ISSN: 2658-8455
Volume 5, Issue 7 (2024), pp. 335-350.

Industrial policies in the 21st century: the 4th generation of industrial revolutions

Yassine ALIA, *(PhD student)*
Faculty of Economics and Management
Ibn Tofail University of Kenitra

Nouh EL HARMOUZI, *(Full Professor)*
Faculty of Economics and Management
Ibn Tofail University of Kenitra

Correspondence address :	Faculty of Economics and Management University Campus Ibn Tofail University Kenitra
Disclosure Statement :	Authors are not aware of any findings that might be perceived as affecting the objectivity of this study and they are responsible for any plagiarism in this paper.
Conflict of Interest :	The authors report no conflicts of interest.
Cite this article :	ALIA, Y., & EL HARMOUZI, N. (2024). Industrial policies in the 21st century: the 4th generation of industrial revolutions. *International Journal of Accounting, Finance, Auditing, Management and Economics*, *5*(7), 335-350. https://doi.org/10.5281/zenodo.12740233
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Received: May 22, 2024 *Accepted: July 12, 2024*

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Abstract:

Industry 4.0, also known as the Fourth Industrial Revolution, is characterized by the integration of advanced digital technologies into manufacturing processes. The main pillars of Industry 4.0 include the Internet of Things, artificial intelligence, additive manufacturing and robotics. These technological advances aim to increase the efficiency, flexibility and productivity of factories, opening the way to new opportunities for businesses and economies. The impact of Industry 4.0 on industrial policy is significant, as it leads to a major transformation of industrial processes and economic models. Technological advancements such as the Internet of Things, artificial intelligence and additive manufacturing are changing the way businesses operate. This requires adapting industrial policies to encourage innovation, competitiveness and sustainability. In the context of Industry 4.0, industrial policy faces several major challenges such as the need to adapt to rapid technological advances, ensure data protection and respond to the challenges linked to the digital transition. However, these challenges also offer unique opportunities for industrial policy, notably in terms of promoting innovation, boosting business competitiveness and promoting sustainable economic growth. The key lies in the ability of governments and industry players to work closely together to seize these opportunities and successfully address the challenges.

Observation of the main experiments underway since the second decade of the third millennium allows us to note the multitude of objectives for each case. Feedback from international experiences reveals a concentration on digitalization, the Internet of Things, Data and renewable energies. The main objective of this work is to provide researchers and policy makers with a range of data that will be used to implement academic choices in economic studies or public policies regarding industrial development visions.

Keywords: Industry 4.0, industrial policy, Internet of Things, Data, Cloud
JEL Classification: *B15, F68, G18, O31*
Paper type: Theoretical Research

ISSN: 2658-8455
Volume 5, Issue 7 (2024), pp. 335-350.

IJAFAME
International Journal of Accounting, Finance, Auditing, Management & Economics

Introduction

At the dawn of the third millennium, the industry gradually transformed by integrating new technologies. The use of industrial policies, particularly in developed and emerging countries, increasingly integrated cutting-edge technologies, and the industrial sector became a fertile ground for implementing technological developments. The rush towards global leadership in industrial matters is no longer quantitative, but it depends on the degree of mastery of technological pre-requisite which represent the essential knot in the global value chain. Industrial economists speak of the fourth generation of the industrial wave “Industry 4.0”. This concept is a response to the increasing emergence of digital technologies in the industrial sector. Industrial robotization, as part of this 4.0 generational revolution has involved major changes in the structure of production, and the way in which human capital is integrated into the production process.

If previous industrial revolutions represent developments in energy and technology, the 4th generation offers complementarity between technologies and functionalities. The first industrial revolution marked an energetic and mechanical change which broke out in England, and which allowed the transition of the production process from the manual model to manufacturing processes, particularly in the textile sector. The 2nd revolution was triggered following the electrification, which gradually spread to the industrial sector. It has manifested itself in the emergence of several new sectors such as Mechanical Engineering, Food Industry and Chemical Industry (Debonneuil et Encaoua 2014). Thus, the two revolutions were based on energetic developments, and were based on coal for the first and electricity, oil and gas for the second. The latter was also marked by a change in production paradigm, through moving to mass production (Henri Ford defines it in his adage “You can have any colour as long as it's black"). The layout of space and organizational methods by adopting production lines marked a structural evolution which standardized production and targeted improving human labour efficiency and production costs reduction (Hull 1996).

The transition to the third industrial revolution introduced microelectronics and automation (Rojko 2017). The decrease in management costs marked a major development in the industrial world, particularly with the introduction of information technologies and integrated management systems. Companies have transformed into functional structures according to their professions such as Marketing, Research & Development and Finance (Santos, et al. 2017).

Recently, we are experiencing the 4th industrial revolution which differs from the old versions. This wave takes into consideration the energy contribution based on renewable resources. In the future, factories will be connected in smart cities and powered by energy from solar, wind and geothermal sources. On the technological side, it does not consist of revolutionary technological discovery, but of acclimatization between several new technologies. With the expanded use of the Internet of Things, the introduction of Cyber Physical Systems, Cloud Manufacturing, Additive Manufacturing and many other technologies and actuators, a new level of industry and manufacturing can be achieved (ElZant 2021).

In this article, we first present a definition of the concept, and then we discuss the key global experiences of industrialization programs illustrating the realization of this revolution.

1. Industry 4.0 in the literature:

Industry 4.0 is a concept that first appeared in 2011 in Germany, in a presentation of the

strategy to encourage the industrial sector at the Hanover fair[1]; at the same time, industrial experts mark this event as the launch of the fourth industrial revolution. This concept relates the main changes in systems, relationships between machines and relationships between humans and machines (Salkin, et al. 2018). These systems are based on new technologies such as adaptive robotics (Wittenberg 2015), virtualization technologies (Paelka 2014), cloud technologies (Thames et Schaefer 2017) on top of other digital developments.
From the references, it appears that the concept of industry 4.0 is also called "industry of the future", or even "Smart Manufacturing" (Zemzami et Mamad Juin 2021).
(Bidet-Mayer 2016) defines Industry 4.0 as "connected factories made flexible and intelligent through the networking of machines, products and people". They are characterized by radical changes in relation to the advent of new technologies, which makes the innovation flow faster than any time in History, while the three ancient revolutions were also driven by technological changes based on a few key technologies such as mechanization, electricity and information technologies (Veza, Mladineo et Gjeldum 2015). This revolution has focused on four drivers which are: Internet of Things, Industrial Internet of Things, Cloud-based Manufacturing and Smart Manufacturing (Erol, et al. 2016).
(Bodrow 2017) specifies that industry 4.0 involves substantial changes that affect companies of all sizes; small, medium or large. These changes particularly concern the areas of production, logistics, and the optimization of production processes based on data processing.
McKinsey and Company focuses on the technical aspect of Industry 4.0 in its definition. They specify that this revolution integrates the Internet of Things using sensors and actuators, and connects production systems to supply chains and demand functions; which makes it possible to reduce contractual risks and limit human intervention. Thus, management structures are expected to be more decentralized, although more specialized (Santos, et al. 2017).
From another perspective, the concept of industry 4.0 has been approached as a concept of integration. For (Geissbauer, Vedso et Schrauf 2016), industry 4.0 is primarily based on the integration of the supply chain while digitalizing the company's internal processes through logistics and services. (Mamad 2018) specifies that the integration is carried out on 3 axes:

- Horizontal integration: the horizontal integration process allows real-time communication throughout the value chain, where men and machines communicate directly at the operational center. Likewise, companies are integrated into networks that promote industrial partnerships.
- Vertical integration: the management of systems and subsystems through the flexibility and reconfiguration of production networks.
- Temporal integration: connected objects throughout the product life cycle record product design, manufacturing and use data.

(Santos, et al. 2017) listed four benefits for Industry 4.0. This involves developing green and sustainable industrial processes and supply chains, lowering production costs following the use of autonomous machines, creating a new advantage in the markets and guaranteeing accelerated product development. For his part, (Rojko 2017) specifies that industry 4.0 could reduce production and logistics costs by 10 to 30%, in addition to a decrease of 10 to 20% in management and quality costs.

2. The forced recourse to the digitalization of industry 4.0

The transition to the 4th wave of industrial revolutions is not only a technological improvement, but it is a set of economic, social and human transformations. Through industry

[1] *In 2011, this technology was presented to the general public for the first time at the Hannover Messe, Germany's largest industrial fair. 6 institutes presented their demonstrations around the subjects: robotization, simulation, ICT and Micro and Nano Technologies.*

4.0, the paradigm of industrial strategy and its economical logic shifted from mass production to mass customization. Several studies mentioned this principle before the emergence of the concept of industry 4.0 in 2011 (Zheng, et al. 2008, Zhang et Rodrigues 2009, Schierholt 2001).This work promoted concepts allowing the reconfiguration of production processes based on interaction and automation, the "Systematic Knowledge Model" and the installation of a "Tree unification" which reports the generic links between the product families. In the era of Industry 4.0, production no longer relies on scale and volume effects, but on flexible and localized production close to demand. It places usage rather than the product at the heart of its logic, and it moves from a rigid organization of work to a flexible one, with a higher attractiveness of work as a result (Blanchet 2016). Max Blanchet specifies that digital transformation is not limited to product design and means of production, but it also integrates fixed assets (machines and equipment) which are optimized and interconnected in real time to be able to adapt to customer demand changes and respond to developments, allowing products to be customized and offering a higher level of quality. Digitization is seen as a revolution that occurs throughout the production chain with three major innovations:

- Advanced or decision-making computing with learning machines and the utilization of Big Data and the Cloud.
- Connected objects with the possibility of creating links between physical and digital objects.
- Advanced robotization with collaborative robots (Gaudron et Mouline 2017).

On their side (Lin, Lan et Huang 2019) specified four elements to explain the vital importance of resorting to the digitalization of industry. These are agility for handling unforeseen events, adaptability for product diversity, efficiency for optimizing the production process and reorganization to create new features.

The change in the paradigm of industrial production is not limited to the digitalization of the production structure, but it also incorporates the architecture of the value chain and the business model. The aforementioned elements indicate that the positioning of each country on the new industrial map implies a redefinition of the traditional industrial paradigm, and consequently the implementation of the necessary transformations in the process of catching up or standing out from potential competitors.

The recourse of States to the adoption of new generation industrial policies is a choice shared between public authorities whatever their political vocation is. Industrialized countries, new industrialized countries and less industrialized countries have moved to varying degrees towards accentuating programs of structural transformation of industrial production units. We will discuss the examples of fourth generation industrial policies in 4 countries; Germany, the United States of America, China, and South Korea.

3. Industry 4.0: A global transformation; Each country has its own challenge:

The second decade of the third millennium marks a break with traditional versions of industrial policies, and the progressive recourse to the new generation Industry 4.0. Each country has its own logic and priorities, but their visions agree on the necessity of using the Internet of Things, robotization, virtualization, Cloud technologies and other aspects of digitalization of the industrial production process (Kagermann et Wahlster 2022). The constraints of several countries are demographic following the aging of populations, the decline in fertility and the transformation towards older societies, the scarcity of the workforce necessary to ensure competitiveness in the global mapping of industry (UNIDO 2013). Industrial production costs are one of the main causes for resorting to Industry 4.0 policies. according to the Boston Consulting Group BCG report (Sirkin, Zinse et Rose 2014).

The world's top three manufacturing producers are China, Germany and the United States of America, but China is suffering from an increase in labor and energy costs and Germany has the highest manufacturing costs. The United States benefits from the lowest energy costs and low wage growth, which threatens the position of the Chinese leader. The response of public authorities to the different situations of the above-mentioned countries and others was the adoption of a generation of industrial policy that (Kuo, Shyu et Ding 2019) qualifies as a policy of revitalization through industry 4.0.

3.1.Germany: Birthplace of the Industry 4.0 concept

As we have already mentioned, the concept of Industry 4.0 appeared for the first time at the Hanover Forum 2011. German public authorities aware of the less competitive situation in Germany, decided to pursue a policy industrial revitalization. While Germany is positioned as a leader in the machinery and equipment industry, including embedded systems and engineering automation, it has found itself faced with obvious challenges. The revitalization of American industry and Chinese competition were not the only threats. The gradual realization of the technological catch-up process of the Asian tiger equipment industry sounded a strong alarm for German industry (Müller, Buliga et Kai-Ingo Voigt 2018). The adoption of an industrial structure based on small and medium-sized entities SMEs in Asian countries had changed the model of value added creation in the sector. On the other hand, software and internet technology represented weaknesses in German industry. Supported by the German Academy of Engineering, the Fraunhofer Association, Siemens and other universities and industries, the Federal Ministry of Economics and Technology and the Federal Ministry of Education have included Industry 4.0 among the 10 prospective projects of Education and Research 2020. Over a period of 10 to 15 years, the Industry 4.0 plan committed 200 million Euros and defined 10 projects in the High-Tec Strategy 2020 plan (BMBF 2014). The German federal government focuses its High-Tec 2020 plan objectives on six key areas:

- Digital economy and the company: the integration of new information & communication technologies NICT into the German economy is a decisive condition for improving its competitiveness. Education, culture and the media are oriented to ensure the necessary resources as well as the efficient use of NICTs and the interactive management mode with the company. This point includes several dimensions, and the German government prioritized Industry 4.0. The start of the fourth industrial revolution required the German government to initiate the process of defining individualized, flexible products which integrate suppliers and consumers into the management and value creation process, while connecting all its elements to achieve success to hybrid products. The government should support industry 4.0 to make the country a leading supplier of these technologies and a future center of its production. In addition, the government was directing its vision towards Smart Services, Smart Data, Cloud Computing, Digital Networking, Digital Science, Digital Education, Digital life environments (the digital living environment).
- Sustainable economy and energy: with the target of rationalizing energy resources, and making them more compatible with environmental requirements, the plan defined areas for performing energy production & consumption in Germany. The federal government decided to carry out researches in energy (storage, electricity network, solar construction and energy efficiency in the cities). These efforts were part of the federal energy strategy which goes hand in hand with other public sector plans. The measures also concerned the promotion of green economy, bioeconomy, sustainable agricultural production, continuous supply of raw materials, cities of the future, future of construction and sustainable consumption.

- Healthy living: the major challenges of common diseases and those linked to demographic transformations present strong potential for the German health system locally and internationally. Innovative developments are thus creating new global markets, where Germany should position itself through the fight against major diseases. By engaging six German health research centers, two core research networks and Berlin Institute of Health, the federal government is linking a network of basic research and patient follow-up research. In addition, the government based its strategy on individual medicine, research in nutrition and prevention, innovation in the healthcare sector, strengthening pharmaceutical research and innovation in medical technologies.
- Intelligent mobility: the concept of mobility requires efficient logistics that allows people and goods to be transported comfortably and within competitive deadlines. To meet this challenge and ensure smart mobility, the federal government is committed to the road infrastructure transformation plan. Government stating that the transport infrastructure is the lifeline of industries in highly industrialized countries. In addition, demographic transformations pushed the federal government to increase its interest in rural areas, and the interconnected network of means of transport by benefiting from innovations and the expansion of digitalization of this service. The environmental contribution is present in the German public logic which aimed to limit CO_2 emissions and the electrification of means of transport and the enrichment of research linked to batteries. Finally, it should be noted that the smart mobility strategy partly concerns maritime transport (With its “National Maritime Technology Master Plan”, the federal government is developing strategies to support the strengths of the innovative German maritime sector) and air transport (“ Aviation strategy” which aims to make Germany a global technological leader for environmentally friendly, safe, efficient, competitive and passenger-friendly aviation systems).
- Civil security: the contribution of security concerns the digital aspect. Thus, the preservation of personal data and the fight against digital crime would require research into civil security to protect the population and important infrastructures through the federal national security program. This program aims for the proper use of technologies and ensuring the protection of operating routes. In addition, “the cyber security strategy for Germany” provides a working framework against cyber crime, and would make it possible to find viable solutions to preserve Internet network users, private and public data and internet security resilience (BMBF 2014).

The German 4.0 strategy focused on two aspects, the first defensive to preserve industrial production in Germany, and the second is offensive to preserve German competitiveness and maintain the export model (Blanchet 2016).

3.2.The experience of the United States of America:

The United States of America stood out as the leading industrial producer during the 20th century. At the dawn of the 21st century, American leadership was strongly threatened following the relocation of production units to Asian countries and the rise of the Chinese competitor. The deterioration was also observed for labor in the industrial sector. American industry lost 2 million jobs between 1980 and 2000. This deterioration intensified between 2000 and 2010 with 6 million jobs lost (Kofi, Hurst et Schwartz 2018). In 2011, the United States of America launched the “Advanced Manufacturing Partnership (AMP)” initiative, which aims to bring together industry, university research centers and the federal government (The White House 2011). This initiative has committed 500Mn($) as a first step in achieving the objectives of upgrading American industry through the construction of local industrial capacities in important American industries, the promotion of a futuristic policy ensuring

American leadership in the robotics industry, the realization of renewable energy choices and the development of technologies that would save time in the industrial manufacturing process. In 2014, federal authorities implemented the second version "The Advanced Manufacturing Partnership 2.0 (AMP 2.0)" following the work of 43 research and administration centers, 51 leading manufacturers and 6 independent experts. who contributed to the evaluation and prospecting of AMP launched in 2011. This version was based on three pillars; and 11 recommendations. (PCAST 2014)

Table 1: pillars and recommendations; Advanced Manufacturing Partnership 2.0

	Pillar I: Opinion on innovation
Recommendation#1	Establish a national strategy to ensure U.S. advantage in emerging industry technologies
Recommendation#2	Create an Advanced Manufacturing Advisory Consortium to provide coordinated private sector input on national research and development priorities for advanced manufacturing technology
Recommendation#3	Establish a new industrial research and development infrastructure (public-private) to support the innovation pipeline
Recommendation#4	Develop processes and standards enabling interoperability of industrial manufacturing technologies.
Recommendation#5	create a National Network for Manufacturing Innovation (NNMI) governance structure that can ensure a return on investment for NNMI's many stakeholders by including contributions from various organizations as well as private sector experts , unions and universities
	Pillar II: Securing the talent pool
Recommendation#6	Launch a national campaign to change the image of the industry and support National Manufacturing Day efforts to highlight real careers in manufacturing.
Recommendation#7	Encourage private investment in implementing a system of nationally recognized, transferable and stackable skills certifications that employers use for hiring and promotion
Recommendation#8	Make the development of online training and accreditation programs eligible to receive federal support through federal job training programs.
Recommendation#9	Curating the documents, toolkits and playbooks that have been created by AMP2.0 to scale and replicate these important talent development opportunities, through the Manufacturing Institute.
	Pillar III: Improvement of the business climate
Recommendation#10	Coordinate existing federal, state, sectoral and private intermediary organizations
Recommendation#11	Reducing the risk associated with scaling advanced manufacturing

Source: Executive Office of the President: President's Council of Advisors of Science and Technology

In 2016, the White House launched a 4-year plan, continuing previous plans (AMP versions 1 and 2). This new strategy aims to develop new technologies and train the future skills of the workforce. The predefined objectives are the development and transition to new industrial manufacturing technologies, education, training and connection of the workforce and the expansion of domestic industry supply chain capabilities. This strategic plan was developed by the National Science and Technology Council Subcommittee on Advanced Manufacturing, co-chaired by the U.S. Department of Commerce/NIST (National Institute of Standard and Technology), with representatives from 17 different federal agencies and offices with interests

ISSN: 2658-8455
Volume 5, Issue 7 (2024), pp. 335-350.

in advanced manufacturing, technologies, international trade and workforce development (SAM 2018). The technical and technological contribution is predominant. The strategy accentuated previous efforts and prioritized smart and digital manufacturing, advanced industrial robotization, artificial intelligence infrastructure, cyber security of industrial manufacturing, high performance of hardware, additive manufacturing (3D printing), important materials including important minerals, low distribution cost manufacturing, biomanufacturing of medical tissues and organs, semiconductor design and manufacturing, and production and safety of the food supply chain.

In 2021, and following the COVID-19 pandemic, American guidance has become more involved in the industrial sector with “The Innovation and Competition Act” program. This strategy is motivated by the international context (trade tensions with China, supply disruptions, the inflationary wave, etc.).

The new American industrial policy was designed to decarbonize the American economy (renewable energy) and reindustrialize the American Heartland after the devastation caused by hyper-globalization (relocation of production units with high-tech investments known as double military capacity and civil), it also includes important incentives to stimulate private investment (Seydl, Matthews et Schaeffer 2023).

3.3.Made in China 2025

From the start of the 21st century, China stood out as an emerging industrial power, and one of the manufacturing miracles since the first industrial revolution which took place in Great Britain (Li 2013). At the end of 2012, China became the second largest wealth-creating economy in the world, and this is due to the real realization of the “Made in China” paradigm. Manufacturing output in 2014 reached 286.2 million laptops (90% of global production), 109 billion air conditioners (80% of global production), 4.5 billion energy-saving lamps and 70% of global mobile phone production (Chinadaily 2015). In this context of favorable developments, China found itself faced with two major challenges; the first in relation to the demographic deterioration of the Chinese working population following the one-child policy. The second relates to the technological content of Chinese manufacturing production and the challenges of digital transformation and robotization of the Chinese industrial fabric. Chinese industry is also facing the growing problem of competitiveness linked to wage inflation throughout the Chinese east coast, the increase of energy costs, the cost of land and the difficulty of moving workers from the center of the country (Blanchet 2016). However, the majority of Chinese industries are considered relatively low-skilled, heavily dependent on manual labor and suffering from obvious gaps in innovations in their industrial chain. The Chinese ambition, namely "Made in China 2025" stated in 2015, should change this landscape[2]. This master plan; which guides the strategic development objectives over the decade 2016-2025; was jointly developed by China's National Development and Reform Commission and the Ministry of Science and Technology, with additional contributions from the Ministry of Industry and Information Technology and other constituencies. It constitutes the Chinese response to new versions of industrial plans such as “Industry 4.0” from Germany and the “AMP” from the United States of America.

“Made in China” aims to achieve several objectives in relation to the basic principles of the fourth generation of industrial revolutions. According to official Chinese government documents (The State Council 2017), we accept :

[2]*Premier Li Keqiang advances "Made-in-China 2025" plan at State Council meeting. Technical report, State Council of the People's Republic of China.*
http://english.www.gov.cn/premier/news/2015/03/25/content_281475077518617.htm

- China is expected to manufacture equipment of the country's technological innovation (The main Arena). The Chinese Prime Minister insisted on seizing the historic opportunity to improve the technological level of industrial equipment and conduct the necessary research to achieve this objective.
- The innovation of additive manufacturing (3D) ideas, with the aim of competing with developed international industrial powers such as Germany and Japan. Smart industry is the key to stabilizing and resilient growth of China's economy.
- The automotive industry's support for new energies, to build a Chinese brand in this sector.
- The connection of the “Made in China 2025” strategy with the German “Industry 4.0” strategy. The two countries have agreed to cooperate and develop a new industrial revolution while integrating German developed technologies and promoting Chinese industry.
- Using the internet to strengthen the industry. This point integrates two national strategies; “Made in China” and “Internet Plus”. Manufacturing and Internet companies are encouraged to create joint ventures that convey new models. Accordingly, SMEs can integrate and use online and offline resources, and share techniques, facilities and services to optimize the offering, the circular said. Cooperation between the two industries is also encouraged on strategic investments, branding, online sales and logistics.
- Raise equipment standards. Thus, by 2020, 90% of the standards for major national equipment must be updated to be at the same level as international standards. The key sectors targeted are robotics, advanced rail transportation equipment, agricultural machinery and high-performance medical equipment.
- Improving industrial manufacturing through Big Data and Cloud Computing. The Chinese vision follows those of the United States and insists on the transformation of the Chinese economy by engaging the new information economy and new communication technologies.
- Attracting foreign investments to boost the “Made in China 2025” plan. In order to implement the plan, the government has decided to continue its policy of openness, striving to revise the Catalog of Orientation of Industries for Foreign Investment, and to further open up the service sectors, manufacturing and mining.In addition, he encouraged foreign investment to participate in the implementation of China's innovation-oriented development strategy and the upgrading of the manufacturing sector, and encouraged foreign talents to establish enterprises in China, particularly in high-end, smart and green manufacturing.

The Made in China plan focuses on 10 industries: Information technology, high-end and automated numerical control machines, aerospace and aeronautical equipment, maritime engineering equipment and high-tech ship manufacturing, railway equipment , energy-efficient vehicles, electrical equipment, new materials, biomedicine and high-performance medical devices, and agricultural equipment (The State Council 2017).

Based on its own experience in economic reform that follows the gradual steep-by-steep model, the "Made-in-China 2025" plan is expected to be expanded to three phases. The first phase covers the decade 2015-2025; during this period, China strives to be included in the list of global manufacturing powers. The second phase will extend over the period 2026-2035; during which, China will move to the middle level in the camp of global manufacturing powers. The last phase will be completed in 2049, the year of celebration of the centenary of the People's Republic of China. The country dreams of being a leading manufacturing power in the world (Li 2017).

ISSN: 2658-8455
Volume 5, Issue 7 (2024), pp. 335-350.

3.4.South Korea's desire for confirmation

The Korean model often presented as an industrial miracle, and an idol experience to follow, (Stiglitz 2017, Tassinari, et al. 2019), has not escaped the trend of renewing its industrial policy, and is part of the new generation “Industry 4.0”. The Korean government launched “The Manufacturing Industry Innovation Strategy 3.0” (MIIS 3.0) based on the German “Industry 4.0” model. The context of this launch was very competitive for Korean industry, given that the country had two major advantages in the race towards mastering the technologies of the 4th industrial revolution. The first is in relation to the large historical conglomerates – the Chaebols[3]- like LG and Hyundia which were developing activities in both industrial robotics and digital technology. The second advantage traces very high robotization statistics. According to the International Federation of Robotics, in 2013 the country had 437 robots for 10,000 employees compared to 323 in Japan and 282 in Germany (Bidet-Mayer 2016).

MIIS 3.0 prepared by the Ministry of Trade, Industry and Energy focuses on the concept of smart factory to solve the problems of the Korean manufacturing industry, including rising production costs, increasing of offshoring and the decline in competitiveness of Korean products with high added value (MOON, CHUNG et CHOI 2018). It is based on 4 strategies and 13 assignments (Kang, et al. 2016)

Table 2: the 4 strategies and 13 assignments of the Manufacturing Industry Innovation Strategy 3.0

Strategies	***Assignments***
Proliferation of smart manufacturing	• Distribute the proliferating smart factories • Develop 8 smart manufacturing technologies • Strengthening the soft power of manufacturing • Promote investments in the sophistication of production facilities
Creating new industries for a creative economy	• Early Visualization of Intelligent Convergence Products • Develop and commercialize 30 smart materials components • Promote R&D and private sector investment
Smart innovation from local industry	• Enabling manufacturing activities through a creative economy innovation center • Create smart local industrial complexes • Promote new specialized smart industries locally
Business reorganization and creation of an innovation base	• Encourage spontaneous business reorganizations by companies • Improving regulatory systems for the convergence of new products • Advance staff training to support manufacturing innovation

Source: Kang, et al. 2016

Like Germany and the United States of America, Korean technology choices focused on key areas. The key and representative technologies selected for intelligent manufacturing include CPS (Cyber Physical Systems), Internet of Things, cloud computing (cloud manufacturing), big data, additive manufacturing (3D printing), sensors , energy savings and holograms. Regarding the implementation of this vision, the Korean government focused on two axes, the first focused on SMEs (small and medium-sized enterprises). 10,000 SMEs are targeted by the

[3] *In Korea, Chaebol are groups of companies, from various fields, maintaining cross-shareholdings among themselves. They are the Korean equivalents of the ancient Japanese zaibatsu.*

diffusion of the “Smart Factory” intelligent factory system. A Smart factory is defined as a high-tech intelligent factory focused on the integration of all production processes - from product planning to purchasing - via ICT (information and communication technologies) to produce customized products in a time and cost efficient manner (Ko, et al. 2020). By 2020, the Korean government planned to reach 500 billion dollars in exports to ensure the future growth plan by targeting industrial sectors such as automobiles, petrochemicals, shipbuilding or ocean factories, machinery , steel, display and semiconductors. The second relies on large industrial units. Most large companies are the main players in manufacturing 3.0 innovation. Thus Samsung SDS, SK C&C and LG CNS have launched their own Smart Factory solutions (MOON, CHUNG et CHOI 2018).

In June 2019, the Korean government announced the new initiative named "Manufacturing Renaissance Vision" to revitalize and improve innovation dynamics in the manufacturing landscape, with a long-term vision to realign industries with higher value-added strategies. This plan aims to create a smart manufacturing industry by accelerating innovation in industrial structure by applying intelligence, environmental friendliness and convergence. The Korean government's measures aim to address rapid changes such as Industry 4.0 developments, increasingly stringent environmental regulations and the realignment of the global business environment. Korea's private and public sectors have agreed to increase the number of national smart factories, with the aim of having 30,000 smart factories operating nationwide with the latest digital and analytical technologies by 2022. Additionally, With an eye toward the year 2030, they set a goal of creating 20 smart industrial zones as part of efforts to support Korea's declining working-age population. Under this framework, 2,000 new smart factories powered by Artificial Intelligence are expected to be created to keep pace with the rapid development of comprehensive digitalization and automation in the era of the fourth industrial revolution (International Trade Administration 2023).

Korea stood out as the world's leading innovative country according to Bloomberg Innovation Index 2021[4]. This index performs a comprehensive analysis using seven measures by which numerical data aggregated by each country is scored to assess a country's innovation capacity. South Korea ranks first in five sub-indicators of the index: 2nd for R&D intensity, 2nd for value-added manufacturing, 4th for high-tech density, 3rd for researcher concentration and 1st for the number of patents.

3.5.4th generation industrial policies: a shared practice

Several experiments have been launched to integrate the wave of fourth generation industrial policies. Traditional industrial countries, emerging economies and countries in the catching-up phase have given themselves resources of varying intensity to implement public choices and cooperation with the private sector. The transformation of the manufacturing sector and the demands of global competition have pushed States to register different degrees of commitment in this process. Despite the wishes expressed, the disparities are very wide, and factors linked to the position of each country imply distinct degrees of commitment and implementation. We state for informational purposes and not exhaustive, the experiences of a few countries whose status varies in the mapping of global industrial production (Yang et Gu 2021).

[4] *The Bloomberg Innovation Index is an annual ranking of the most innovative countries in the world. The index created by Bloomberg in 2017 measures a country's innovation performance in seven categories: research and development (R&D) intensity, manufacturing value added, productivity, high density technology, researcher concentration, tertiary efficiency and patent activity. It also takes into account factors such as the quality of education systems, infrastructure investments and government policies that support innovation.*

ISSN: 2658-8455
Volume 5, Issue 7 (2024), pp. 335-350.

IJAFAME
International Journal of Accounting, Finance, Auditing, Management & Economics

Table 4: 4th generation industrial policies (industry 4.0) in 11 countries

Country	Industrial plan	Launch year
Australia	Industry 4.0 Testlabs	2017
Belgium	Made Different	2015
Denmark	Manufacturing Academy of Denmark	2017
Spain	Industry Connectada 4.0	2014
France	Industry of the Future	2015
Italy	Print 4.0	2016
Japan	Society 5.0	2015
The Netherlands	Smart Industry	2014
Portugal	Industry 4.0	2017
United Kingdom	The Future Manufacturing	2017
Singapore	Research, Innovation and Enterprise 2020 Plan	2015

Source: Yang and Gu 2021

The reasons for implementing these new industrial strategies remain similar, namely technological catch-up, the drop in the volume of the workforce and the challenges of product maturity and the deconfiguration of global demand.

4. Conclusion:

The new generation of industrial policies is a practice undertaken by all industrial and emerging powers. In fact, its implementation involves a horizontal vision of cooperation and coordination among multiple institutions, and consequently, it confirms the recent conception of the broader notion of industrial policy. This step towards confirmation addresses the requirements imposed by demographic data, related to the decline of active populations in developed countries, or the lack of highly skilled human resources and competencies in less developed countries. Each country that claims the legitimacy to integrate into global value chains must craft its own technological vision and capitalize on its industrial past to continue competing in a turbulent and innovative environment.
This very important phase in the history of industrial activity can involve shortening the technological catch-up period, as it can widen the gap between different categories of countries.

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