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Strategic Vision for the Implementation of the Industrial Revolution 4.0 in the Vietnamese Context

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Abstract. Vietnam has been in the process of modernization and industrialization for the last 40 years. Vietnam's socio-economic development strategies are in line with this vision. However, the country needs a sharper strategy to take advantage of the significant technological development and the IT boom, also known as the 4th industrial revolution or the industrial revolution 4.0. This research aims at identifying key factors that Vietnam should focus on for a comprehensive national strategy to develop within the industrial revolution 4.0. The research results help policymakers, researchers and managers establish a strategic vision for the economic development in Vietnam. A survey is conducted among 145 respondents who are either working for the Government, academic institutions, or managing enterprises. Findings of the research involve levels of awareness about industrial revolution 4.0 and the readiness for industrial revolution 4.0 in Vietnam. Moreover, three factors are also identified to be the key elements of a strategy for social-economic development in Vietnam, including human resources, policies, and infrastructure.

Keywords: 4IR; Fourth industrial revolution; Industrial revolution 4.0; Strategic vision; Vietnam

1. Introduction

The fourth industrial revolution (4IR) is breaking out dramatically all over the world. 4IR is at the first stage of its evolution, characterized by the application of advanced technologies such as 3D printing, biotechnology, new materials, automatic and robotic technologies, artificial intelligence (AI), etc.

This revolution is to optimize new processes and the operation of automatic production. 4IR is an opportunity and a stimulant for the promotion of Vietnamese industrialization and modernization (UNIDO, 2017).

The 4IR brings a huge challenge to Vietnam. The challenge lies in the swift shifting from an economy based mainly on natural resources and low labour costs to an economy of knowledge and advanced technologies (NCIF, 2016). It is believed that 4IR is happening globally more quickly than in any previous industrial revolution. It is supposed to change

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production and management all over the world. In the World Economic Forum (2018), Mr. Nguyen Xuan Phuc, the Vietnamese Prime Minister, said Vietnam is aware of the strong influence of 4IR. The Vietnamese should be the revolution's pioneer to become a revolutionized government. This Government will be fully capable of managing the country in the digital era (Hung, 2018).

As 4IR gives profound opportunities and challenges to the whole world (UNIDO, 2017, 2018) and this study seeks to identify what factors and to which extent they influence the Implementation of 4IR in the Vietnamese context. In doing so, researchers can identify opportunities and challenges that Vietnam might confront in its process of IR implementation. A successful research study could assist Vietnamese policymakers and business leaders in better identifying a strategic vision for social-economic development in the digital era.

2. Literature Review

2.1. What is the Fourth Industrial Revolution (4IR)?

Previous industrial revolutions have been characterized by the adoption of various techniques for production. A 4IR is developed from the Third with the digital revolution occurring in the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres (Schwab, 2015).

The 4IR is being approached from different perspectives, making it somewhat difficult to conceptualize. Therefore, researchers worldwide define the 4IR by identifying various elements to be the core of the 4IR. Klingenberg (2017) posed that the 4IR results from technical advances, economic scenarios, and demographic changes. It should be noted that technological advances do not necessarily mean new technologies (Scheer, 2015). Oguro (2016) claimed that AI, the Internet of things (IoT), and big data are core elements of the 4IR. These three elements comprised massive breakthroughs in IT, biotechnology or digital technology, smart mobile applications, AI, IoT, and intelligent production (Oguro, 2016; UNCTAD, 2016).

AI was created to enable computers to automize activities as intelligently as human beings. Specifically, AI helps human intelligence in actions that humans can do better than computers (Marr, 2018a). One Emerging technology is the Internet of Things (IoT), which may generate so-called "big data" that will be useful for business insight (Jonny et al., 2021). Specifically, AI enables computers to practice human-like critical thinking and communicate in human language. IoT happens when real stuff or a person's identification can be transferred or contacted through a network without direct person-to-person or person-to-computer interaction. IoT has evolved from the convergence of wireless technology, microelectromechanical technology, and the Internet. According to Feinberg (2022), “Data has become the most important asset of any organization and data and analytics are more critical than ever. New use cases for data to support machine learning, AI and analytics are endless. As the rate of change continues, embracing flexibility, agility and adapting to new challenges is a must”. Manufacturers are aware of Industry 4.0 trends due to the new technologies and the transformation of processes that require new competencies of employees and an integrated system (Chumnumporn et al., 2022).

According to Gaskell (2018), an enterprise or a system will be considered in industry 4.0 when meeting the following criteria: 1) Interconnected, referring to the close connection between applicants and human beings; 2) Transparent information. The system will create a copy of the real world; 3) Technology. The machine can make decisions, solve problems, and replace people to take over hazardous work; 4) Automatic simple decision-making. The machine can make simple decisions without human 'beings' interaction.

2.2. Barriers to the Implementation of 4IR

There are barriers that a country may face when starting the industrial revolution.

2.2.1. Insufficient Awareness of the Industrial Revolution (Level of Adoption)

Regarding the definition of 4IR, the awareness of the 4th of revolution starts from understanding the core concepts, namely AI, IoT, Big Data, robotics, and other advanced technologies. It also refers to the level of new technology adoption, the low level of which results in inefficient production (UNIDO, 2018). Insufficient awareness of IR is the first challenge. Technology will completely change how we live, work and enjoy. What is true today may no longer exist tomorrow (Marr, 2018b). The 4th of IR remains a new concept. All business models that fall outside of the 4IR will fail to be predicted by most experts in the world. Therefore, it is primarily important to build wide awareness before any strategic planning to prepare well for the 4IR (UNIDO, 2018).

A relevant concept to awareness is the readiness of 4IR. Research on readiness among Vietnamese enterprises is still limited. The readiness level of enterprises for 4IR has an interchangeable influence on industry policies toward 'enterprises' infrastructure investment thus, indirectly affecting the IR development process (UNDP, 2019). At the moment, few researchers have tested the critical relationship between IR readiness and 4IR Implementation as well as other independent factors. This results in the lack of adequate evaluation that prevents the Government from designing an efficient policy framework for 4IR development (UNDP, 2019).

2.2.2. Technology – Infrastructure Constrain

The advancement in digital technologies, comprised of AI, IoT, Big Data, and robotics… together with other technological development in material sciences, nanotechnology, and biotechnology, are forming the 4IR (UNIDO, 2018). Rapid technological advancements will profoundly affect future employment patterns, which yields challenges to the labour market, especially in developing and under-developed countries (UNIDO, 2018). According to Le (2017), it is vitally important that businesses which should not be considered a strategy but the core of the business. Particularly, technological advances voiced concerns about the impact that technological advances will have on jobs, especially for developing and least developed countries.

The investment for infrastructure for 4IR involves all infrastructure elements including factories, applicants, data, machines, systems, etc. (Hung, 2018). Underpinning technologies of 4IR can help provide advanced input infrastructure (Bonilla et al., 2018). On the other hand, providing a capable infrastructural investment is also a big challenge for any country that wants to start the 4IR (Hung, 2018).

2.2.3. Challenges from Human Resources

Challenges from human beings are also critical. As governments do not see the long-term benefits of the 4IR, they have yet to put sufficient investment in developing a good policy system to nurture the revolution, such as tax policies, investment policies, or those policies encouraging research and development (Marr, 2018a). Meanwhile, businesses are hesitant to invest in development or hiring talented employees. Such assumptions are believed to hold them back or fall out of the fierce competition and, thus, serve as a barrier to IR implementation (Arnold, 2018). Various studies have researched the relationship between 4IR development and human capital (Gan & Yusof, 2019; Hassan & Ismail, 2018; Shamim et al., 2016; Agolla, 2018). However, few have mentioned the impact of human resources on the implementation speed of 4IR in the Vietnamese context.

2.2.4. Privacy and Information Security Issues

Challenges come from privacy and information security (Martin, 2017). The transparency of data and information, the accuracy and trustfulness of data, and the collection and storage of data in places without Internet are also questioned. Moreover, as organizations are working in such a critical environment of mandatory policies on data privacy and usage, data governance and supporting architecture have become long-lasting problems that constrain AI 'programs' development (Briggs et al., 2020).

2.3. Advantages and Disadvantages of the 4IR

2.3.1. Advantages of 4IR

Industrial revolution 4.0 brings many common benefits such as:

Faster production with less manpower; data are collected more sophistically; decisions are made more quickly; the ability to control the supply chain from raw materials to end consumers while ensuring equal quality among batches of products (Scheer, 2015). In addition, machine learning works more precisely when more detailed data are available to make better decisions. Butt (2020) believes 4IR will enable manufacturing to avoid wasting resources on surplus production and develop strategies for better managing the supply chain and production (Ghobakhloo & Fathi, 2019). In their research, Phaninee Naruetharadhol et al. (2022) proved the four-dimensional factor. centralization, knowledge management, technology transfer evaluation process, and networks support Open Innovation Implementation.

Individuals also benefit from the 4IR such as: doing less hands-on work, having more free time, or getting a higher salary if the labour force contributes their intellectual working abilities to shift their organization towards industrialization and modernization (Oguro, 2016). Thanks to the application of technology, people do not have to work in dangerous environments. This helps significantly reduce death and illness rates for workers. The decrease in occupational injuries and illnesses also reduces costs and increases organisation organization. In addition, thanks to IR, we can buy cheaper items (reduced business costs), with better and more uniform quality (made by machines). Besides, food sources or the living environment will be better controlled (Al-Zadjali & Ullah, 2021).

2.3.2. Disadvantages of 4IR

On the other hand, industrial revolution 4.0 resulted in several disadvantages.

There is a concern that the 4IR will break down the labour market as automatic systems will gradually replace manual labour. Robots will replace people in areas such as financial consultancy, banking, law, automobile engineering, operations, etc. When automation replaces manual labour, millions of workers will be unemployed (UNIDO, 2017).

According to Moore (2019), besides technology, human is also a huge challenge around the 4IR. Businesses must ensure that employees have the skills to cope with new technologies and working methods. If businesses invest in retraining programs and employees can flexibly adapt to changes, the 4IR will likely be a job maker. However, businesses can still see some resistance to changes among their employees.

2.4. The Practical Situation of the 4IR in Vietnam

The Vietnamese economy is facing many disadvantages due to the consequence of wars a few decades ago. The productivity is low, and the application of science and technology is considerably limited. In addition, no world-leading corporations have their base in Vietnam. The current production scale of Vietnam is still equivalent to the 1IR. With this low production level, it is not easy to jump toward the 4IR. 4IR requires a complete change in the way people live and manage to take advantage of the IoT and AI.

Suppose Vietnam cannot catch up with the fast-moving development of the world and region as soon as possible. In that case, it will face enormous challenges such as a lag in technology, a decline in production and business, or redundancy of low-skilled labour. In addition, if Vietnam is unable to catch up, it may face a wave of outdated technology transmitted from developed countries to developing countries.

According to Dione (2018), the technology itself is not enough to solve the problems. It is not simply about buying software or a piece of hardware; Vietnam will have a 4.0 Government. State managers cannot become a part of the 4IR if they are still stuck in the bureaucracy of the 1IR. He pointed out that the three most important elements in the promotion of the 4IR in Vietnam are technology, institutional, infrastructure, and people.

In addition, at the 4IR Forum held in Hanoi in July 2018, the concept of "researched and developed in Vietnam" was recommended to replace "Made in Vietnam". At the same time, data on internet users in Vietnam is quite impressive with 54% of the population, but 40% of internet users just access social networks. Vietnam ranks 11/11 compared to countries from the same region in digital applications (Table 1).

Table 1 Digital Application Ranking (Source: The World Bank's Development Report 2016 on Digital Dividends)

Rank	Overall Ranking	Financial Capital	Digital Products	Human Capital	Digital Community
1	Singapore	Australia	South Korea	Singapore	Japan
2	Australia	Singapore	Japan	Malaysia	Singapore
3	South Korea	Japan	Taiwan	New Zealand	Australia
4	Japan	Taiwan	Australia	India	India
5	New Zealand	Malaysia	New Zealand	Taiwan	South Korea
6	Taiwan	New Zealand	Singapore	Australia	New Zealand
7	Malaysia	India	Malaysia	South Korea	Taiwan
8	India	Indonesia	Vietnam	Indonesia	Indonesia
9	Indonesia	Thailand	India	Japan	Malaysia
10	Thailand	South Korea	Indonesia	Thailand	Thailand
11	Vietnam	Vietnam	Thailand	Vietnam	Vietnam

The long-term development of 4IR will closely require a well-structured legal framework of technological-supported policies, public policies, societal reactions, and environmental policies (Bonilla et al., 2018). According to the Vietnamese Minister of Information and Communication Hung (2018), the 4IR is more of a policy revolution rather than a technological revolution. One of the most suitable policy approaches for Vietnam in promoting the 4IR is to let it develop freely in the initial stage. The Government can have a good understanding of its nature and development trends. Stronger state management should be enhanced when the revolution is fully formed (Hung, 2018).

The literature review reveals that, besides human resources, other important elements that may significantly impact the implementation of the 4IR in Vietnam include the Vietnamese policies and the infrastructure (Hung, 2018; Dione, 2018). However, none of the existing research has tested and measured to what extent human resources, policies, and infrastructure elements affect the 4IR Implementation in Vietnam.

2.5. Research Framework

During the research process, we focused on analyzing three factors that directly impact Vietnam's strategic vision in the Implementation of the 4IR as shown in figure 1. Apart from that, Awareness and Readiness of 4IR were proved to have an indirect and critical relationship to the adoption of 4IR technology. They are also tested to see to which extent

they affect 4IR and/or alter the relationship between direct factors and 4IR implementation.

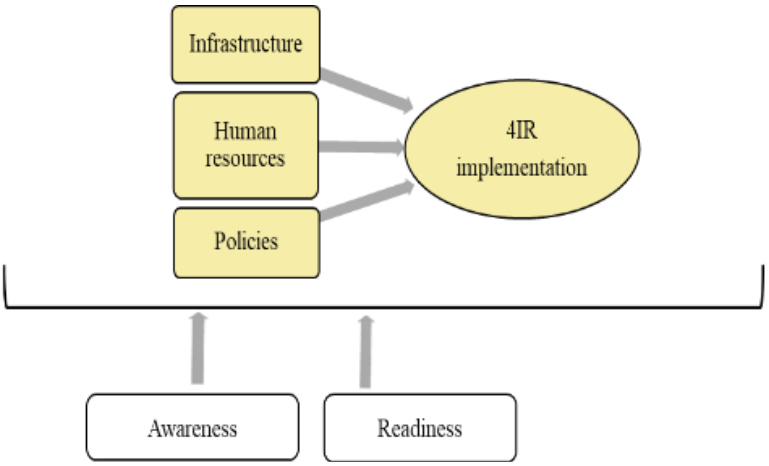

Figure 1 Research Framework adapted from Anh et al. (2019)

3. Research Methodology

This research studies the factors that directly and indirectly affect the implementation of the 4IR in Vietnam, including policies, human resources, and infrastructure (direct effects) and awareness of 4IR and readiness of 4IR (indirect effects). Descriptive and exploratory researches are the most appropriate methods to acquire insights relating to such a new concept of 4IR (Burns, 2017). Data was collected from two main sources. Primary data is collected through survey questionnaires with a sample of 145 people, including policymakers, business managers, and researchers. Precisely, most of the questions have been managed based on a five-point Likert scale. Based on the ' 'scale's measurement, a goodness of fit and multiple regression analysis was carried out to identify the relationship between the Implementation of the 4IR and the other three independent variables by using the statistical package for social sciences (SPSS 20) will be continuously employed in computing the coefficients. The sampling was targeted sampling using a list developed based on a database of frequent contacts of the Ministry of Finance. Whereas data collection for research also includes observation and recording during direct interviews with some managers and policymakers. Secondary data from the reports and studies are also used in this study.

4. Data Analysis

In Table 2, the adjusted R-square of the multiple correlation coefficient value indicates that the 3 factors can explain 74% of the variances associated with the 4IR. The F-statistics is also significant (F = 11.839), which confirms that all 3 variables collectively contribute significantly to the regression model's fitness and are statistically significant in explaining the variance of the 4IR.

Table 2 The Goodness of Fit

Dependent Variable	R Square	Adjusted R Square	F Change	Std. An error of the Estimate	Sig. F Change
Industrial Revolution 4.0	0.739	0.740	11.839	0.945	0.000

Model 1 in Table 3 shows the coefficients for the three 'predictors' variables with the 4IR as the base level. The significant value of the constant ($p < 0.05$) indicates that there is a relationship between the 3 factors and the 4IR ($p<0.05$).

Table 3 Results of Multiple Regression Analysis (H1, H2 & H3)

Independent Variable	t Test	Sig.	Unstandardardized B	Standardized Beta	Conclusion
Human resources	1.239	0.000	0.377	0.376	Supported
Policies	0.423	0.000	0.326	0.326	Supported
Infrastructure	2.756	0.003	0.170	0.170	Supported

4.1. Findings and Discussion

The research results show that most respondents have low awareness of the 4IR. Some have very little or no knowledge. Even though 80% of the respondents said that they use applications in their daily work and life, a negligible 3% of them understand the definition and possible impacts of the 4IR on socio-economic development. The majority (74%) of them have heard of the 4IR but lack a clear understanding. Additionally, 73% of the respondents do not know Big Data, IoT, or AI, while only 15% of respondents know the definition of Big Data. The proportions of respondents knowing the definition of IoT or AI are not larger than 7% and 8%, respectively. This finding supports arguments in existing journals that because 4IR is a relatively new concept, a large part of the world currently has poor awareness of this revolution and its key elements (UNIDO, 2017, 2018).

However, the sample of policymakers and enterprise managers are optimistic about the future improvement of 4IR awareness and adoption in Vietnam. When asked about the potential of robots replacing humans in 20-year time, 65% of participants are confident that humans will play a major role in all life and business aspects and that robots can replace humans in manual work only. Surprisingly, a group of respondents also believe that robots will replace humans completely (30%). Another 5% of the respondents think robots will never replace humans.

Table 4 Indirect and Critical Relationship Between Awareness & Readiness and the Adoption of 4IR Technology (H4&H5) (data from Vietnam Ministry of Finance)

Awareness	1	*What is 4IR?*			
		Heard about it, but not clear		74%	
		Limited knowledge		15%	
		Understand the concept but not clear about the impact		8%	
		Fully understand the concepts and the applications		3%	
	2	*Awareness about Concept*	Big Data	IoT	AI
		Know concept	15%	7%	8%
		Heard but 'don't understand	16%	20%	20%
		Never heard	69%	73%	72%
Readiness	3	*Technology Application in Daily Work and Life*			
		Regularly		80%	
		Do not use		8%	
		Unusual		12%	
	4	*Role of Robot in the Next 20 Years*			
		Robot can handle simple tasks		65%	
		Human being will be replaced by robot		30%	
		Robot cannot replace human being		5%	

The survey results show that all three factors including policy, human resources, and infrastructure are important to developing a good implementing strategy of the 4IR (R2 =

74%) in which, human resource is the most significant factor (B = 0.377). Respondents highly supported the statements given in the questionnaire, with a Mean value above 4. Factors including policy, human resources, and infrastructure directly impact the implementation of the 4IR in Vietnam.

Human resources, the factor with the highest beta (B = 0.377), has the greatest impact on the 4IR in Vietnam. Most surveyed statements relating to this factor were highly supported. It was strongly agreed that highly qualified human resources of the technological industries such as automation, data industry, are difficult to recruit in Vietnam"(Mean = 4.1). This is a very common problem in Vietnam and other countries, including those with the advanced automation industry.

It was highly supported that an advanced infrastructure is very important for Vietnam to integrate into the 4IR. The synchronization of infrastructure systems in different sectors will help Vietnam better prepare for 4.0has a high Mean value (4.4). It is also the case that 'Vietnam's infrastructure system needs to be invested more to meet the requirements of technology development (Mean = 4.2). This is the revolution of the synchronous combination of technology and machine based on applying software and machine learning.

The final factor is the legal framework, one of the barriers and also the conditions for the realization of Vietnamese modernization and industrialization. Most respondents agreed with statements regarding this factor, such as Policies supporting the development of IT help Vietnam better develop the domestic IT sector with Mean = 4.2; and Policies must be not only advanced but also practical for industries to be ready for the 4.0 revolution.

The study received a lot of positive feedback about the readiness of Vietnam in the 4IR. All countries around the world are at the same starting point; the 4th industrial revolution has not happened. Many respondents believe that Vietnam should take the lead in applying new technologies to industries (Mean = 4.1). This finding casts doubt on the existing research argument that up to 85% of Vietnamese enterprises of all sizes have low readiness for 4IR while only 13% of the enterprises serve as beginners of 4IR (UNDP, 2019). Research results confirm that it is currently challenging to develop a good strategy for Vietnam to participate in the 4IR. Many factors may affect this revolution process, such as technical infrastructure, high-tech workforce, policies, political environment, information security, human rights, and especially the G' 'Government's determination to integrate Vietnam into the global revolution of industrialization and automation.

4.2. Limitations of The Study

This research has some limitations. Firstly, the 4IR is quite a new concept in general. Indeed, the revolution has yet to happen officially. There might exist many unforeseeable factors that are not fully understood and measured. Consequently, it is impractical at this point to develop a generic model for Vietnam's industrial revolution process.

The second limitation is that the Vietnamese consumption and production cultures differ from those of developed countries. This is an equally important factor in making Vietnam one of the countries to join the revolution early.

Finally, the Vietnamese Government is still in the progress of forming a vision for putting the country into the 4IR. This revolution is not only related to the economy – science and technology but also to politics, security, human rights, and national resources. Therefore, the findings of this research are generic. They will serve mainly as important milestones for the Government to put on the map for the 4IR journey.

4.3. Recommendations for Future Research

As found in the literature review the three independent factors also impact one another. Specifically, the convergence of technologies at IR level 4 requires supportive

innovation and other policies. Meanwhile, underpinning technologies can help provide advanced input infrastructure. Apart from that, many countries are focusing on supportive innovation and environmental policies to optimize the infrastructure by 4IR (Bonilla et al., 2018). Furthermore, technological advancements significantly affect future patterns of human resources management, which put pressure on the current labour force and education (UNIDO, 2018). As a result, future research should focus on a broader image in Vietnam of how such independent factors as Policies, Human resources, and infrastructure affect one another and, thus, alter their impact on 4IR advancement. It is also important to add the technology factor to the research model as the factor was found to have a moderate effect on the relationship between independent factors as well as between the 4IR Implementation and independent factors (Arnold, 2018; Bonilla et al., 2018; UNIDO, 2018).

Moreover, given the research limitations, future research should take a deeper look into the impact of the 4IR on Vietnamese production. The study should measure the strong influence of machines on Vietnamese production activities. There should be a comparison of the ' 'IR's effects on the Vietnamese economy and society with that of other countries in the region, such as Singapore, China, Thailand, or developed countries, namely the UK and the US.

Secondly, future research should test the negative and positive impacts of the 4IR on Vietnamese social and economic elements, social impact, information security, and the young labour force. It is also interesting to study how the Vietnamese Government should prepare for the 4IR. This includes analyzing the policy and mechanisms that support the state management and enterprises with increasing investment in high technology. Especially enterprises that apply automatic production to bring high economic value to Vietnam. Besides, it is necessary to focus on transparency and database management, as this will be a very sensitive issue related to national security, human rights, and ethical factors.

5. Conclusions

Similar to the global situation, the Vietnamese development of 4IR is perceived as significantly influenced by the G' 'Government policies system, people, and infrastructure. Moreover, the next generation of IR remains a new concept that arouses low awareness and readiness for Implementation. However, this study reveals an optimistic attitude, among policymakers, researchers, and enterprise managers, toward the rapid readiness and adoption of 4IR in Vietnam. To do so, more profound research should be done on the topic of 4IR in Vietnam. This research serves as a prerequisite for future research on the IR topic. The research findings open a broader picture of potential areas and study more factors to explore more elements that impact the practice of the next generation of IR in Vietnam. The study results help Vietnamese policymakers and business managers better establish strategic planning for social-economic development in the digital era.

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