietnamese citizens have high expectations about its results. The poll about Industry 4.0 conducted in Vietnam showed that 67% of respondents expected a significant impact of Industry 4.0 on their activities and 65% of respondents expected significant benefits and opportunities for their companies, careers and future [11].
Mobile user density in Vietnam exceeds that in other countries with similar income in the ASEAN. The number of Internet users in Vietnam reached 64 million in 2017 accounting for 67% of the population [12]. An increase in the number of mobile and Internet users is the first condition for the development of the cyberphysical production system [13]. According to the Global Competitiveness Report 2017-2018, all Vietnam’s indicators related to Industry 4.0 tend to grow [14]. The improvement of the education competitiveness, technological readiness and innovations provides for the development of the industry 4.0 infrastructure.

Although the fourth industrial revolution in Vietnam was rather successful at the foundation building stage, the implementation of Industry 4.0 has certain weaknesses. According to the report on the readiness to the future of production, Vietnam is in the lower group of countries with the moderate readiness to Industry 4.0. The overall readiness to industrial revolution 4.0 was assessed at 4.9 out of 10 [15].

To assess the implementation of the fourth industrial revolution in Vietnam, the main macroeconomic indicators of the country for 2018 were compared with the “four new Asian tigers”: Malaysia, Indonesia, Thailand and the Philippines. Table 1 shows the respective data.

**Table 1.** Statistics about Industry 4.0 in Vietnam, Malaysia, Indonesia, Thailand and the Philippines for 2017-2018

| Indicators                                      | Vietnam | Malaysia | Indonesia | Thailand | Philippines |
|------------------------------------------------|---------|----------|-----------|----------|-------------|
| Technology & Innovation 0-10 (best)            | value   | 3.1      | 5.9       | 4.0      | 4.6         | 4.0         |
|                                                 | rank/100| 90       | 23        | 61       | 41          | 59          |
| Technology Platform 0-10 (best)                | value   | 4.3      | 8.3       | 5.4      | 7.0         | 6.3         |
|                                                 | rank/100| 92       | 4         | 69       | 29          | 47          |
| Ability to Innovate 0-10 (best)                | value   | 1.9      | 3.4       | 2.6      | 2.1         | 1.8         |
|                                                 | rank/100| 77       | 30        | 44       | 63          | 85          |
| R&D expenditures % GDP                         | value   | 0.2      | 1.3       | 0.1      | 0.5         | 0.1         |
|                                                 | rank/100| 84       | 30        | 96       | 62          | 89          |
| Human Capital 0-10 (best)                      | value   | 4.5      | 6.5       | 5.0      | 5.0         | 4.6         |
|                                                 | rank/100| 70       | 21        | 55       | 53          | 69          |
| Future Labor Force 0-10 (best)                 | value   | 3.5      | 6.2       | 4.6      | 4.2         | 3.5         |
|                                                 | rank/100| 62       | 15        | 40       | 45          | 63          |
| Quality of the education system 0-10 (best)    | value   | 3.6      | 5.2       | 4.4      | 3.7         | 4.2         |
|                                                 | rank/137| 71       | 14        | 33       | 65          | 46          |
| Global Trade & Investment                      | value   | 7.0      | 7.4       | 5.1      | 6.7         | 4.5         |
|                                                 | rank/100| 13       | 7         | 61       | 20          | 69          |
| Institutional Framework 0-10 (best)            | value   | 5.0      | 6.6       | 4.6      | 5.0         | 4.4         |
|                                                 | rank/100| 53       | 30        | 69       | 51          | 76          |
| Future orientation of government 1-7 (best)    | value   | 3.8      | 5.3       | 4.5      | 3.8         | 3.4         |
|                                                 | rank/100| 43       | 7         | 23       | 45          | 68          |
| Sustainable Resources 0-10 (best)              | value   | 4.6      | 6.0       | 4.1      | 6.3         | 5.5         |
|                                                 | rank/100| 87       | 60        | 94       | 49          | 69          |
| Technological readiness 0-10 (best)            | value   | 4.0      | 4.9       | 3.9      | 4.4         | 3.8         |
|                                                 | rank/137| 79       | 46        | 80       | 42          | 83          |
Table 1 shows that Vietnam has the following disadvantages related to the fourth industrial revolution:

Vietnam’s competitiveness index remains low as compared with Thailand, Malaysia, the Philippines and Indonesia. The technology & innovation index equals 90/100, while Malaysia scored 23/100. Vietnam’s technology platform index is the lowest among new Asian tigers.

Vietnam does not have many human resources or educational innovations. Vietnam’s human capital is the lowest scoring 4.5 out of 10. According to its future labor force, Vietnam is ranked the 62nd out of 100 countries. The quality of the education system was assessed at 3.6, i.e. the 71st place in the list of 137 countries. R&D expenditures account for only 0.2% of GDP.

The quality of the institutional framework is also low. Future orientation of government was assessed at 3.8 on a 1-10 scale. The immaturity of the institutional framework in Vietnam is represented by the following indicators: low level of intellectual property protection (3.6/10), low efficiency of legal framework in settling disputes (3.4/10), low transparency of government policymaking (3.0/10) and low efficiency of government spending (3.3/10) [14].

Vietnam has a low level of technological readiness. Vietnam is ranked 112th out of 137 depending on its readiness to state-of-the-art technologies. The Philippines is ranked 73rd out of 137, although it has the lowest level of technological readiness among “new Asian tigers”. Vietnam is ranked low according to its firm-level technology absorption, investment capital and technology turnover as compared with the group of countries with similar socio-economic development.)

### 2.2. Industry 4.0 and sustainable economic development in Vietnam

Industry 4.0 is beneficial for the sustainable development of the Vietnamese economy [15]. Vietnam does not have any official statistics on the results of Industry 4.0, so it is possible to assess the impact of Industry 4.0 on the economic development by assessing the impact of changes in structural elements and features of Industry 4.0 on the sustainable changes in Vietnam’s economic structure.

An increase in investments in the manufacturing and processing industry, education, technologies and R&D is one of the signs of Industry 4.0 in developing countries. Table 2 shows the correlation between investments in Industry 4.0 and the national economy in Vietnam (correlation coefficients were calculated using SPSS).

| GDP (bill. dong) | Investment in Manufacturing and processing industry | Investment in Professional, scientific and technical activities | Investment in Education and training |
|-----------------|-----------------------------------------------|-------------------------------------------------|-----------------------------------|

Table 2. Results of the correlation analysis of the economic data of the Socialist Republic of Vietnam
The following conclusions may be drawn from the data shown in Table 2:
- There is a high correlation between the amount of funds invested in the development of Industry 4.0 and the size of the national economy of Vietnam. In particular, the Pearson correlation coefficient for GDP and investments in education and R&D is over 0.9, which indicates close correlation.
- The Pearson correlation coefficient for the GDP share of the manufacturing and processing industry and investments in Industry 4.0 (in the manufacturing and processing industry, education and technologies) is over 0.9. It means that Industry 4.0 has a big impact on the structural changes of the Vietnamese national economy and the development of the manufacturing and processing industry.

The incremental capital-output ratio, ICOR, was calculated to assess the efficiency of investments in Industry 4.0 depending on their impact on the national economy of Vietnam using the following formula:

\[
ICOR_t = \frac{(I_t / GDP_t) / p_{t+1}}{p_{t+1}}
\]

where \( t = 2006, 2007, \ldots, 2011 \), \( (t - \text{year}) \)

I – Investment for education and professional, scientific and technical activities
GDP - Gross domestic product
\( p_{t+1} \) - Gross domestic product growth rate in year t compared to year t-1.

The calculation is based on the data available at the website of the General Statistics Office of Vietnam [17]. Table 3 shows the results of the ICOR calculation.

**Table 3. Incremental Capital-Output Ratio (ICOR) from 2009 to 2017**

| Year | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|
| GDP * Bill dong | 2027591 | 2157828 | 2292483 | 2412778 | 2543596 | 2695796 | 2875856 | 3054470 | 3262548 |
| Investment in professional, scientific and technical activities * | 8101 | 9299 | 9318 | 11703 | 14640 | 19631 | 17860 | 19501 | 20342 |
| Investment in education and training* | 24308 | 23580 | 22256 | 25113 | 21541 | 32751 | 33526 | 39026 | 41942 |
| GDP growth rate | 5.4% | 6.4% | 6.2% | 5.2% | 5.4% | 6.0% | 6.7% | 6.2% | 6.8% |
| Investment in scientific and | 0.4% | 0.4% | 0.4% | 0.5% | 0.6% | 0.7% | 0.6% | 0.6% | 0.6% |
Table 3 shows that the share of investments in Industry 4.0 was rather small from 2009 to 2017. The low and stable ICOR means that the fourth industrial revolution has a strong impact on the economic growth in Vietnam. For Vietnam to develop its economy, it is necessary to increase investments in education, and scientific and technical activities.

3. Results and Discussion
The global economy has been going through the fourth industrial revolution during the last several decades [18]. Industry 4.0 has a multifaceted impact on the sustainable development of Vietnam. The government of Vietnam is making efforts to create favourable conditions and incentives for Industry 4.0.

The following conclusions were drawn from the correlation analysis of Vietnamese economic data from 1995 to 2017 and the calculation of the Incremental Capital-Output Ratio related to investments in industry 4.0 for 8 years:

1) the implementation of the fourth industrial revolution in Vietnam has a series of advantages: great attention from government; availability of legal documents related to the implementation of industrial revolution 4.0 and decentralization of powers of public authorities in the implementation of industry 4.0; commitment to Industry 4.0; and an increase in the number of mobile and Internet users;

2) there are certain weaknesses in the implementation of the fourth industrial revolution in Vietnam: low competitiveness index, limited human resources and educational innovations, low quality of institutions, and low level of technological readiness to industry 4.0.

4. Conclusions
The fourth industrial revolution is a strategic priority for Vietnam to create the sustainable economic development model. Industry 4.0 not only changes the size of the national economy and provides for the GDP growth, but also makes the structural transformation into the green and sustainable economy faster. In the future, the Vietnamese government will need to continue implementing Industry 4.0 by overcoming the above-mentioned weaknesses. To develop industry 4.0 in Vietnam, it is necessary to follow general recommendations stated in [19] - to strengthen the legal framework of Industry 4.0, to introduce incentive mechanisms and policies to encourage economic entities to conduct R&D, to apply and develop science and technology, especially high-tech technologies in production and business processes; to train high quality human resources and to develop the knowledge-driven economy – and, as it was proved above, it is advisable to increase amount of investments in Industry 4.0.

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