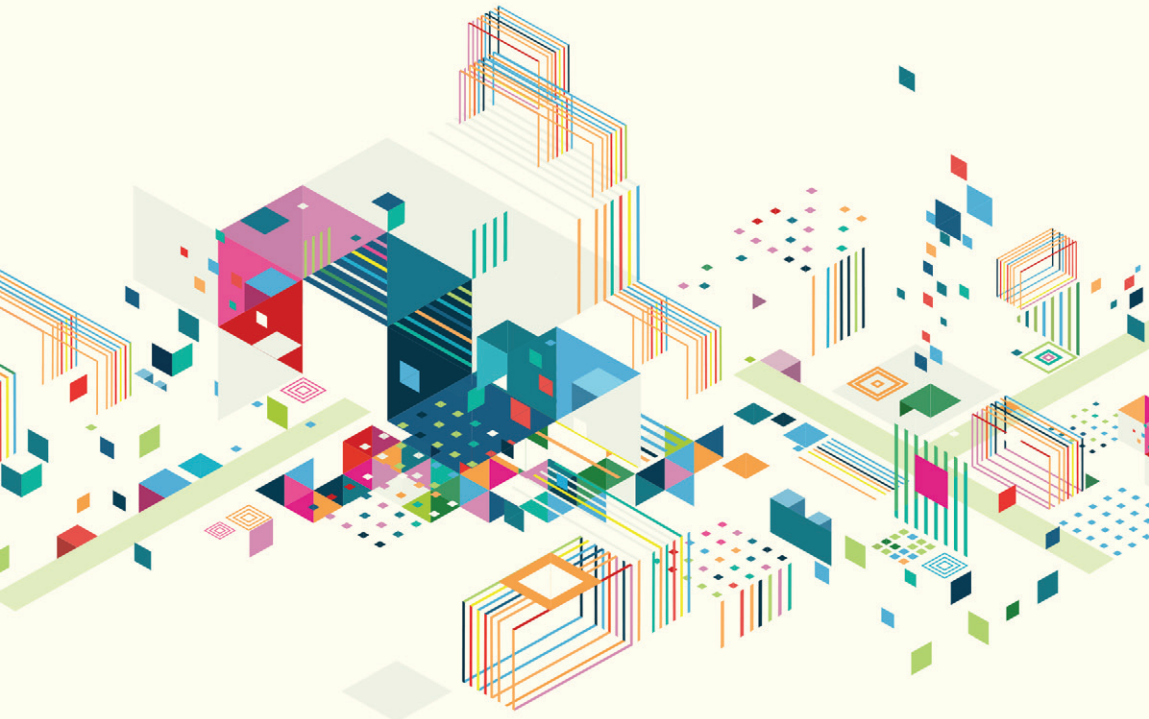
Industry Clusters and Innovation in the Arab World

Challenges and Opportunities



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Industry Clusters and Innovation in the Arab World: Challenges and Opportunities

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Foreword

The Arab World has been a zone of treasure for the whole world with immense flow of natural resources, trained labor, and youth innovations. During the last few decades, many countries in the Arab World started to migrate from resource dependency and raw material exporting, to the development of heterogeneous resource bundles and building world-class competitive industry conglomerates. The emergence of the petrochemical industry cluster in Egypt, the tourism cluster in the UAE, the technology cluster in Saudi Arabia, and the artisanal cluster in Tunisia are just examples. Building clusters in the Arab World necessitates the existence of strong firm-level rivalry, government support, technical and vocational education, technological advancement, developed suppliers, and citizens that support their local brands. Only through clusters with those necessary pillars will the Arab World states be able to emerge as key players in international markets.

If we take Egypt as an example, the story of the Egyptian cotton is one of the marks in building the textile industry cluster in the region. Since the Pharaonic period, cotton cultivation has been a well-known commodity in Egypt, and has been a major factor that has affected the country's development over the past half-century. Undoubtedly, Egypt economic fate was linked to the flows of cotton production. As in 1927, cotton cultivation developed to cotton manufacturing when Talaat Harb established Egypt Cotton Spinning and Weaving Company as one of the companies of Banque Misr. The Company started its production at 12,000 reaching 357,000 spindles. Due to the country's pioneering achievements in the spinning and weaving of cotton, Egypt was able to establish a global reputation for its quality. This became a trademark of the country and the Egyptian cotton shirt; that is "Made in Egypt" is exported to various parts of the world. Referring to it as "white gold", Egyptian cotton exports are believed to be the past and future of the modern Egyptian renaissance rather than just a simple crop.

The Egyptian cotton shirt is manufactured with the finest Egyptian cotton, the latest spinning and weaving techniques, superior finishing materials, and unique design. Due to its strong competitiveness, technological advantages, and higher spinning consistency, it outperforms the quality of international kinds. All connected sectors, including those in research, agriculture, production, marketing, and industry, contributed their efforts to this outcome. This ultimately resulted in the creation of direct and indirect employment for one million people with investments totaling 26 billion Egyptian pounds in agriculture and its related

businesses, such as the textile industry, dyeing, and apparel industry. Currently, the textiles industry accounts for 20% of the country's employment, and it is one of the country's major exporters of high-quality cotton. Egypt is additionally one of the world's largest producers of long-staple cotton, which is a type of textile that is known for its superior quality. Egypt supplies around 17% of global long-staple cotton, which is about half the output of the United States (world's top exporter) as well as China.

The Arab World has always been a major contributor to global oil and gas production. It accounts for five of the top 10 global producers and is responsible for approximately 27% of the world's production. Two of the top market players in the Middle East are Saudi Arabia and United Arab Emirates. Saudi Arabia is a major producer and exporter of oil to the whole world. It has the second-largest proven crude oil reserves; holding 15% of the world's proven oil reserves. It retains the largest crude oil production capability at close to 12 million barrels per day and is the top crude oil exporter in the world. The Saudi Arabian economy is mostly based on oil exports; in 2020, oil exports made up over 70% of the nation's total exports in terms of value, and 53% of the Saudi government's revenue stemmed from oil. As for the United Arab Emirates, it is one of the world's largest oil producers. About a 100 billion barrels of proven reserves are located in Abu Dhabi, which is regarded the sixth-largest producer in the world. The country produces approximately 3.2 million barrels of oil and liquids per day. The country's reliance on hydrocarbons continues to be a critical part of its economy. About 30% of the country's GDP is derived from its oil and gas industry, and 13% of its exports. The UAE government continues to rely on the country's oil and gas exports for a huge portion of its revenue.

Instead of being heavily dependent on oil and gas exports, Saudi Arabia and the UAE induced development of industry clusters using oil and gas; including fueling new power stations, and water desalination plants. Additionally, major industrial facilities use gas as feedstock to produce petrochemicals, fertilizers, steel, metal smelting, and other products that in turn supply a booming industrial sector. One of the largest projects that was developed is water desalination plants, as water scarcity possess a serious concern all over the Middle East. Saudi Arabia owns the largest overall desalination plant in the world in Jubail located in the east coast, with an output capacity of 1.4 million m3/d. Additionally, the UAE uses natural gas in the process of oil production designed for pumping into the wells and for desalination of water. Moreover, gas has also been used for the jet fuel consumption; Saudi Arabia consumed a value of 16.91000 barrels per day in 1980 compared to 81.58000 barrels per day in 2019. Similarly, UAE has used 4.2000 barrels per day in 1997 compared to 163.75000 barrels per day in 2019.

The rapid advancements in the Arab World allowed the region to become a remarkable exporter after being limited to merely importing goods. Not only are there products being exported, but there are also national industries being established. These industries utilize national labor force, which in turn develop labor skills and build cadre of local talents. Hence, the overall education system evolves and adjusts accordingly. Therefore, when building the Arab industries, we are building skills, we are building an economy based on exports, and we are

building other industries (upstream and downstream) that increase the competitiveness of local industries to compete globally.

As the Chairman of the Federation of Egyptian Industries, we have been keen to move forward in construction, reform, and innovation and in strengthening the infrastructure of all sectors of the local industry. A strong industry can help provide the necessary financing for the development of various vital systems related to the lives of citizens. These include education, health, and scientific research. The yield from an industry can also be used to fund the establishment of other national industries in the region. Additionally, we work on the establishment of industrial parks in each governorate with the appropriate natural resources and the market requirements. Moreover, we are involved with supplementary industries for large industries in order to create new job opportunities especially for young people as well as the continuous effort to encourage exports, open new markets, and attract new exporters.

It is my utmost pleasure to present you this piece of work; the first book written on the development of industry clusters for innovation in the Arab World. Presenting cases from different countries in the region, this book, we hope, shall add to the knowledge of academics, students, and practitioners in various fields, and shall shed the light on the emergence of Arab world industries as the "new tigers" in the coming years. I dedicate this book to our Arab firms, local brands, and Arab conglomerates that make us all proud!

Thank you and hope you enjoy it!

Eng. Mohamed Zaki El Sewedy
Chairman of the Federation of Egyptian Industries (FEI)

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Preface

Over the last decades, studying industry clusters have risen to prominence and became popular among academics, policymakers, and economic development professionals, who have stressed the importance of encouraging and supporting clusters for national innovation and global competitiveness. Porter's seminal article "The Competitive Advantage of Nations," published by *Harvard Business Review* in 1990, drew the attention to the notion of industry clusters as a group of geographically close-by and linked – vertically or horizontally – industries; helping one another in a mutually reinforcing process. By definition, clusters are a group of similar things, or people, close together, to form a group, either by surrounding something, or by creating something, to achieve a shared vision. Within this perspective, business and industry clusters emerged and later, due to technological developments and globalization, innovation clusters and information clusters followed. Despite the differences among these clusters, but all serve as enablers to have easier access to skills, suppliers, customers, specialized information, and complementary products and services that lead to achieving lower costs and higher quality.

Clusters promote innovation via collaboration among businesses, businesses and research institutions, and businesses and governments, which lead to the creation and sharing of different aspects of knowledge. It promotes professional networking, interfirm links, access to spillover knowledge, and talent pool which are the necessary elements supporting the spawning of innovation. Moreover, clusters can spill over innovation through the demand conditions, due to the presence of sophisticated and demanding local customers who will force industry cluster firms to continuously innovate and stay on the leading edge. In turn, this will be the main pillar to achieve competitive advantage. Another reason for the increasing interest in clusters is its capacity to foster economic development, especially in emerging countries. In addition, the impact of industry clusters extends to improve micro and small firms' performance and induce their internationalization. This is through availing knowledge and information gained from the various cluster members, in addition to creating a pool of specialized labor. Furthermore, these linkages build suppliers' capacities in terms of their specialization and quality, making the way for those suppliers to also have international presence.

Examples from different parts of the world has shown that clusters helped in strengthening competitiveness by increasing productivity, stimulating innovative new partnerships, and presenting new opportunities for entrepreneurial activity and new SMEs' formation and growth. Consider the IT cluster in Bangalore/India, that was identified as one of the most important and growing IT clusters

outside the US and OECD region. Nigeria has another successful example for micro, small, and medium enterprises forming industry clusters, which helped in the creation of competitive advantage for various industries and advanced the Nigerian economy in the past years. To name a few, there is the leather and apparel cluster in Aba, Abia State; the Kannywood cluster in Kano, and the Adire tie and dye cluster in Abeokuta.

Thus, there is no doubt that industry clusters are capable of supporting the Middle East North Africa (MENA) countries in their socioeconomic development and transformation. The region is endowed with a central geographic location situated at the crossroads of three continents, a growing young well-trained and educated population, and a significant share of the world's energy resources. However, the MENA region is increasingly under pressure to face the external and internal challenges that have slowed the economic development of some of its countries. For example, the region has witnessed unprecedented turmoil over the last 10 years, a rapid population growth with high unemployment rates, low economic diversification, geopolitical tensions, and fluctuations in foreign currency exchange, which all threaten long-term economic growth. Despite of these challenges, the countries in the region have embarked on a series of reforms to increase economic openness and diversification, improve productivity, and encourage innovation and competition. These reforms initially led to an increased investment, trade, an improvement in the levels of innovation and entrepreneurship, as well as economic growth. In the core of these reforms, different MENA countries have integrated the establishment of industry clusters as a central component of their 2030 vision. For example, Saudi Arabia is establishing an automotive industry cluster, the United Arab Emirates is giving attention to its Tourism cluster, Egypt is focusing on its textile and furniture clusters, and Morocco is developing its agriculture cluster.

Since most of published research on industrial clusters and its impact has focused on developed countries as well as countries in Asia, this book is one of the few attempts to shed light on the emerging industry clusters in the Arab World. Industry Clusters and Innovation in the Arab World introduces readers to wide array of pragmatic perspectives and case studies on successful industry clusters in the region, and demonstrates the challenges faced by industries in different Arab countries with suggested solutions that are practically applicable. The book constitutes 10 chapters, shedding the light on different industry clusters in number of Arab countries and explaining the macroenvironmental characteristics surrounding these clusters, posing opportunities or threats.

Chapter 1 focuses on the strategies that the Algerian public authorities may employ to build a solid National Innovation System (NIS) to improve economic performance in Algeria. The chapter analyzes the different components of the Algerian NIS, evaluates its learning and innovation capacities, and measures the production of innovation, as well as how these affect the economic performance of the country. Chapter 2 tackles the automobile industrial cluster in Egypt that possesses promising potential yet faces some challenges. The chapter displays the importance of the labor dimension in increasing the labor competitiveness of the cluster and showcases this through two cases of German automobile

manufacturers that pioneered in venturing into the market through employing technical and vocational education and training (TVET).

Chapter 3 takes us to Saudi Arabia, which investigates how clustering promotes knowledge sharing and transfer in an emerging, government-directed industry cluster. It is determined that lateral actors play a key facilitating role, and that cluster knowledge exchange is supported by the existence of formal, informal mechanisms, and interpersonal links among actors. Limited social capital strength and depth, as well as a lack of trust that prevent knowledge sharing are partially explained by the cluster's limited vertical and horizontal actors. Chapter 4 explores how state-business relations (SBR) in the Arab World influence public policy on industrial clusters and the resulting economic benefits from these clusters on innovation and productivity. This chapter suggests that the development of industrial clusters in the Arab world necessitates institutional reform addressing the power relations governing SBR in the region. Chapter 5 examines the competitiveness of the tourism cluster in the United Arab Emirates (UAE) by applying Porter's competitiveness of nation diamond model, with its four dimensions factor conditions, demand conditions, the related and supporting industries, and, lastly, the firm's strategy and rivalry. Chapter 6 applies the five drivers of productivity framework to regional microdata for Egypt and extends it by introducing an index of industrial clusters as an explanatory factor of the productivity performance of local private sector firms.

Chapter 7 illuminates out understanding of the Palestinian context, where the chapter analyzes the challenges facing five Palestinian clusters and to comprehend their dynamics and level of development. The five clusters in Palestine are located in a complex environment that imposes a mix of challenges, which adversely affect their performance. As for Chapter 8, it proposes a framework for developing an index measuring both organizational cluster involvement and organizational supply chain including the three pillars (Economic, Social, and Environmental). The proposed framework aids firms within a cluster in making timely decisions about what needs addressing to improve supply chain sustainability performance. Chapter 9 illustrates the role of higher education establishments in Middle Eastern countries specifically in Saudi Arabia. The contributions of higher education establishments are particularly significant in relation to regional and national innovation system, which have been earmarked as engine for growth of the local economy across the region. Chapter 10 is a practitioner view for understanding the challenges facing agricultural micro and small enterprises in Egypt, and the role of Agro-Industrial Parks (AIP) in creating synergies and competitiveness in the sector.

It is our utmost honor and pleasure to present you with this piece of work that spans across the borders of the Arab World, brining diversified knowledge, experience, and novel ideas for the development of the region. Hope you enjoy it!

Raghda El Ebrashi
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Chapter 1

Construction of the National Innovation System in Algeria and Economic Performances: In Search of Action Policies[1]

Rédha Younes Bouacida

Abstract

Since the end of the 1990s, the Algerian public authorities have implemented research and innovation policies in order to build a solid National Innovation System (NIS) and improve industrial and economic performance. Today, the NIS remains immature, which hinders the learning and innovation processes. Our objective here is to analyze under a broad vision the Algerian NIS by examining its various components, to evaluate the capacities of training and innovation, and to measure the production of the innovation and the economic performances. Our research question is the following: How could the Algerian public authorities build a solid NIS in order to improve economic performance? To answer this question, we use a research methodology that mobilizes three types of complementary indicators in order to analyze the processes of learning and innovation from a systemic and interactive perspective. We also use economic performance indicators in order to put the analysis into a broader perspective. At the end, we propose action policies in favor of the construction of a complete Algerian NIS to improve economic performance.

Keywords: National Innovation System; economic performance; innovation capacities; learning capacities; innovation; Algeria

Introduction

The National Innovation System (NIS) was developed by Lundvall (1988, 1992) and Freeman (1988) to understand the systemic dimension of innovation in advanced countries. Thus, analyzed from the conceptual angle of the NIS, innovation is placed at the heart of economic growth and the performance of

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advanced economies. While the NIS conceptual framework was initially conceived to explain differences in the organization of innovation activities in developed countries, it has been recognized as relevant for examining the situation in developing countries (Freeman, 1995; Gu, 1999; Lundvall, 2007).

Since the late 1990s, the Algerian government has implemented innovation policies to build a strong NIS and improve economic performance. Today, the NIS remains immature and suffers from institutional inertia and underlearning (Amdaoud, 2017). Indeed, the economy remains undiversified and largely dominated by the hydrocarbon sector, which accounts for 97% of exports and generates about 50% of government revenues. As a result, the country is still experiencing great difficulty in triggering the virtuous circle of innovation-based growth to emerge from underdevelopment and ensure decent living conditions for the population.

The analysis of the NIS in Algeria has been the subject of important research (Amdaoud, 2016, 2017; Ben Slimane & Ramadan, 2017; Casadella & Younes Bouacida, 2020; Djeflat, 2009, 2016; Younes Bouacida, 2019). However, few studies (Casadella & Younes Bouacida, 2020; Younes Bouacida, 2019) have used three types of complementary indicators to analyze this NIS in a broad dimension, without using economic performance indicators such as technological and industrial indicators. The objective here is to analyze the different components of the Algerian NIS, to evaluate the learning and innovation capacities and to measure the production of innovation, but also the economic performance.

Our research question is the following: How could the Algerian public authorities build a solid NIS in order to improve economic performance? To answer this question, our approach is the first of theoretical scope around the conceptualization of NIS and the role of institutional dynamics in the construction of learning and innovation capacities. Then, we use three types of complementary indicators in order to analyze under a systemic and interactive vision the processes of learning and innovation. The analysis methodology consists of mobilizing not only secondary sources from data from local and international institutions but also sources from innovation survey data collected from Algerian companies. There are three types of complementary indicators: science and technology indicators (scientific publications, R&D personnel and resources, patents, etc.), composite indicators (the Global Innovation Index, the Global Competitiveness Report, etc.), and indicators from the results of surveys on innovation (the introduction of new products and processes, innovation expenditure, staff training, acquisition of licenses and patents, sources of knowledge, obstacles to innovation, etc.) (Lizunka & Hollanders, 2017).

While developing countries have a wide choice of indicators to use for policy purposes, all indicators have their strengths and weaknesses. However, the use of these three types of indicators is quite complementary for analyzing NIS and innovation processes (Lizuka & Hollanders, 2017). These authors explain that "composite indicators are available at low cost and provide easily comparable indicators with other countries. However, these alone are not enough to understand innovation processes and develop policies in developing countries. Science and Technology (S&T) Indicators, as narrowly defined proxy measures of factors strictly associated with innovation, provide credible and analytically sound options. But without a contextual understanding of innovation processes in

developing countries, it is difficult to fully exploit the results of the analysis. Indicators linked to innovation surveys, through the direct collection of innovation information from enterprises as key actors, offer the best source of information on innovation. Innovation survey data are expensive to obtain though. And to have policy-relevant results, population samples must be carefully selected to match policy needs" (p. 26). To go further and put the analysis in a broader perspective, we also use economic performance indicators. These are indicators of industrial and technological performance, such as the value added of the manufacturing sector per capita, exports of high-tech products, etc.

This research work will be organized in four parts. In the first part, we will review the NIS, capacity building, and economic performance. In the second part, we will present the NIS in developing countries. In the third part, we will use three types of complementary indicators as well as some industrial and technological performance indicators in order to analyze the Algerian NIS and to evaluate both innovation and economic performance. Finally, in the fourth part, we will propose policies for a comprehensive NIS in Algeria to improve economic performance.

National Innovation System, Capacity Building, and Economic Performance

Conceptual Framework of the NIS

A National Innovation System can be defined as all the networks of institutions in the public and private sector (companies, universities, laboratories and research centers, financial institutions, intellectual property institutions, etc.) that produce, absorb, use, and disseminate scientific and technical knowledge within national borders (Niosi, Bellon, Saviotti, & Crow, 1992). The state therefore plays an important role in the development of the NIS. Indeed, it defines scientific and technological policies and contributes to the establishment of a climate of trust between the various actors to promote the innovation process.

The construction of the NIS concept approach has developed from two different perspectives: "narrow" and "broad." The narrow approach is developed by Nelson (1993). It is limited to R&D activities, science and technology, and sometimes education. It only involves institutions and organizations linked to research and exploration activities (R&D laboratories, research centers, universities, etc.). As for the broad approach, it is developed by Freeman (1988) and Lundvall (1992). In this approach, innovation is considered as a continuous cumulative process also emanating from the diffusion, absorption, and use of knowledge (Johnson, Edquist, & Lundvall, 2003). At the macroeconomic level, the broad conception of the NIS therefore extends to all formal organizations and institutions (governmental structures, compulsory education and vocational training establishments, rules, laws, etc.) and informal organizations and institutions (culture, customs, national traditions, values, routines, etc.). In addition, it is linked to all the financial means available to public authorities to act on economic activity, monetary policies, rules for problem-solving, labor market regulation, etc. These affect the innovation system. Today, the broad approach is

generally the most used (Chaminade, Lundvall, & Haneef, 2018) to explain innovation performance.

NIS and Building Learning and Innovation Capacities

In a conception of NIS in the "broad" sense, the construction of innovation capacities is of great importance and represents a tool for developing innovation policies (Adeoti, 2002). Innovation capacities are rooted in technological capacities. The latter represent the skills, knowledge, experience, routines, as well as the structures and institutional links that are necessary for companies to innovate (Bell & Pavitt, 1993). Therefore, innovation capacities are linked to the ability to enhance the skills of economic actors to use knowledge and skills in innovation processes. Innovation capabilities are therefore linked to R&D activities and learning processes. But they are also linked to the benefits of basic research activities. This is therefore a consequence of the organization of the NIS, in which the learning links (science/industry interface) are well developed. Innovation capabilities are also linked to the ability of companies to combine internal knowledge with external knowledge allowing new applications in production processes.

Innovation capacities are developed by building learning capacities. Learning refers to the process by which one can solve problems, acquire new knowledge, that is to say, learn, and learn to learn according to an expression of Lundvall. It also represents the process of acquiring know-how not only through observation, imitation, trial, and repetition but also through study, research, and exploration or relearning processes (Johnson, 1992). As for learning abilities, they are associated with acquired knowledge and experience. They also refer to the ability to develop knowledge and the ability to improve business performance over time.

Learning within the firm is a cumulative, continuous, and dynamic process (Nelson & Winter, 1982). It has different forms such as learning by research, learning by observation, learning by imitation, and learning by training. But the main forms of learning are learning by doing, learning by using, and learning by interacting (DUI). Beyond these routine learning processes, there are also organizational learning processes that oppose individual learning processes (Edquist, 1997). These are controlled by people and are linked to the formation of skills (education and training, continuing education or experience, etc.). The individual learning process can be defined as a process, a series of cognitive or physical actions allowing the individual to increase his knowledge or his know-how (Guilhon & Weill, 1996). As for organizational learning processes, these are collective mechanisms controlled by companies (R&D and DUI). Organizational learning is therefore apprehended as the operation by which it is possible to increase the collective knowledge of a company by carrying out an evolution of the mental models shared by individuals by simple loop (modification of operating frameworks) or double loop (modification of frames of reference) (Argyris & Schon, 1978). It thus includes the processes of dissemination, confrontation, and exchanges likely to build collective knowledge. The organizational learning process thus allows the company, over time, to develop skills to innovate. In short, organizational and individual learning processes are essential for understanding innovation processes and estimating the economic performance of companies.

Along the same lines, Gregersen and Johnson (1997) separate direct learning processes from indirect learning processes. The former essentially concern the university system, research centers and laboratories, and formal organizations. The latter concern the routine learning processes within the companies described above. It is obvious that these two learning processes are essential to the development of learning and innovation capacities. Overall, learning and innovation capacities are at the heart of the construction of NIS. Therefore, the developing countries that manage to take off are those whose technological capacities increase and improve gradually, thus allowing the construction of innovation capacity for economic performance.

Innovation at the Heart of Economic Performance

Innovation has become a strategic issue for promoting economic performance and creating wealth. Indeed, today, the world economy is characterized by a phase of radical innovation in the sense of Schumpeter involving new technologies, profound organizational transformations of companies and markets, as well as modes of regulation (Dutraive, 2008). This trend is linked to the role of science and technology, which has become essential for the performance of the production and service sectors. Therefore, innovation, technical progress, and capacity building are among the major elements determining economic performance, both business performance and macroeconomic performance (Haudeville & Younes Bouacida, 2022).

Thus, in the knowledge economy, intangible assets have become strategic elements for economic performance. As such, endogenous growth theory models emphasize the importance of capital accumulation in all its different forms: physical capital, human capital, technical capital, technological capital and public capital. Thus, based on the concept of learning by doing highlighted in Arrow (1962), Romer (1986) explains in his growth theory model the increasing returns that accompany the accumulation of knowledge and skills. In another model, Romer (1990) shows the role of R&D activities in the accumulation of knowledge to promote innovation processes. On the other hand, Lucas (1988) adopted the concept of learning to explain the increase in returns to human capital. According to this economist, human capital, that is to say the stock of knowledge, know-how and skills incorporated into individuals as a result of training and education, has a positive effect on growth because it improves labor productivity. As a result, human capital has a constant marginal productivity and is the source of positive externalities. This justifies the intervention of public authorities through education and training policies to promote the development of human skills. Finally, growth and economic performance also find their source in investment in public infrastructure (Barro, 1990).

All in all, knowledge has thus become quantitatively and qualitatively more important as a factor of production (Smith, 2000) and represents the main resource for the creation of value. It is at the heart of the new economy and now occupies a key place in innovation processes and business performance. These performances are dictated by the imperative "to offer products which are in demand on the world market, in terms of assortment, quality, compliance with international health or technical standards, delivery times, services accompanying

the delivery products, and this at prices compatible with the prices in force on this market" (Haudeville, 2012, p. 14). This is the general rule that generates real rents and makes it possible to generate high amounts of added value.

NIS in Developing Countries

Immature NIS are the least developed systems and concern developing countries. They are generally characterized by a fragile institutional framework, bureaucratic governance, and inertia in the freedom to operate and regulate markets and inefficient public services. On arrival, the effective application of innovation policies in the field is penalized. As highlighted above, the Algerian NIS is immature and suffers from institutional inertia and underlearning (Amdaoud, 2017). As a result, this developing country still has great difficulty in triggering the virtuous circle of growth based on innovation to improve its economic performance. Thus, we assume that in Algeria, the weak regulatory environment, poor governance, as well as institutional rigidity do not allow the construction of an NIS and the development of an environment favorable to learning and innovation processes (*H1*).

The NISs of developing countries are incomplete due to the inadequacy and/or ineffectiveness of innovation policies. Indeed, the institutional structures in terms of R&D are weak and the scientific and technological infrastructures are insufficient. Expenditure on R&D activities generally does not exceed 1% of GDP (Haudeville & Le Bas, 2018). This seems to be the case for Algeria, since, despite the innovation policies that have been in place for two decades, the NIS remains underdeveloped (Younes Bouacida, 2018) (*H2*). This seems to be linked to the weakness of the institutional structure in terms of R&D, which does not generate specific actions promoting the development of knowledge production and innovation (Casadella & Younes Bouacida, 2020) (*H3*). Thus, in developing countries, research activity is largely concentrated in the public sector. Research programs are generally academic and lack coordination and ambition to achieve results. Research in the private sector is relatively underrepresented. The weakness of R&D efforts limits the increase in the stock of knowledge and automatically reduces the capacity to absorb external knowledge (Cohen & Levinthal, 1990) in a situation where the part of external origin for these lagging countries scientifically and technologically is supposed to be dominant. Also, the overall system by which agents and institutions can increase their stock of knowledge is weak. And the mechanisms that allow the reappropriation of the return on investment in R&D to encourage innovation efforts (intellectual property rights, patents, etc.) are poorly developed. The heterogeneity of NIS between developed countries and developing countries also stems from weak networking between the various research centers, public and private, which limit the circulation and promotion of knowledge (Younes Bouacida, 2019).

The modest economic performance of developing countries is the result of weak learning and innovation capacities. The weakness of innovation capacities is primarily linked to the limited efforts in terms of investment in R&D to produce, use, and absorb knowledge. Then, it is linked to the unavailability of a trained

workforce and average capacities in qualified people, which do not favor the possibilities of production and valorization of knowledge in economic activities. This is the consequence of the weakness of the different forms of learning, namely, apprenticeship in companies, proper, continuous, or professional training and theoretical training, in particular the training of scientific and technical skills in the higher cycle, which is generally disconnected from the production system (Haudeville & Younes Bouacida, 2018). This seems to be the case for Algeria (Casadella & Younes Bouacida, 2018). We therefore hypothesize that, among the systemic failures of the NIS that hamper innovation performance, there is the low quality of education and the formation of scientific and technological skills in the higher cycle to promote effective capacities, learning, and innovation (*H4*). These forms of learning largely condition the efficiency with which the resources, which are never inexhaustible, are used (Casadella & Younes Bouacida, 2019). Weak innovation capacities are also linked to weak interactions between the different actors of the NIS to promote learning capacities. These capacities are lacking in developing countries because of the absence of the state as regulator and coordinator between the different actors of the innovation system in order to develop the sharing and transfer of knowledge. Finally, weak learning capacities are linked to the lack of learning opportunities for local skills in the labor market in order to improve the knowledge base (Arocena & Sutz, 2003). In addition, the weakness of learning capacities is due to the inability of economic actors to establish relations with other companies in their environment in order to obtain knowledge and thus benefit from technological advances.

Ultimately, the NIS approach in developing countries is represented by innovation processes in low- and medium-technology sectors (Johnson & Lundvall, 2003 cited by Djeflat, 2009). Unlike developed countries where innovations in high-tech sectors are sophisticated and grounded in science and radical innovation, innovation in the Global South reflects routine learning perspectives within small traditional structures (Djeflat, 2009). Innovation is therefore the result of informal and collective connections between actors and involves learning techniques through practice, use, and interaction (Djeflat, 2009). NISs in developing countries are poorly organized and/or incomplete to promote innovation. The focus is then no longer on what constitutes the systems (actors, networks, etc.), but rather on the missing components of these systems, according to a "hollow" analysis (Haudeville & Le Bas, 2018). In any case, the solutions to these dysfunctions will necessarily be specific to each country and its context to build complete and structured NIS.

Construction of the Algerian NIS, Capacities, and Economic Performance

Research and Innovation Policy

The emergence of an innovation policy in Algeria dates back to the end of the 1990s. It was part of the national strategy of building an efficient NIS to promote a knowledge-based economy. This strategy resulted in the creation of a legal and

regulatory framework and the establishment of financial measures for research activities as well as the establishment from 1998 of five-year programs for the development of research and innovation (Younes Bouacida, 2006, 2018).

It can therefore be considered that, for more than two decades, there has been a continuous and growing commitment in Algeria to scientific research and technological development, and that these areas now constitute stated priorities. Overall, the scientific and technological institutional structure in Algeria is not too different from that of developed countries. Indeed, it is centralized and steered by the National Council for Scientific Research and Technologies (NCSRT), an independent body, placed under the supervision of the prime minister. It is directly involved in the development of research activities within universities and research centers and ensures the intersectoral coordination of research activities. It is also responsible for formulating opinions and recommendations on the major orientations of the national research policy and determining the priorities between the national programs and assessing their execution. The NCSRT is installed at the top of the pyramid to lead the national research policy. The public research system is made up of 48 universities, more than 1,500 research laboratories, around 30 research centers under the supervision of the MESRS and other ministerial departments, and around 10 support centers for innovation and the transfer of technologies. To this must be added a dozen research units, six R&D agencies that ensure the coordination of research projects, as well as a few support centers for innovation and technology transfer. Also, the Algerian National Institute of Industrial Property (ANIIP) was created. Finally, the National Agency for the Valorization of Research and Technological Development Results (NAVRTDR), providing the science/industry interface, as well as the National Agency for the Promotion and Development of Technological Parks (NAPDTP). Despite this rather important institutional structure, we will see later that the individual and collective dynamics of all these research institutions within the National Innovation System is quite timid, and moreover, the learning and innovation processes are limited (MESRS, 2020).

Capacities and Innovation Activities

Methodology of analysis: in analyzing different aspects of the NIS in a broad conception, there are generally three types of indicators (Lizuka & Hollanders, 2017):

- Science and technology indicators that measure activities concerning the creation, dissemination, and transfer of knowledge such as scientific publications, citations, R&D personnel and resources, patents, etc.
- Indicators resulting from surveys of business innovation. They are linked to the results of innovation (the introduction of new products and processes, the percentage of sales of new products, etc.), the expenses of innovation (training of personnel, acquisition of licenses and patents, product design, market analysis, etc.), and information on what precedes innovation (sources of