



Chapter 8

New Wave of Digital Transformation, Industry 4.0, and Innovation

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1. Introduction

Viet Nam has been one of the most successful countries in aggressively utilising the mechanics of international production networks (IPNs) (Ando and Kimura, 2005) or the second unbundling (Baldwin 2016), and accelerating its industrialisation. Although the country started with low-income status, it abandoned the old import-substitution development strategies in the 2000s and boldly engaged in freer trade and investment to fully utilise the forces of globalisation. As a result, it has become an important player in global value chains (GVCs). The next step will be challenging, though. While the links with the world economy have become very tight, the formation of domestic industrial agglomeration is delayed, and ample room remains for the enhancement of innovative capabilities to graduate from simple labour-intensive operations. It is now crucial to think of the accelerated deployment of new technologies, particularly digital, to upgrade the development path of industries.

Over the past decade, the world has witnessed rapid progress of the Fourth Industrial Revolution (4IR), which has brought breakthroughs in various fields – from biotechnology to 3D printing and digitalisation. The application of 4IR technologies has fundamentally changed people's lives, consumption patterns, and business and production methods across the globe. Typical examples include production lines assumed by robots, artificial intelligence (AI) replacing humans in handling simple to complex tasks, chatbots advising consumers before making purchases, or the Internet of Things (IoT) connecting people and machine systems in factories. 4IR progressively transforms the source of competitive advantage from business size to speed of innovation.

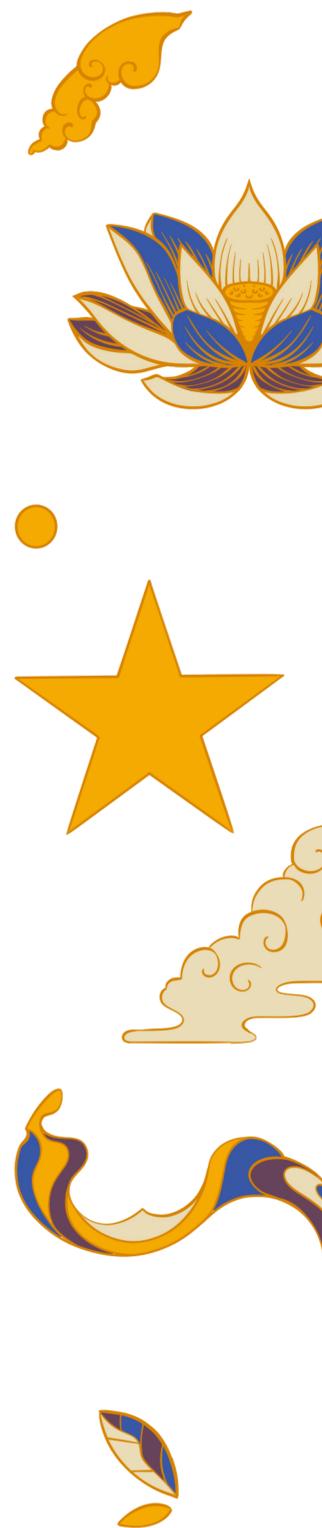
Digital transformation plays a crucial role in 4IR. Indeed, digital transformation has become a new priority for all countries. The already vast literature has shown the potential of the digital economy and digital transformation (e.g. Google, Temasek, and Bain, 2021; 2022; Cameron et al., 2019; Alpha Beta, 2021; APEC, 2019). Well before 2020, digital transformation had started in various business areas. The coronavirus disease (COVID-19) outbreak in 2020 compelled all economies to accelerate the pace of digital transformation. Rather than limiting their actions to domestic policy efforts, economies promoted international cooperation on the digital economy. Various economies have embarked on digital economy partnership agreements. Meanwhile, a range of cooperation initiatives has proliferated in areas such as online dispute resolution of cross-border business-to-business disputes, e-commerce, and paperless trading.

Since 2016, long-term economic growth in Viet Nam has been slowing, as its traditional growth paradigm – relying on expanding production factors (such as land, labour, and capital) – almost reached capacity. Searching for new drivers of growth thus becomes imperative. Viet Nam has promoted innovation and digital transformation to boost economic growth. By 2020, it had attempted to popularise various information technology (IT) applications such as e-commerce platforms, ride-hailing apps, and e-wallets linked with domestic banks. Viet Nam also started deploying 5G networks, and licensed two telecom companies – Viettel and MobiFone – to pilot-test the 5G networks commercially.

Vietnamese policymakers acknowledge the potential to develop the digital economy. Notwithstanding its developing economy status, Viet Nam may not necessarily lag in the growth of the digital economy (CIEM, 2020). With the determination to digitise the economy, the Government of Viet Nam issued Resolution No. 01/NQ-CP dated 1 January 2020 'to research and establish legal frameworks, pilot mechanisms and policies, aiming to effectively address problems arising in practice in order to develop the digital economy'. Resolution No. 01/NQ-CP dated 8 January 2022 of the Government of Viet Nam set out the direction to 'promote development of e-commerce, digital economy and new IT- and digitally enabled business models'.

Even the COVID-19 pandemic could not divert Viet Nam's policy focus away from 4IR, digital transformation, and innovation. Instead, the disruptions of various economic activities based on traditional modalities compelled Vietnamese enterprises and government agencies to deepen efforts towards 4IR, digital transformation, and innovation. Along with the efforts of businesses, the government quickly issued various policy documents to strengthen institutional support for the digital economy and the digitisation of public service delivery. These initiatives started prior to 2020 but intensified during 2020–2022. The Prime Minister's decisions, such as No. 645/QD-TTg in 2020 on a master plan to develop e-commerce in 2021–2025; No. 749/QD-TTg in 2020 on a national digital transformation program to 2025, vision to 2030; No. 942/QD-TTg in 2021 on a development strategy for e-government moving towards digital government in 2021–2025, vision to 2030; and No. 411/QD-TTg in 2022 approving a national development strategy for the digital economy and digital society, are examples of such concerted efforts.

This chapter attempts to provide an overview of the new waves of digital transformation, 4IR, and innovation, as well as implications for Viet Nam. In doing so, it mainly adopts a qualitative approach, reviewing the traditional growth model led by the manufacturing



subsector, recent policies, and progress in promoting digital transformation, 4IR, and innovation. On that basis, the chapter makes some recommendations for accelerating digital transformation, 4IR, and innovation in Viet Nam.

The remainder of the chapter is structured as follows. Section 2 reviews the traditional manufacturing-led growth model in Viet Nam. Section 3 elaborates on the emerging trends of digital transformation, 4IR, and innovation as future drivers of growth. Section 4 summarises the key policies for selected sectors. Section 5 concludes with some recommendations.

2. Industrial Policy within Traditional Manufacturing-Led Growth Model in Viet Nam During 2000–2022

Viet Nam embarked on industrialisation policy decades ago. While the emphasis on industrialisation began even before the Doi Moi (Renovation), it was only since 2000 that the country's industrialisation policy became more focused on the manufacturing sector. It should be noted that the country also started phasing out trade barriers progressively in the 2000s. Viet Nam promoted economic restructuring between 2001 and 2005, with the goal of laying the foundation for industrialisation and modernisation. The policies, which were introduced by the Socio-Economic Development Strategy (SEDS), 2001–2010, primarily promoted the growth of the industrial sector. To help retain the domestic market, Viet Nam adopted a protection strategy with a focus on a range of industrial subsectors, such as the mining and oil industries, cement, metalworking, manufacturing, electronics, and the main chemical industries. Within domestic policy consideration, Viet Nam also made attempts to reform state-owned enterprises in key industrial sectors, including via such measures as sale, lease, assignment, and equitization, to make their operations more commercially competitive. The Socio-Economic Development Plan (SEDP), 2001–2005 also amended the industrial policy towards more emphasis on the growth of small and medium-sized enterprises (SMEs).

During this period, tariff policy changed considerably. On the one hand, Viet Nam started to include more products under its tariff schedule. Dinh and Nguyen (2006) showed that the number of tariff lines rose from 6,316 in 2000 to 10,682 in 2004. On the other hand, Viet Nam began to implement various tariff schemes under the most-favoured nation (MFN) track and the Association of Southeast Asian Nations (ASEAN) framework (Truong et al., 2011). As Viet Nam negotiated various free trade agreements (FTAs) under the ASEAN framework, its tariff levels decreased, but not drastically. The average MFN tariff on manufacturing products appeared to increase slightly during 2001–2005, though the effectively applied rate steadily decreased (Figure 8.1).

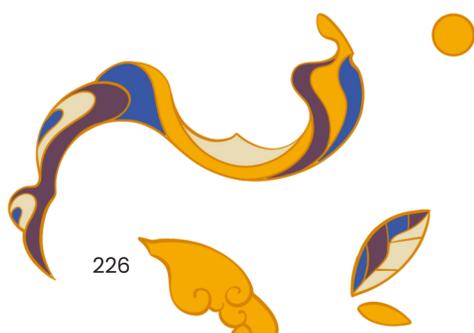
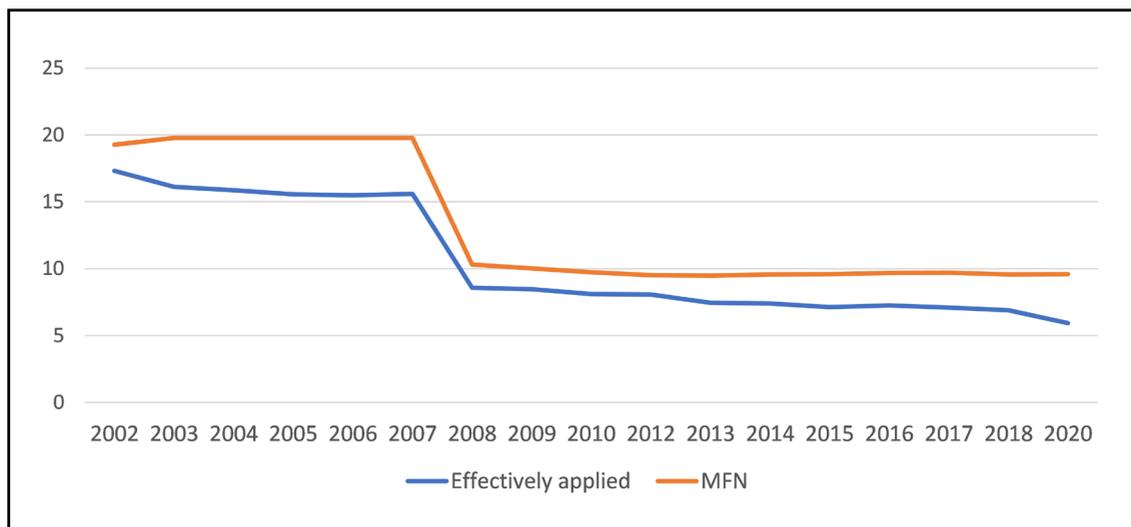


Figure 8.1. Viet Nam's Tariff on Manufacturing Products, 2002–2020



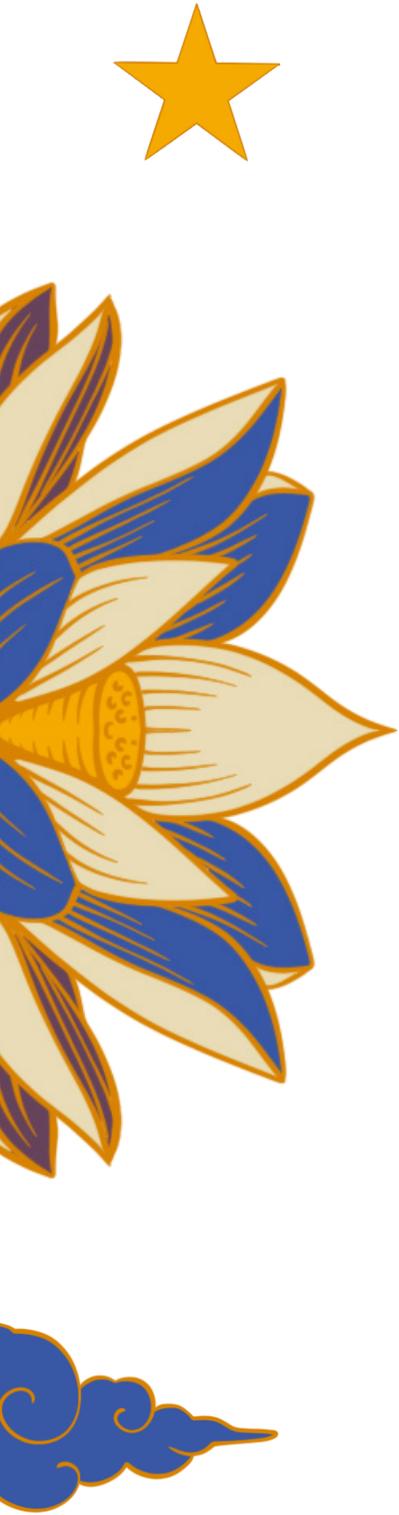
MFN = most-favoured nation.

Source: World Bank (n.d.), World Integrated Trade Solution (WITS). <https://wits.worldbank.org/> (accessed 28 February 2023).

The subsequent period (2006–2010) followed with Viet Nam's accession to the World Trade Organization (WTO) in 2007 – a major milestone in the country's economic integration process. Following the WTO accession, Viet Nam started to update or issue dozens of new development strategies for various industrial sectors, though the number of key identified sectors appeared to be overwhelming (CIEM, 2012). The mining industries started to grow more slowly during this period because the country shifted its policy focus towards protecting the environment and conserving natural resources. In contrast, despite increased competition following Viet Nam's WTO membership, the manufacturing sector continued to benefit from exploiting cheap labour. As a result, some labour-intensive businesses in subsectors such as textiles and garments, and leather shoes began to export more, albeit sourcing intermediate inputs and materials largely from imports rather than from domestic firms (Vo and Nguyen, 2006; Truong et al., 2011).

Additionally, Viet Nam started to pay attention, albeit to a modest extent, to policies and mechanisms that would improve service links for the supply chain, such as competition in the telecommunication sector, improvement of logistic services, and development of economic infrastructure. This enabled Viet Nam to take advantage of IPNs or the second unbundling. With a view to providing favourable location advantages for investment and for promoting agglomeration, the country made numerous attempts to modernise and enhance its industrial estates. As of 2010, Viet Nam had 260 industrial zones and 15 economic zones. Again, the number of economic zones was overwhelming, reflecting inadequate attention to promoting cooperation across provinces to attain economies of scale.

The tariff system has undergone substantial changes because of the more active economic integration efforts during 2006–2010. Following the adoption of FTAs such as the ASEAN–Korea Free Trade Area, ASEAN–China Free Trade Area, and Viet Nam–Japan Economic Partnership Agreement, and especially with the WTO accession, the applied tariff decreased sharply (Truong



et al., 2011). The MFN tariff was also lowered significantly from mid-2006. In general, Viet Nam is committed to lowering tariffs on a wide variety of goods, with some exceptions under the Exclusion List and Sensitive List. However, there are significant differences in the levels of tariff reductions across integration tracks and product categories. In general, the drop in tariffs for manufacturing products has been significant (Figure 8.1).

Other policy changes related to industrial development were also in place during 2001–2010. First, to facilitate trade and implement administrative changes, customs procedures were simplified and modernised with the goal of streamlining and eliminating intermediary steps and promoting automation (CIEM, 2012). In 2004, the Japan International Cooperation Agency began supporting Viet Nam’s customs reform and modernisation by implementing the Vietnam Automated Cargo Clearance and Port Consolidated System and the Vietnam Customs Information System. Second, to boost export competitiveness, the national currency was gradually depreciated, albeit to varying degrees over time. However, given the high dependence on imported inputs, exporters sometimes found it very stressful to have access to foreign exchange for their import needs. Furthermore, according to an empirical analysis by Truong et al. (2011), the nominal dong–United States dollar depreciation had negligible impacts on promoting exports. Third, Viet Nam offered preferential credits for exports, both in terms of the total amount and the interest rate, which were discontinued after the WTO accession. Fourth, Viet Nam worked on a few high-tech policies to encourage technological development and technology transfer from foreign direct investment (FDI). However, government expenditure on research and development (R&D) remained modest; the share of budget expenditure on science and technology decreased from 1.9% to 1.6% during 2006–2010 (Vo, Nguyen, and Dinh, 2018). Meanwhile, the spillover effects of FDI via technology transfer appeared to be less significant than forward and backward linkages (Nguyen, 2005; 2015). Fifth, Viet Nam started enforcing standards for food safety and environmental protection, aiming to promote more environmentally friendly products but at the cost of higher costs for industrial businesses. Finally, frequent increases in the minimum wage had a major impact on industrial firms’ payroll costs, especially those of labour-intensive businesses. Such salary increases, however, were not followed by a significant increase in labour productivity.

During 2011–2021, Viet Nam showed more serious attempts to renew industrial policy. In 2011, the government instructed different ministries to collaborate with the Embassy of Japan in Hanoi and Japanese business associations to develop a joint industrialisation strategy in the context of Viet Nam–Japan cooperation until 2020,

with a vision to 2030. Such a Joint Industrialisation Strategy, published in 2013, helped innovate the policymaking process in Viet Nam by following concrete steps, including a review of potential manufacturing subsectors in Viet Nam that attracted investment interest from Japanese investors. The process entailed the first formal effort to shorten the overwhelming list of key industrial sectors in Viet Nam. The participation of Japanese and Vietnamese business representatives at the meetings of the joint working group also contributed to improving the practices of consulting the private sector in Viet Nam's policymaking process. The Joint Industrialisation Strategy led to Prime Minister's decisions in 2014–2015 to approve the respective action plans to develop six sectors: food processing, agricultural machinery, electronics, shipbuilding, automotive, environmental, and energy-saving industry. Despite a good design and innovative process, these action plans did not receive much attention at the implementation level – nor was a rigorous review conducted to assess the progress (if any) of the approved action plans by the end of 2021.

Likewise, Viet Nam developed the Strategy and Master Plan for Industrial Development by 2025, with a vision to 2035 under Decisions No. 879/QĐ-TTg and No. 880/QĐ-TTg in 2014. The development of these policy documents was in parallel to the Joint Industrialisation Strategy, so it also benefited from inputs on key sectors. These decisions aimed for more focused industrial development towards higher productivity and value added, innovation, and exports. As an example, the Strategy for Industrial Development under Decision No. 879/QĐ-TTg set out the directions to (i) gradually alter the manufacturing growth model from being based mainly on quantity to being based on productivity, quality, and efficiency; (ii) accelerate the development of manufacturing subsectors and products with high added value and exports, to link manufacturing with the development of industrial services; and (iii) focus on the development of supporting industries, especially mechanical, chemical, electronic, and telecommunications products, to serve industrial production, and concurrently participate in the global production network, amongst others. Nevertheless, these decisions suffered from various shortcomings: (i) failure to secure resources for identified tasks; (ii) lack of adaptation to new contextual changes, especially since 2017 with evolving trends such as 4IR, digitalisation, and shifting of FDI; and (iii) failure to shorten the list of priority sectors.¹

While promoting targeted industrial development, Viet Nam no longer had tariff-based trade protection as in the previous decade. During 2011–2020, import tariffs decreased as Viet Nam engaged in various integration tracks. While the average MFN tariff on manufacturing products remained relatively stable, the

¹ CIEM's review in 2011 showed that 40 industrial subsectors were prioritised or targeted. Even the Politburo's Resolution No. 23-NQ/TW in 2019 approved the direction to develop national industrial policy, rather than the focused and enforceable industrial policy itself.





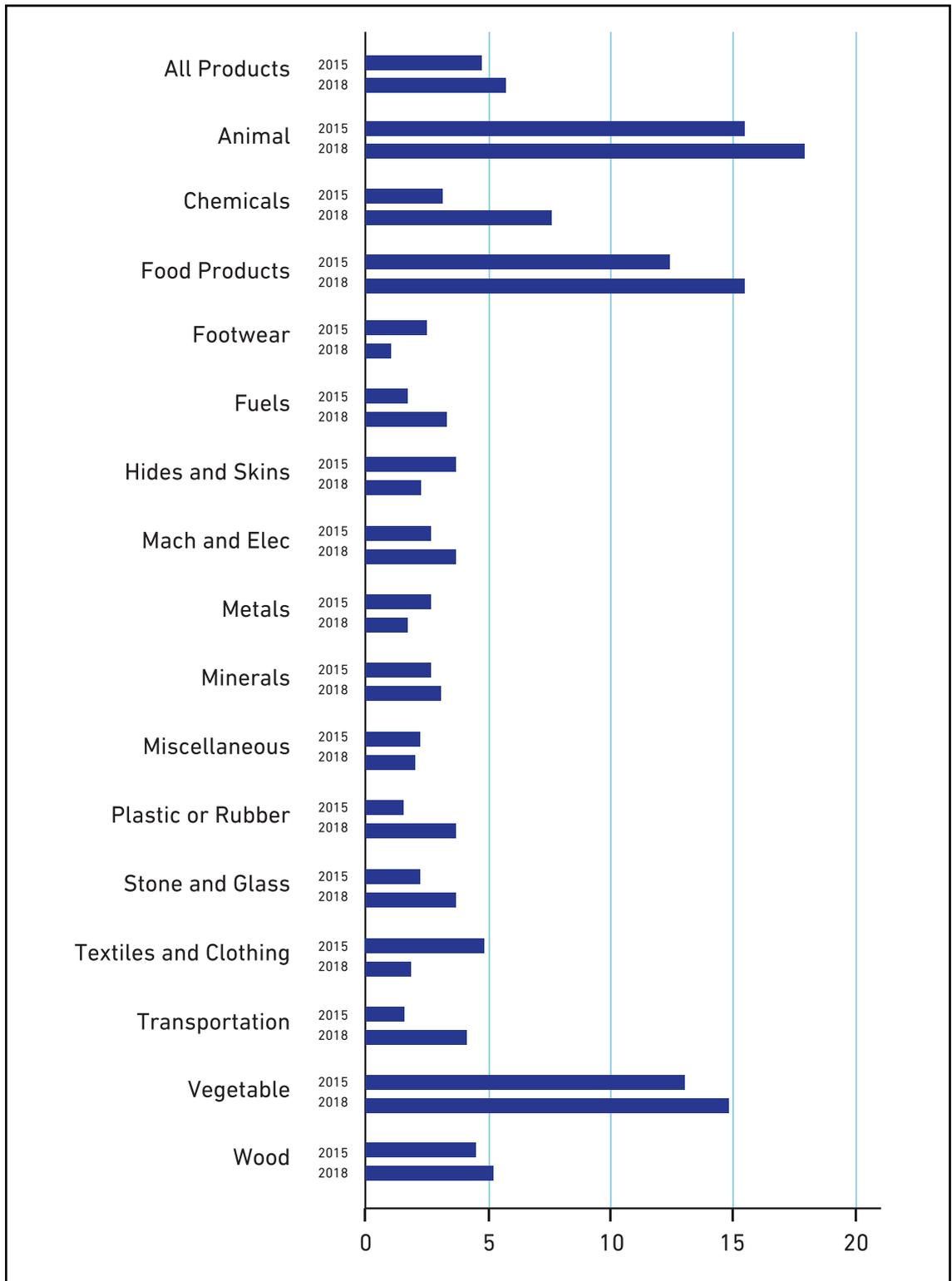
effectively applied tariff decreased further from the level after the WTO accession (Figure 8.1). The tariff reduction was even more drastic from 2019, as various tariff schemes were put in place under new-generation FTAs such as the Comprehensive and Progressive Agreement for Trans-Pacific Partnership and the European Union–Viet Nam FTA, as well as the Regional Comprehensive Economic Partnership in 2022. This was accompanied by trade facilitation efforts incorporated under Viet Nam’s business environment reforms via the series of Resolution 19 (during 2014–2018) and Resolution 02 (since 2019) of the Government of Viet Nam. Specialised inspections were simplified to facilitate imports of inputs and materials for export-oriented production in Viet Nam. The Authorised Economic Operator program also started in June 2013, enabling large manufacturing enterprises to cut down on trade costs.

These trends did not imply that Viet Nam fully liberalised its industrial sector during 2011–2020. Indeed, various studies have shown that Viet Nam increased the use of non-tariff measures since 2011 (Vo, Nguyen, and Tran, 2016; Nguyen et al., 2019) though most of them were presented as justifiable regulations for enhancing safety and other public policy purposes. The prevalence score appeared to rise in 2015–2018 on imports of selected manufacturing products, such as food products, machinery, and electronics (Figure 8.2). The most notable non-tariff measures were related to automotive imports, which arguably create some competitive advantages for domestic automotive assemblers vis-à-vis automotive importers.

Viet Nam also made more policy efforts to promote innovation in manufacturing. The country quickly issued development policies for 4IR from 2019 (with Resolution No. 52-NQ/TW of the Politburo).² In 2015, the government issued the first decree ever on promoting supporting industries, with explicit wording about ‘supporting industries’ and specific incentives for firms. The revised Law on Science and Technology, 2013 made way for science and technology firms to conduct business (Vo, Nguyen, and Dinh, 2018). Viet Nam also worked with major multinational corporations in the electric and electronics industries (e.g. Canon and Samsung) to establish and increase their presence in Viet Nam during 2011–2020.

² To be discussed in section 4.

Figure 8.2. Prevalence Score of Imports in Viet Nam, 2015 and 2018

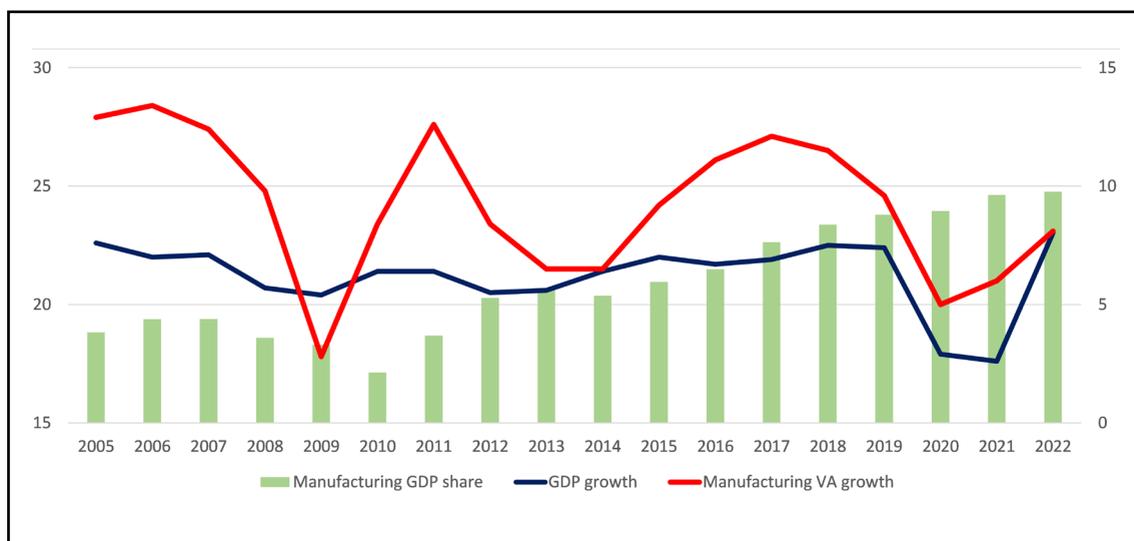


Source: Nguyen et al. (2019).

The manufacturing sector experienced almost continuous improvement in its gross domestic product (GDP) share during 2010–2022 (Figure 8.3). Manufacturing value added accordingly grew faster than the GDP growth rate. However, the technical capacity (and more broadly, innovative capacity) of Viet Nam’s manufacturing sector failed to be quickly upgraded. The sub-indicators of the Global Competitiveness Index show that Viet Nam’s capacity for innovation and companies’ spending on R&D failed to be significantly improved over time and vis-à-vis other countries (Table 8.1). The manufacturing enterprises were largely in positions with low value added in GVCs, seeking to exploit cheap labour and/or natural resources. This led to only steady growth of manufacturing value added, while the share of manufacturing in overall GDP failed to leapfrog (Figure 8.3).

More importantly, labour productivity in the manufacturing sector did not register a breakthrough during 2011–2020. Labour productivity growth decelerated from 11.4% per year on average in 2010–2015 to 6.4% per year on average in 2016–2020. A more recent survey showed that Vietnamese firms remain in the incipient stage of adopting 4IR technology, such as cloud computing for business tasks (by 6.9% of surveyed firms), robots (1.8%), and 3D printing (5.9%) (Cicera et al., 2021). Another survey-based assessment by the United States Agency for International Development (USAID) and Agency for Enterprise Development (2023) showed that only 2.2% of surveyed firms have mastered technology and management software for data analysis, while 48.8% of firms discontinued a digital application they once deployed during the COVID-19 period.

Figure 8.3. Performance of Manufacturing Sector, 2005–2022 (%)



GDP = gross domestic product, VA = value added.

Note: Growth rates are indicated on the right-hand axis.

Source: General Statistics Office. <https://www.gso.gov.vn>. (accessed 28 February 2023)

Table 8.1. Innovation Sub-Index of Viet Nam in the Global Competitiveness Index, 2010–2018

Item	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Ranking out of	139	142	144	148	144	140	138	137
12th pillar: Innovation	49	66	81	76	87	73	73	71
Capacity for innovation	32	58	78	86	95	81	79	79
Company spending on R&D	33	52	75	59	63	57	49	46
Score (1–7)								
12th pillar: Innovation	3.4	3.2	3.1	3.1	3.1	3.2	3.3	3.3
Capacity for innovation	3.6	3.2	3.0	3.4	3.5	3.8	4.0	4.0
Company spending on R&D	3.6	3.2	3.1	3.2	3.2	3.3	3.5	3.6

R&D = research and development.

Note: In 2018, the World Economic Forum introduced the Global Competitiveness Index 4.0 with different methodology.

Source: World Economic Forum, Global Competitiveness Index database. https://www3.weforum.org/docs/GCR2017-2018/GCI_Dataset_2007-2017.xlsx (accessed 28 February 2023).

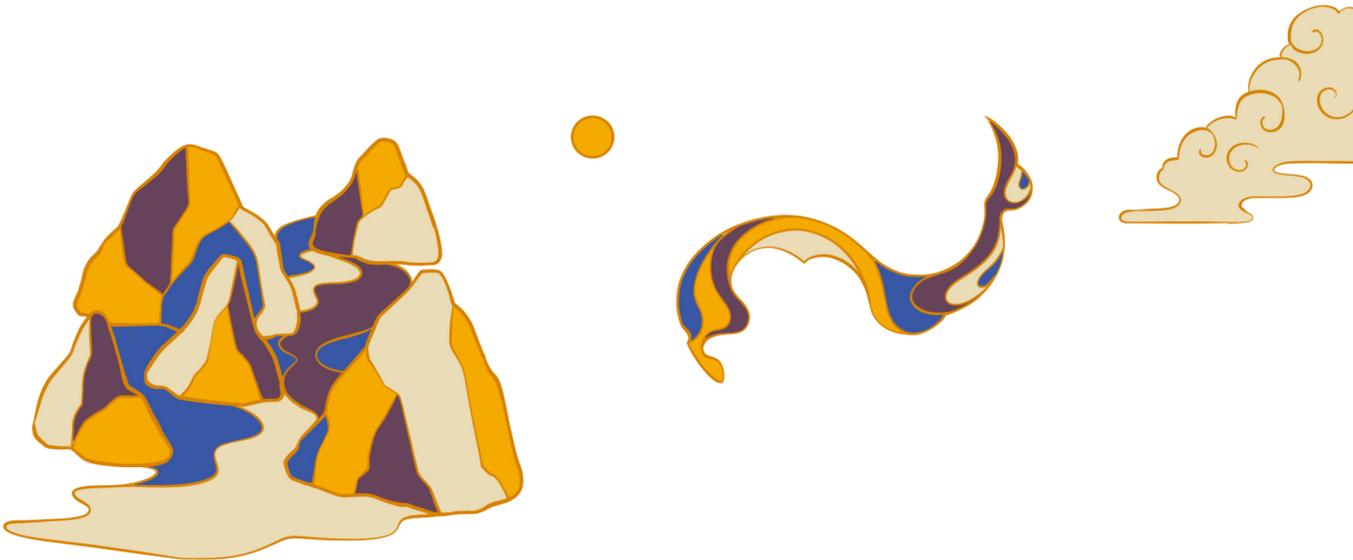
Various studies (Ohno, 2003; Dapice, 2003; National Economic University and Japan International Cooperation Agency, 2003; Vo and Nguyen, 2006) have shown Viet Nam's industrial dualism in recent decades. This could be attributed to the industrial and trade policies that Viet Nam had pursued for decades before the WTO accession. On the one hand, export manufacturing firms, especially foreign-invested enterprises (FIEs) and some domestic private firms, form the sectors that are globally competitive. Major large private corporations such as THACO and Vingroup have been making efforts to build up manufacturing capacity with export orientation. On the other hand, import-substituting firms, especially state-owned enterprises and some FIEs, are weak and protected.

No concrete microdata-based assessment of Viet Nam's industrialism has taken place since 2005. However, using data for 2006–2016, UNIDO (2019) showed that Viet Nam suffered from an almost fivefold increase in trade deficits in automotive, engines, and spare parts, reflecting inadequate participation of domestic producers in GVCs, and that the textile and garment, and shoe leather sectors still source significant inputs from imports for their export-oriented production. This led to the risk of disruption in the face of major economic health shocks. Indeed, during the



outbreak of the COVID-19 pandemic in the first half of 2020, various exporters in Viet Nam in such sectors as textiles and garments, and electronics encountered disruption of import activities.

Notwithstanding a range of FTAs that work to reduce various tariff and non-tariff barriers to trade, Viet Nam still considered the model of special economic zones (SEZs). This reflects an attempt to replicate the model of Shenzhen, China (Box). However, the proposal for a law on SEZs did not gather sufficient consensus for approval in 2018. Still, Viet Nam may have potential to promote agglomeration in manufacturing with the adoption of digitalisation. Such potential may be attributed to several factors. First, Viet Nam has been explicitly and progressively prioritising industrial upgrading and digitalisation.³ Second, Viet Nam continues to appeal as an investment destination to foreign investors, especially in high tech. Third, Vietnamese stakeholders became increasingly aware of the importance of digital transformation to mitigate supply chain disruptions. Indeed, Vietnamese firms need support in almost all stages of digital transformation (USAID and Agency for Enterprise Development, 2023). Finally, Viet Nam issued various policies at the Politburo and government levels in 2022 to promote subnational economic linkages, including for industrial agglomeration.



³ To be discussed in Section 4.

Development Policy of Shenzhen, China

In 1979, Shenzhen was established as China's first special economic zone (SEZ). Before this, the city was a traditional fishing village with rich land resources and a border with the advanced economy of Hong Kong. The ability to adopt new institutional changes was one of the reasons for selecting the city (Zeng, 2010).

Shenzhen quickly became a megacity thanks to easy access to finance from Hong Kong. The city enjoyed the fastest growth in the country and was frequently referred to as China's Silicon Valley (Upton and Huld, 2022). More importantly, innovation became a key source for sustaining growth. Shenzhen had the largest research and development in Guangdong, reaching RMB80 billion or 4.1% of gross domestic product (GDP) in 2016 (Lin et al., 2019). Shenzhen, behind Shanghai and Beijing, is China's third-largest city by GDP as of 2021 (Upton and Huld, 2022).

Shenzhen has been transforming towards digitalisation. The city has offered testing opportunities for new digital business models (Zeng, 2010; and Lazic, 2019). By the end of 2021, the digital economy industries in Shenzhen attained value of more than RMB900 billion (\$134.5 billion), accounting for 30.6% of the city's GDP. Shenzhen's 14th Five Year Plan, 2021–2025 targets the core digital economy industries reaching 31% by 2025 – considerably higher than the national target of 10% (Upton and Huld, 2022).

The manufacturing sector continues to be a significant economic pillar in Shenzhen. Like other major industrial estates, Shenzhen experienced a slowdown in 2020 due to the coronavirus disease (COVID-19) pandemic's effects on business. However, the sector quickly recovered in 2021, with several manufacturing industries experiencing tremendous expansion, including new energy vehicles (173.9% year on year), industrial robots (60.5%), mobile phones (40.9%), and 3D printing (21.2%) (Upton and Huld, 2022). In this regard, manufacturing and innovation have jointly forged economic recovery in the city.

Source: Compilations from various sources.

3. Emerging Trends of Digital Transformation, Industry 4.0, and Innovation as Future Drivers of Growth

As Viet Nam aims to promote digital transformation and 4IR, it should consider and adopt major progress in technology trends. Such trends are emerging fast. Within its limited scope, this section provides an overview of selected key technologies/trends, such as AI, IoT, robotics/automation, additive manufacturing, and digitalisation of government. This provides information on the depth of digital transformation in Viet Nam.

3.1. Artificial Intelligence

AI has been emerging with a more profound, if not critical, role. This trend is well grounded in the rapid development of machine learning technology. As different methods of machine learning train computers to learn from and analyse data, and make predictions and inferences, with significantly improved accuracy, AI has received increasing attention regarding its potential to transform production and business activities with incredibly accurate outcomes. As a result, more money will be spent on AI research and applications in the near future. According to Davies (2022), work on AI is currently in the stage of artificial narrow intelligence, in which AI systems can perform a limited set of defined tasks, while slowly approaching artificial general intelligence – AI capable of reasoning as well as human beings.

In manufacturing, as AI has advanced, complicated jobs have been automated and previously hidden patterns in manufacturing processes or workflows have been discovered. McKinsey (2020) found that companies using AI have benefited from cost savings and revenue growth. Some 16% of those surveyed noticed a 10%–19% decrease in costs, whereas 18% saw a 6%–10% increase in overall revenue. Sales platforms and websites are increasingly reverting to chatbots to help boost their revenue. However, as computer thinking and reasoning are unprecedented, the evolution of AI is accompanied by several issues, such as ethical standards and integrity related to the development and use of AI or the legitimacy of content provided by chatbots during sales processes.

As Viet Nam aims to upgrade its manufacturing capacity by 2045, appropriate use of AI may be beneficial. For example, AI could help scan industrial products quickly to identify those failing to meet production standards. In another instance, as Viet Nam embarks on the target of net zero emissions by 2050, promoting sustainable production plays a critical role. AI could then play an important role in helping businesses achieve sustainability standards through better measurement, data collection, and calculation of carbon emissions. AI also helps to improve predictability and achieve greater supply chain resilience for businesses, such as predicting demand and correcting receipts in warehousing and routing of goods in transit. Such applications can also help improve the linkages between foreign-invested enterprises and local firms in Viet Nam, which enables the latter to participate in GVCs.

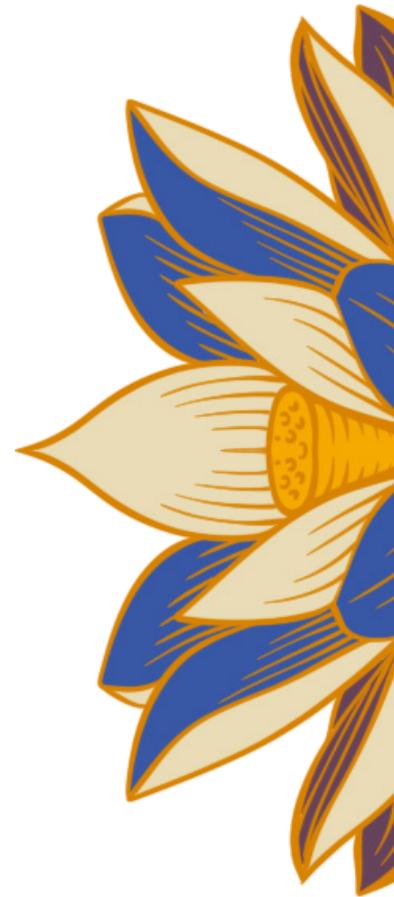
3.2. Internet of Things

IoT is defined as a network of connected computing devices, mechanical and digital machinery, items, animals, or people that may exchange data across a network without requiring human-to-human or human-to-computer interaction. The IoT ecosystem is made up of web-enabled smart devices that use embedded systems, such as processors, sensors, and communication gear. Such a system of devices gathers, sends, and acts on the data it receives from its surroundings. These gadgets communicate with other similar devices and act on the data they exchange. Although individuals can engage with the devices to set them up, give them instructions, or retrieve data, the gadgets can in principle accomplish most of the tasks in the absence of such support or instruction. IoT can also employ machine learning and AI to help make data collection processes simpler and more dynamic. As the number of connected devices grows, the IoT market value could rise at an exponential pace.⁴

Viet Nam's manufacturing sector could benefit from the IoT expansion. The IoT market in Viet Nam was valued at \$2.02 billion in 2019 and is projected to increase at an average annual growth rate of about 24.03% to \$7.3 billion by 2025 (Research and Markets, 2021). According to Cisco (2021), more than 50% of surveyed Vietnamese firms ranked IoT as one of the top three technologies that will have an impact on their organisations' digital future, and 36% of businesses have already started implementing IoT solutions. Areas that can benefit directly from IoT include supply chain optimisation, automatic remote management and surveillance of industrial devices, and predictive maintenance of industrial equipment.

3.3. Robotics/Automation

As 4IR technology emerges, the world is entering a new era of smart manufacturing. Such smart manufacturing can rely less on the physical labour force, as robots start to assume various activities in the traditional production system. The International Federation of Robotics estimated that 2.7 million industrial robots may have been working in industries around the world in 2020. Factories and industrial premises in North America ordered a record 29,000 robots during the first 9 months of 2021, rising by 37% year on year, due to challenges in recruiting staff (World Economic Forum, 2021). The use of industrial robots/automation may be enhanced by the parallel development of AI. Together, AI and robots/automation can allow manufacturers to



⁴ As of 2021, the number of connected devices had reached 12.2 billion (IoT Analytics, 2022, cited in Trong Dat, 2022).

cut labour costs dramatically while increasing overall manufacturing productivity and efficiency. Manufacturing processes, including difficult ones, may be automated. Such automation becomes more useful during health crises (such as COVID-19), reducing the risk of manufacturing disruption.

As Vietnamese manufacturers aim higher in GVCs, accommodating the rise of industrial robots becomes inevitable. Manufacturers in Viet Nam are increasingly aware that industrial robots not only assist industries to increase productivity but also address issues of worker safety and labour shortage. Manufacturing facilities can increase efficiency and product quality by using industrial robots. Some local firms have already started developing robot facilities. Further investment in robots is, however, constrained by such issues as limited infrastructure, underdeveloped supporting industries, and limited robot quality testing equipment (*Vietnam Investment Review*, 2020). More broadly, a key challenge for the country is how to adapt its labour skills to the future of work.

3.4. 3D Printing/Additive Manufacturing

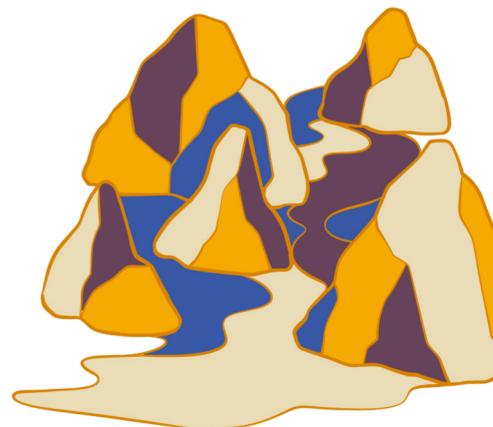
Additive manufacturing is defined as the process of joining materials to make parts from 3D model data, usually layer upon layer, according to ISO/ASTM 52900-15. Although the first patents were registered in the late 1980s, additive manufacturing has only experienced rapid growth since 2010. Significant development of innovative techniques using a range of new materials and offering exceptional advantages has been taking place, thus expanding additive manufacturing opportunities. Thanks to the advantages of time and cost savings, which shorten the product development cycle, additive manufacturing could contribute to transforming sustainable business models (Elhazmiri et al., 2022).

In Viet Nam, additive manufacturing has been applied, albeit still in the early stages. The development of domestic 3D printing technology is enabled by the emergence of high-tech industrial complexes. The Vinfast – An Phat Plastic Auto Part Co., Ltd.; Samsung Vietnam electronic industry complex; fashion footwear companies; large enterprises in the plastic industry; and automobile production complexes of Truong Hai (Thaco), Vinfast, and others have all gradually modernised and transformed themselves to join the supply chain of technical plastic products over the past few years. Most of these businesses focus on industrial 3D printing applications. Various industrial products, such as automotive, motorcycle, and electronic parts, made of technical plastics could already be produced using 3D printing in Viet Nam. Ample room remains for further application of additive manufacturing. Indeed, Viet Nam is considered amongst the countries applying the third wave of 3D printing (Cameron et al., 2019).

3.5. Digitalisation of Government

Digital transformation has been progressive, not only amongst corporate entities but also in the public sector. Governments around the world have deepened efforts to digitalise the delivery of public services. A McKinsey study (Manyika et al., 2013) estimated that government digitisation, using current technology, could generate more than \$1 trillion annually worldwide. Services, procedures, decisions, and data exchange are the four capabilities on which governments often focus their digitisation initiatives.

Facing the scarcity of recurrent budget, Viet Nam has been making efforts to control the expansion of staff on the government payroll. To ensure the quality of public services and the productivity of the public sector, the government has attached importance to its own digitalisation process. Viet Nam has built databases on population, enterprise, social insurance, etc., which can be used across agencies. During the COVID-19 pandemic, Viet Nam experienced greater demand for digitalising government to complement the digital transformation efforts of firms. Given that several public services are not yet provided online with good quality and/or complementary online payment, significant room remains for further digitalisation of government activities.



4. Selected Development Policies for Innovation in Viet Nam

Viet Nam has issued broad development policies for innovation, including at the sectoral level. Resolution 52-NQ/TW on 4IR of the Politburo in 2019 set out the vision to 2045 that Viet Nam will become one of the leading smart manufacturing and service centres, start-ups, and innovation centres in Asia; have high labour productivity; and be capable of mastering and applying modern technologies in all socio-economic, environment, national defence, and security fields. The resolution identifies the key policies to realise this vision.

First, Viet Nam will increase attempts to develop key infrastructure for digital transformation. Specific areas mentioned in the policy include deploying high-quality broadband nationwide; encouraging capable private enterprises to participate in building telecommunications and other infrastructure for the national digital transformation; building and developing the national data infrastructure synchronously; forming a system of national, regional, and local data centres with a synchronous and unified connection; investing in equipment systems for collecting, storing, processing, and protecting public data; building the national digital payment infrastructure and using the telecommunications network infrastructure to deploy payment services to people at a low cost; improving mechanisms and policies to promote cashless payments; and upgrading technical infrastructure to ensure network safety and security.

Second, Viet Nam will upgrade innovative capability by building and developing national innovation centres, focusing on core 4IR technologies; improving the efficiency of public investment in scientific and technological research; applying special mechanisms and policies to innovation centres; developing a national innovation system centred on enterprises, universities, and research institutes; adopting a system of national standards and regulations as a foundation for the application and development of core 4IR technologies in production; and enforcing a legal framework and system of policies to deploy and develop new technologies.



Third, Viet Nam emphasises the development of human resources for innovation and digitalisation. Policy will focus on reviewing and renovating educational and training content and programs to facilitate the accommodation of and adaptability to the constantly changing and evolving technological environment; innovating the way of teaching and learning based on digital technology applications; taking enterprise assessments as a metric for training quality; encouraging new models of education and training based on digital platforms; incentivising organisations, individuals, and technology enterprises to participate directly in the education and training process, and to create products for the digital economy; and building a number of excellent education and training centres in technology in the form of public–private partnerships.

Following Resolution 52-NQ/TW, the Prime Minister issued Decision No. 2289/QĐ-TTg in 2020 on the National Strategy for Industrial Revolution 4.0 by 2030. This decision identifies specific tasks towards developing infrastructure for connection, building, and using databases; developing human resources; transforming e-government towards digital government; upgrading national innovation capacity; performing research and development of priority technologies to participate in 4IR, such as robotics, AI, IoT, big data, and blockchain.

The idea of promoting innovation has also been concretised at the sectoral level. As a flagship project, during 2021 and early 2022, the Ministry of Planning and Investment prepared a project on circular economy development in Viet Nam. This project makes a rigorous attempt to distinguish the new circular economy evolution, which uses innovation and digitalisation amongst other technological advance, from the traditional circular economy projects that have been discussed for decades. In the project report to the Prime Minister, the Ministry of Planning and Investment elaborated on the viewpoints, targets, and tasks involved in developing the circular economy, including a proposal for a quick pilot mechanism of the circular economy in priority sectors, while amending policies and regulations for the circular economy in the medium to long term. On that basis, the Prime Minister issued Decision No. 687/QĐ-TTg in June 2022 approving the Project to Develop Circular Economy in Viet Nam.

Digital transformation has been a major priority in Viet Nam, with a series of action plans and measures. The Prime Minister issued Decision No. 749/QĐ-TTg in 2020 on the National Digital Transformation Programme, which aims to transform Viet Nam into a prosperous digital country that leads the application of new technologies and models. The basic targets include the development of digital government with enhanced efficiency, digital economy

development, and digital society development and bridging of the digital divide. The decision then sets out various measures to develop digital infrastructure and a digital platform, and cyber safety and security.

Decision No. 942/QĐ-TTg of the Prime Minister in 2021 focused on promoting digital government. The decision envisions that by 2030, Viet Nam ranks in the top 30 countries on global e-government and digital government development indexes, and that digital government fundamentally changes how citizens and enterprises are served. More importantly, the decision perceives data as a new resource, and emphasises the importance of related tasks, such as developing national digital data, sharing data, and protecting cybersecurity and cyber information security.

The Prime Minister then issued Decision No. 1968/QĐ-TTg in 2021 on IT applications and digital transformation in trade promotion during 2021–2025. The decision aims to establish a digital trade promotion ecosystem by 2025, which is to be upgraded by 2030. It also covers increasing trade promotion activities and related procedures completed via the trade promotion platform, establishing a related database, and connecting them to support trade promotion. Specific tasks include the development of a digital trade promotion ecosystem; education and training to improve awareness and skills for digital trade promotion; and cybersecurity in trade promotion.

In 2022, the Prime Minister issued Decision No. 411/QĐ-TTg approving the National Strategy for Development of Digital Economy and Digital Society by 2025 and Orientation towards 2030. The decision sets out two important visions, amongst others. First, digital development, with the creation of growth based on digital technology and digital data inputs, has become one of the new mainstream development methods for Viet Nam. Second, digital economy development makes people richer, contributes to Viet Nam overcoming the low average income level by 2025, reaching the high average income level by 2030, and achieving the high income level by 2045. Accordingly, the objective for a digital economy is to use digital technology and digital data as the main inputs, use the digital environment as the main operating space, and use information and telecommunications technologies to increase productivity, innovate business models, and optimise the economic structure. Decision No. 411/QĐ-TTg set out the key tasks related to improving the related institutions; developing infrastructure and digital platforms; and others related to digital data, cyber information security and cybersecurity, digital workforce, digital skills, digital businesses, and digital payments.

In 2021, the Prime Minister also issued Decision No. 127/QĐ-TTg on National Strategy on AI. The decision aims to promote research, development, and application of AI, making AI an important technology field in Viet Nam in

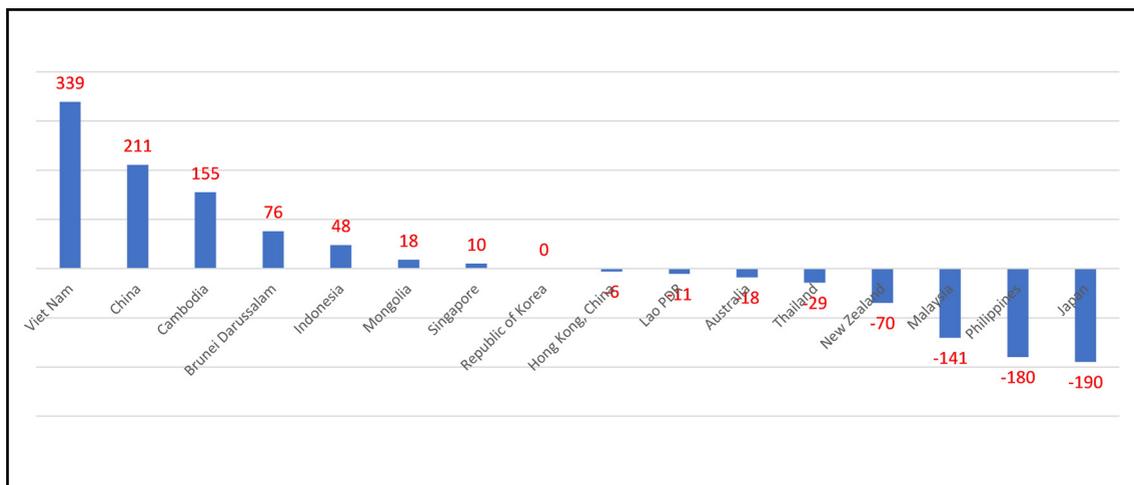


4IR. By 2030, the aspiration is for Viet Nam to become a centre of innovation and development of AI solutions and applications in the ASEAN region and around the world. The key tasks include improvement of specific regulations on AI, development of data and computing infrastructures for AI, and development of the AI ecosystem and applications.

Viet Nam also acknowledges the importance of building capacity for its enterprises to approach and benefit from innovation and digital transformation. The Law on Small- and Medium-sized Enterprises, and Decree No. 80/2021/ND-CP of the Government of Viet Nam in 2021 on the elaboration of some articles of the law, provide for different assistance to SMEs in terms of technology, information, counselling, and human resources development.

The above action plans and policies have improved Viet Nam's approach to adopting innovation and digital transformation. Ministries and provincial authorities have started to compete for higher rankings on the information and communication technology (ICT) index, e-government index, and digital transformation index, etc. This has been commended by the business community, especially during the COVID-19 pandemic. At another level, according to the European Center for Digital Competitiveness (2021), Viet Nam ranked first in East Asia and the Pacific in terms of the Digital Riser index (Figure 8.4). More importantly, when breaking down the result in the ecosystem and mindset dimensions, Viet Nam improved the most in both dimensions (compared with other economies in East Asia and the Pacific).

Figure 8.4. Digital Riser Index



Source: Redrawn from European Center for Digital Competitiveness (2021).



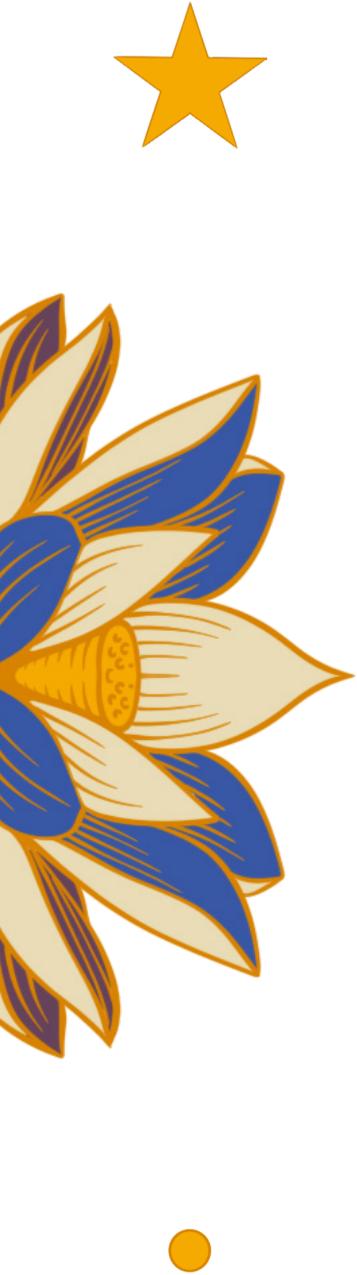
Still, Viet Nam needs to address several key issues/challenges in the future path to adopt 4IR, innovation, and digital transformation by 2045. First, the country needs to enhance policy consistency and coordination for both manufacturing and digital aspects. To do so, on the one hand, it needs to overcome the shortage of data, especially related to digital transformation of manufacturing activities. The Statistical Law was only amended in 2021 and, while adding indicators related to ICT, it does not touch upon the measurement of the digital economy. Besides, developing both manufacturing and digital aspects in targeted industrial estates (if any) must balance the need for adequate monitoring of and facilitation for business entities operating in those estates.

On the other hand, Viet Nam needs to adopt a whole-of-government approach in reviewing and amending policies related to 4IR and innovation. For instance, the development of electric vehicles could help induce digital transformation, including the development of digitally enabled platforms and services. However, long-term electric vehicle development may encounter a risk if government agencies do not identify/enforce complementary measures (e.g. the development of charging stations or retaining/increasing the environmental protection tax on the use of fossil fuels). Policy consistency by no means implies that innovation policies must remain unchanged over time. Instead, it is critical to ensure the adaptability of the legal framework to innovation, including new business models. In this respect, however, Viet Nam still ranks relatively low in the Asia-Pacific region, which affects its growth of innovative companies (Table 8.2).

Table 8.2. Adaptability of Legal Frameworks and Innovation Growth

Growth of Innovative Companies		Legal Framework's Adaptability to Digital Business Models	
APEC Economy	Score (out of 7)	APEC Economy	Score (out of 7)
United States	5.59	United States	5.68
Malaysia	5.19	Singapore	5.59
Singapore	4.98	Malaysia	5.20
Hong Kong, China	4.96	New Zealand	4.91
New Zealand	4.93	Hong Kong, China	4.69
Philippines	4.91	China	4.57
Indonesia	4.83	Canada	4.48
Taiwan	4.76	Indonesia	4.48
Canada	4.75	Australia	4.40
Australia	4.65	Republic of Korea	4.31
Japan	4.64	Japan	4.24
Thailand	4.56	Chile	4.09
Republic of Korea	4.54	Taiwan	3.93
China	4.43	Russia	3.89
Chile	4.18	Mexico	3.80
Viet Nam	4.09	Philippines	3.67
Mexico	4.00	Thailand	3.63
Russia	3.74	Viet Nam	3.59
Peru	3.65	Brunei Darussalam	3.15
Brunei Darussalam	3.60	Peru	3.04

Source: World Economic Forum (2019), compiled by TRPC (2020).



Second, Viet Nam may have to look seriously into the use of fiscal incentives to induce the adoption of 4IR, innovation, and digital transformation. Investing in innovation can be risky by nature; thus, fiscal incentives can help alleviate the difficulties for firms while promoting risk sharing between government agencies and firms in innovation. Moreover, Viet Nam must carefully weigh the impacts of a global minimum tax mechanism on attracting foreign big tech corporations. At the same time, the country needs to better justify the need to support IT companies, tech corporations, and start-ups in the new context, rather than exempting these entities from tax incentives just because they have made profits thanks to adaptation to times of volatility (e.g. the COVID-19 pandemic).

Third, developing a policy framework is just an intermediate step towards the goal of innovation. Indeed, government agencies do not follow through on the implementation of policies. For instance, hardly any actions were undertaken to promote IT application and digital transformation in export promotion activities in 2022 after Decision No. 1968/QĐ-TTg was issued in 2021. This could be attributed to poor ex ante impact assessments and public consultation related to the policy documents, and/or the inadequate allocation of resources to implement the tasks identified under such policy documents. In the absence of allocated resources, especially financial resources, a number of tasks may not be implemented.

Fourth, the policy content on international cooperation is still too general. Documents do not mention in sufficient detail the sectors and areas in which Viet Nam can cooperate with partners. Even regarding issues related to digital economy partnership agreements, cross-border data flows, and interaction between technology and security issues, the direction for international cooperation is yet to be clarified. Viet Nam should look back carefully to the experience of working with important partners in innovation-related issues. For instance, the experience of Viet Nam and Japan in developing the Joint Industrialisation Strategy during 2011–2015 shows that cooperation for innovation can take place at the process level (i.e. development of policy documents), the policy level (i.e. the policy documents), and the innovation activity level (i.e. the development of industries under the Joint Industrialisation Strategy).

Lastly, it is a smart move for newly developed countries such as Viet Nam to adopt a strategy for quickly exploiting the opportunities of disruptive innovation based on digital technology. In disruptive innovation, the deployment of technologies is relatively easy, and there is ample room for creative imitation with localisation, which enhances national welfare and provides opportunities for catching up or even leapfrogging. At the same time, in a longer perspective towards a fully developed economy,

Viet Nam should gradually but steadily build up its capabilities for incremental innovation that requires steady R&D investment in basic science and technology as well as raising up human capital in international collaboration.

5. Conclusions and Recommendations

This chapter is an attempt to provide an overview of how Viet Nam has been approaching 4IR, innovation, and digital transformation. The country embarked on industrialisation policy decades ago, emphasising the need to build manufacturing capacity alongside economic integration efforts. Nevertheless, its industrial policy under the traditional approach could not deliver breakthroughs as anticipated, due to the failure to secure resources for identified tasks, lack of adaptation to new contextual changes, and failure to shorten the list of priority sectors.

Given that background, Viet Nam appreciates the importance of new waves of 4IR, innovation, and digital transformation as inducement to renovate industrial policy. So far, the country has quickly issued various policy documents to ensure a timely approach to 4IR, innovation, and digital transformation, which has appealed to the business community. Still, Viet Nam needs further efforts to overcome challenges in its pathway to 2045, specifically related to policy consistency and coordination, appropriate use of fiscal incentives, momentum for policy implementation, and specific direction for international cooperation.

The chapter makes the following recommendations:

First, Viet Nam needs to improve the institutions for adopting 4IR, innovation, and digital transformation. This does not necessarily require the establishment of a focal agency responsible for all these issues; instead, a whole-of-government approach should apply to ensure policy consistency and synergy across innovation areas and those that can be transformed with innovation. More importantly, fostering public–private partnerships in innovation, including via proper acknowledgement of risk-sharing, would play a critical role.

Second, Viet Nam requires adequate attention to implementing the identified development policies for 4IR, innovation, and digital transformation, including by allocating sufficient time, personnel, and financial resources for implementation. A concrete long-term action plan, with specific regulations to be newly issued, amended, or abolished, is critical. Such an action plan must also be open to the possibilities of incorporating regulatory sandboxes in selected activities, such as fintech or the circular economy, as well as overhauling business entry conditions in innovation-related sectors.

Third, Viet Nam needs to review and popularise good domestic models at both the policy and business levels, for approaching and adopting 4IR, innovation, and digital transformation. Such models can serve as examples to convince stakeholders, including policymakers and potential investors, to work towards realising initiatives and taking advantage of opportunities from 4IR, innovation, and digital transformation.

Fourth, Viet Nam needs to invest in data collection and compilation to support the design, monitoring, and evaluation of innovation policy. Measurement of the digital economy, especially the digital transformation of traditional economic activities, should be an area of key effort. Measuring and assessing labour productivity in the digital economy presents another area of priority. Besides, Viet Nam requires research on readiness at the national, provincial, and sectoral levels for specific economically innovative models, those with potential to contribute to promoting subnational linkages; value chains; and innovation/digital transformation; and to improve labour productivity.

Finally, Viet Nam should closely monitor the digital divide between government and the business community, between large corporations and SMEs, between geographical regions, and between social groups. In doing so, Viet Nam may benefit from the shared experience of partners such as Japan. Only on that basis can Viet Nam identify and implement the necessary measures for inclusive and innovative growth.



References

- Alpha Beta (2021), *Unlocking Vietnam's Digital Potential: Harnessing the Economic Opportunities of Digital Transformation with Google's Contribution*. <https://alphabeta.com/wp-content/uploads/2021/10/vietnam-economic-impact-report-english.pdf>
- Ando, M. and F. Kimura (2005), 'The Formation of International Production and Distribution Networks in East Asia' in T. Ito and A.K. Rose (eds.) *International Trade in East Asia, NBER–East Asia Seminar on Economics*, Volume 14. Chicago: University of Chicago Press, pp.177–213.
- APEC (2019), *APEC Economic Policy Report 2019: Structural Reform and the Digital Economy*. Singapore: Asia-Pacific Economic Cooperation Secretariat.
- Baldwin, R. (2016), *The Great Convergence: Information Technology and the New Globalization*. Cambridge, MA: The Belknap Press of Harvard University Press.
- Cameron, A. et al. (2019), 'Vietnam's Future Digital Economy – Towards 2030 and 2045'. Brisbane: CSIRO.
- CIEM (2012), 'Industrial Development in Vietnam', Research Report for Japan International Cooperation Agency (April).
- CIEM (2020), 'Developing Digital Economy in Vietnam Post COVID-19: Requirements and Roadmap for Institutional Reform', Report for GIZ.
- Cirera, X., D. Comin, M. Cruz, K.M. Lee, and A.S. Martins-Neto (2021), 'Firm-Level Technology Adoption in Vietnam', *Policy Research Working Paper*, No. 9567. Washington, DC: World Bank.
- Cisco (2021), 'Phó chủ tịch Cisco: Ứng dụng IoT, doanh nghiệp hãy đi từ vấn đề của mình' (Cisco Vice President: To Apply IoT, Firms Need to Start from Their Own Issues). In Vietnamese.
- Dapice, D.O. (2003), 'Viet Nam's Economy: Success Story or Weird Dualism? A SWOT Analysis', Special Report Prepared for the United Nations Development Programme & Prime Minister's Research Commission. <https://www.undp.org/vietnam/publications/viet-nam%E2%80%99s-economy-success-story-or-weird-dualism-1>
- Davies, N. (2022), 'The Evolution from Artificial Intelligence to Machine Learning to Data Science', *KD Nuggets*, 10 AUGUST. <https://www.kdnuggets.com/2022/08/evolution-artificial-intelligence-machine-learning-data-science.html>
- Dinh, H.M. and A.D. Nguyen (2006), 'Vietnam's Import Functions (II)', PAIR-FTA-Vietnam Project, Report for the Institute of Developing Economies – Japan External Trade Organization.



Elhazmiri, B., N. Naveed, M.N. Anwar, and M.I.U. Haq (2022), 'The Role of Additive Manufacturing in Industry 4.0: An Exploration of Different Business Models', *Sustainable Operations and Computers*, 3, pp.317–29.

European Center for Digital Competitiveness (2021), *Digital Riser Report 2021*. Berlin.

Google, Temasek, and Bain & Company (2021), *e-Conomy SEA 2021 – Roaring 20s: The SEA Digital Decade*. https://services.google.com/fh/files/misc/e_conomy_sea_2021_report.pdf

Google, Temasek, and Bain & Company (2022), *e-Conomy SEA 2022 – Through the Waves, Towards a Sea of Opportunity*. https://services.google.com/fh/files/misc/e_conomy_sea_2022_report.pdf

Lazic, M. (2019), 'Digital Business Models in Shenzhen: The Silicon Valley of Hardware'. Kearney, 1 November. <https://www.kenarney.com/digital/article/-/insights/digital-business-models-in-shenzhen-the-silicon-valley-of-hardware>

Lin, X., B. Huang, J. Wu, M. Ge, and J. Lin (2019), 'Industrial Upgrading with Innovation Production Service System: Evidence from Quanzhou, China', *Procedia CIRP*, 83, pp.351–57.

McKinsey (2020), *The State of AI in 2020*. <https://www.mckinsey.com/business-functions/quantumblack/our-insights/global-survey-the-state-of-ai-in-2020> (accessed 6 January 2021).

Manyika, J., M. Chui, J. Bughin, R. Dobbs, P. Bisson, and A. Marrs (2013), *Disruptive Technologies: Advances that will Transform Life, Business, and the Global Economy*. McKinsey. <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/disruptive-technologies>

National Economic University and Japan International Cooperation Agency (2003), 'Vietnam's Industrialization Strategy in the Age of Globalization', 26 May. https://www.grips.ac.jp/forum/module/vietnam/main_en.pdf

Nguyen, T.T.A. (2005), 'Impact of FDI on Economic Growth in Vietnam'. Hanoi: Science and Technics Publishing House. Vietnamese and English.

Nguyen, T.T.A. (2015), *Đầu tư trực tiếp nước ngoài ở Việt Nam: Thực trạng, hiệu quả và hướng điều chỉnh chính sách* (Foreign Direct Investment in Viet Nam: Situation, Efficiency and Directions for Policy Adjustments). Hanoi: Labor Publishing House. Vietnamese.

- Nguyen, A.D., T.H. Dinh, T.N.T. Do, and T.T. Vo (2019), 'Non-Tariff Measures in Viet Nam', in H.T.T. Doan and S. Rosenow (eds.) *Non-Tariff Measures in ASEAN – An Update*. Jakarta: Economic Research Institute for ASEAN and East Asia (ERIA), pp.207–33.
- Ohno, K. (2003), 'The Role of Government in Promoting Industrialization under Globalization: The East Asian Experience'. <https://www.grips.ac.jp/vietnam/VDFTokyo/Temp/Doc/2003-2004/IPE-KOOhnoApr04.pdf>
- Research and Markets (2021), Vietnam Internet of Things Market. Mimeo.
- Trong Dat (2022), 'Việt Nam thiếu nguồn cung nhân lực về IoT' (Vietnam Is Short of IoT Human Resources), *VietNamNet*, 26 October. <https://vietnamnet.vn/viet-nam-thieu-nguon-cung-nhan-luc-ve-iot-i5004682.html>
- TRPC (2020), 'Adapting APEC's Structural Reform Efforts to the Digital Economy', EC 05 2019A: Input Papers/Preparations for Structural Reform Ministerial Meeting (SRMM). 16 November. (Unpublished.)
- Truong, D.T. et al. (2011), 'Tác động của cam kết mở cửa thị trường trong WTO và các hiệp định thương mại tự do đến hoạt động sản xuất, thương mại của Việt Nam và các cơ chế hoàn thiện cơ chế điều hành xuất nhập khẩu của Bộ Công Thương giai đoạn 2011–2015' (Impacts of Commitments on Opening the Market under WTO and other Free Trade Agreements on Vietnam's Production and Trade Activities and Mechanism to Improve Import and Export Management Scheme of the Ministry of Industry and Trade in 2011–2015), Report for Multilateral Trade Assistance Project (MUTRAP). Vietnamese.
- UNIDO (2020), *Viet Nam Industry White Paper 2019: Manufacturing and Subsector Competitiveness*. Vienna: United Nations Industrial Development Organization
- Upton, P. and A. Huld (2022), 'Investing in Shenzhen: Industry, Economics, and Policy', *China Briefing*, 1 July <https://www.china-briefing.com/news/investing-shenzhen-economic-profile-industry-policy-trends/>
- USAID and Agency for Enterprise Development (2023), 'Báo cáo Thường niên Chuyển đổi số 2022: Mức độ sẵn sàng chuyển đổi số của doanh nghiệp Việt Nam' (Preparedness for Digital Transformation 2022). (February). Washington, DC: United States Agency for International Development. <https://digital.business.gov.vn/document/bao-cao-thuong-nien-chuyen-doi-so-2022-muc-do-san-sang-chuyen-doi-so-cua-doanh-nghiep-viet-nam/>



- Vietnam Investment Review* (2020), 'More Companies Invest in Robot Production as Demand Rises', 1 February. <https://vir.com.vn/more-companies-invest-in-robot-production-as-demand-rises-73538.html>
- Vo, T.T., A.D. Nguyen, and B.M. Tran (2016), 'Non-tariff Measures in Viet Nam', in Ing, L.Y., S. F. de Cordoba and. O. Cadot (eds.), *Non-Tariff Measures in ASEAN*. ERIA Research Project Report 2015-1, Jakarta: ERIA, pp.155-167
- Vo, T.T., A.D. Nguyen, and T.H. Dinh (2018), 'Innovation Policy in Viet Nam', in M. Ambashi (ed.) *Innovation Policy in ASEAN*. Jakarta: Economic Research Institute for ASEAN and East Asia (ERIA), pp.247–76.
- Vo, T.T. and A.D. Nguyen (2006), 'Vietnam in the Regional Production Network', Paper presented at the International Conference on 'Comparative Study on Industrial Competitiveness between China and Vietnam in the Context of East Asian Trade Liberalization, and the Experiences of Japan', Danang, February.
- World Economic Forum (2021), 'Robot Workers Are Being Hired at Record Rates in US Companies – Here's Why', 1 December. <https://www.weforum.org/agenda/2021/12/robots-jobs-staff-shortage-automation/>
- Zeng, D.Z. (2010), *Building Engines for Growth and Competitiveness in China: Experience with Special Economic Zones and Industrial Clusters*. Washington, DC: World Bank.

