

The knowledge economy in Algeria: state of the art and challenges

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Abstract:

The aim of this work is to show the importance and the role of the knowledge economy in the competitiveness of companies and the growth of national economies. The success of a Knowledge-based Economic Strategy (KBE) calls for creating an environment conducive to innovation and creativity that stimulates competition and guarantees intellectual and industrial property rights.

Over the past few years, Algeria has adopted a development strategy based on the knowledge-based economy, to boost economic growth, and this must be further pulled out by highly knowledgeable sectors.

After examining the various pillars of this New Economy, the article shows that despite the considerable efforts undertaken by Algeria, the expected results more particularly on a qualitative level have not been achieved. The level of knowledge competitiveness is even lower. The field of research and development is far from fulfilling the demands of competitiveness and integration within the knowledge-based economy because of the obsolete nature of the knowledge gained. Algeria must establish these efforts in this field, and that the state must play the orchestra role in that vision of the information economy.

Keywords: Knowledge Economy, Information Technology and Communication (ICT), research and development R&D, innovation.

JEL Classification: O14, O32, O31.

اقتصاد المعرفة في الجزائر : الواقع و التحديات

ملخص :

يهدف هذا العمل إلى إظهار أهمية ودور اقتصاد المعرفة في تنافسية الشركات ونمو الاقتصاديات الوطنية. إن نجاح الاستراتيجية الاقتصادية القائمة على المعرفة يدعو إلى خلق بيئة مواتية للابتكار والإبداع تحفز المنافسة وتضمن حقوق الملكية الفكرية والصناعية. على مدى السنوات القليلة الماضية، تبنت الجزائر استراتيجية تنموية تقوم على الاقتصاد المبني على المعرفة، لتعزيز النمو الاقتصادي، والذي يجب أن يتعزز بشكل أكبر من قبل القطاعات ذات المعرفة العالية. بعد تحليل الركائز المختلفة لهذا الاقتصاد الجديد، يوضح المقال أنه على الرغم من الجهود الكبيرة التي بذلتها الجزائر، إلا أن النتائج المرجوة، وبشكل خاص على المستوى النوعي، لم تتحقق. مستوى القدرة التنافسية المعرفية لا يزال ضعيفا. مجال البحث والتطوير بعيد كل البعد عن تلبية متطلبات التنافسية والتكامل في الاقتصاد القائم على المعرفة وذلك راجع إلى الطبيعة المتقدمة للمعرفة المكتسبة. يجب على الجزائر بذل مجهودات أكبر في هذا المجال، وعليها أن تلعب دور أساسيا في تلك الرؤية لاقتصاد المعرفة.

الكلمات المفتاحية : اقتصاد المعرفة، تكنولوجيا المعلومات و الاتصال، البحث و التطوير، الابتكار.

تصنيف JEL : O14 ، O32 ، O31.

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1. Introduction :

The knowledge economy is a current of economic thought centered on the driving role of knowledge in the competitiveness of companies and the growth of national economies. Knowledge is becoming a central concept in economic organization and development, and it is becoming increasingly important in all factors of production. From now on, companies do not only count the tangible products and services they market. They also include the production of knowledge, sources of innovation and creativity, which serve to improve products and services, increase productivity and make the company more competitive.

In the world of research, public administration and business, the structural changes observed over the years have led to a proliferation of analyses highlighting the role of innovation and knowledge in the competitiveness of companies and nations. The relationship between knowledge and growth is complex and not immediate, because the effective use of information and communication technologies (ICT), like other technologies, is based on a process of reorganization and learning at all levels, throughout the economy. The current period is marked by an increased role of knowledge in all its forms in the functioning of economies. Countries that are able to organize, manage and exploit their knowledge capital effectively are those that perform best economically. This trend seems to be confirmed also for knowledge-intensive companies and in the allocation of the highest-paid jobs. This strategic role of knowledge explains the increase in investment in research and development, training and education as well as in intangible investment in most countries.

Since its independence, Algeria has adopted a development strategy based on the industrialization of the economy. The objective was to reach a stage of development comparable to that of developed countries and to achieve economic and technological independence. The situation at that time seemed favorable to such an initiative. However, after nearly three decades of activity, the results are not as ambitious and encouraging. By default, the appropriation of the technology by contractual formulas did not allow the constitution of an Algerian know-how to undertake suitably the process of industrialization. From now on, the Algerian economy is still at the stage of a technology consumer country. The crisis of the 80s unmasks the reality of the Algerian economy. The structural adjustment program launched in 1994 has produced positive effects but insufficient since growth is still fragile and dependent on the evolution of hydrocarbon prices.

Algeria can claim an honorable world place in this economy if its human potentialities and its intellectual capital are well mobilized. The various indicators show the important progress in the direction of the economy of knowledge accomplished in Algeria; nevertheless delays exist as well compared to the neighboring countries. Important progress has been made in particular in the field of institutional reforms, research and development (R&D), education, and ICT (information and communication technology), which are called the pillars of the knowledge economy. However, these pillars still need to be strengthened in order to create the right investment climate and to allow for dynamic comparative advantages.

The essence of our analysis in this work will be to know rather how can Algeria use the knowledge economy as one of the vectors of their economic and social development? The sub-questions are among others:

- What are the challenges that prevent Algeria from taking advantage of this phase of the economy?

- Does the current level of mobilization of the knowledge resource allow Algeria to be competitive?

For this purpose, this paper will attempt to see the level of mobilization of its knowledge and will therefore examine the state of play in relation to investment in the different pillars of knowledge. The article is structured in three parts. The first part focuses on the general concept of the knowledge economy. The second part deals with the contribution of the knowledge economy to the economic development of countries. The third part analyzes the knowledge economy in Algeria through the pillars of the knowledge economy, innovation capacity in Algeria, and the main obstacles that limit the process of production and dissemination of knowledge.

2.General concept of the knowledge economy:

This first part will aim to identify and clarify the concept of "knowledge economy", through four important points: a definition of the knowledge economy, a distinction and combination between "information economy" and "knowledge economy", the articulation and combination between knowledge and innovation, and finally, the pillars of the knowledge economy.

2.1.Definition of the knowledge economy:

It is during the 20th century that progressive and slow structural changes have been particularly observed in the determining engine of economic growth. In fact, there is evidence that many authors point out the entry into a new phase of capitalist development (vonortas, 2013). The evolution was carried out in this way: first, it was the recognition of the passage from an agricultural economy whose key resource was the land and then to an industrial economy in which raw materials and low-skilled labor was the main resources. Finally, there is that of today's economic phase where competitive advantages are now translated in terms of innovative knowledge (RADWAN & PELLEGRINI, 2010).

This current phase of the world economy, which describes the stage of development of society when the service sector generates more wealth than the manufacturing sector of the economy, illustrates what is referred to as the society post-industrial (LÉVY & JOUYET, 2006). The use of the concept has been more frequent in statements, speeches and publications by companies and international organizations during the 1990s (CLÉVENOT & DOUYÈRE, 2013). The organisation for economic co-operation and development (OECD) has proposed a general definition which appears to have been adapted by several authors. Thus, the term of this phase of the economy considered also, among others, under the term «knowledge-based economy», is defined as an «economy that is based directly on the production, dissemination and use of knowledge and information (Sossi & Fatima, 2012) ».

Three major trends in this knowledge economy are clearly distinguished: «the increase of intangible capital, the expansion of knowledge-intensive activities and finally the advent of highly skilled workers and the transfer of knowledge (Foray, 2009)», These three major trends are related to technological changes, more precisely to the continuous acceleration of the rate of innovation in the field of ICT. This acceleration raises hypotheses that are sometimes empirically disproved, such as the idea that ICTs have favored a substitution of skilled labor for unskilled labor in the labor market. All things considered, these trends, which are particularly reflected in the growth of OECD economies, can be explained through four pillars defined by the World Bank and mobilized to measure performance in the *Knowledge Economy Index (KEI)*: education and human

capital, information and communication technologies (ICT), research, development and innovation, as well as institutions and economic incentives (Rietdorf, 2013).

2.2.Distinguishing and combining the «information economy» and the «knowledge economy»

These different aspects of knowledge allow us to conclude this definition by emphasizing the distinction (but also the combination) between the information economy and the knowledge economy (sometimes referred to as the "knowledge-based economy"), which are often mistakenly confused.

- The Information Economy:

Of a more quantitative nature, it refers globally to the digital revolution and contributes largely to the diffusion in time and space of digital knowledge, through information and communication technologies (ICT). The costs of reproduction of information are almost zero and tend towards 0. Its value is also associated with its freshness. It concerns the creation, manipulation, processing, transmission, distribution and use of information (Vinceneux, Colletis, & al, 2008).

- The knowledge economy:

It deals with cognitive capacities that generate knowledge, an economy in which investments are made in education and training, research and information systems, with a marked use of information networks. It is the economy of content, of virtual worlds and of digital creation, an economy of creation, of the audience, of the immaterial, of the ubiquity of the centers of production and consumption, with profound questions on the evolution of the notions of value, of property, of innovation, of consumption. An economy in which raw materials are skills, and the means of control and hoarding are no longer land or capital, but the audience (Smith, 2002).

2.3.The articulation and combination of knowledge and innovation:

It is important to emphasize the relationships and interactions between knowledge and innovation, which can be defined simply, at first glance, as "an invention that has spread", often in the form of successful commercialization (which classically differentiates it from invention). Innovation, especially of a technological nature, which is in many respects the engine of growth, feeds on various aspects and configurations of knowledge (Gaglio, 2011).

This articulation between knowledge and innovation most often appears as a combination resulting from the encounter (formal, informal, accidental.....) of actors with differentiated or complementary knowledge and experience and formal organizations (academic institutions, companies, laboratories...) or less formal organizations (professional communities, professional networks....). In other words, knowledge recombination is the essence of idea creation, and interpersonal interaction is a key component of knowledge recombination (Ruggles, 1997). In this logic, knowledge, in its different aspects, can naturally lead, in the form of extensions or a culmination, at a given moment and in a particular context, to an innovation. The formation of knowledge-intensive activities in a given sector owes nothing to chance, but is essentially dictated by the imperatives of innovation.

Knowledge is the most important factor in innovation. However, innovation is different from other economic activities because it involves the creation and deployment of knowledge. Above all, it is both a social and cognitive process. A social process "that brings together individuals from different disciplines, with different skills, using different

lexicons, driven by incomparable motivations". In this respect, it is not generally the result of the work of an isolated inventor, but rather "the combination of different and complementary currents in the field of knowledge". It is a cognitive process that relies on the creative imagination of individuals (Feldman, 2002). Innovation can be defined, therefore, as "the capacity to melt or combine different types of knowledge to make something new, original, unprecedented, which has a Economic value", linked to the reception of the market. It is well situated at the crossroads of "cognitive diversity" (Landmore, 2017).

2.4. The pillars of the knowledge economy:

Four key pillars of the knowledge economy can be distinguished:

- Education:

As the knowledge economy is at the heart of knowledge-based societies and jobs are increasingly skill-intensive, education as a first pillar is an essential prerequisite for investment in human capital. The continuation of the educational effort in countries is essential, with a particular focus on higher education, which places universities as important players on the international scene. This is especially because, education (at the higher education level) is the pillar of the knowledge economy and the acquisition of knowledge through learning the tool of progress for the individual. Generally speaking, the objective is to encourage the development of individual talents, but also to recognize them and understand that training is no longer the prerogative of a single age, but must necessarily accompany all stages of life. In this knowledge-based economy, where human wealth is the primary factor of growth, it is the skills of scientists, the talent of research teams, the creativity of artists, the dynamism of companies and industries, including cultural industries (OECD, 1996).

- information and communication technologies (ICT) :

In all approaches to the knowledge economy, ICT plays a fundamental role. They are integrated as one of the four pillars, one pillar related to the national innovation system, and one pillar related to the institutional and incentive framework. The intensive use of ICT is considered here as an essential and dynamic element (Dahlman, 2003). At the theoretical level, it is clear that ICT contributes significantly to the properties of knowledge as an economic good. The diffusion of knowledge through the fastest means, notably the Internet, becomes difficult to control because of the globalized access to knowledge, and this despite all the progress made in terms of protection, traceability, penalties, etc. If its character as a private good that can be monetized on the market is reduced, the propensity to create externalities is accentuated, in particular for agents in the economies of the South whose means, both financial and technical, remain relatively weak. The link between ICT use and externalities is obvious. In a similar way, the non-rivalry character is accentuated through the reproduction capacities that are increased tenfold by the use of computers in terms of the exceptional speed of duplication and the phenomenal storage capacities. The effects on the transfer of information are quite obvious, which is not the case for the transfer of knowledge, the specific character of which will largely depend on the degree of codification of this knowledge (OECD, 1999).

- Innovation:

The formation of knowledge-intensive activities in this or that sector is not a matter of chance; it is essentially dictated by the imperatives of innovation. It is a response to the dual need to generate a rapid pace of technological innovation in order to continuously

offer new products and services on a global scale, and to overcome the violent waves of obsolescence of knowledge and technologies. A central element of knowledge-based economies is thus innovation, which has replaced price as the fundamental rule of the game (Powell & SNELLMAN, 2004). A technological base conducive to the systematic search for innovation, certain conditions of competition (oligopolistic and global), and adequate institutions are the main factors that place innovation at the center of the economic game in a growing number of sectors. This trend implies a prominent role for intellectual capacities, capacities to produce and mobilize knowledge of all kinds and learning capacity, over natural resources and physical factors in determining economic performance. Another aspect, also linked to innovation, is the ever closer integration of all stages of the production process, from the R&D project to the production of the good or service and the relationship with the consumer, who is himself more closely involved in the design of the product (Baumol, 2002).

- Institutions and economic incentives :

A reform of economic institutions and their mode of organization will have to be carried out because of the intensification of competition in this knowledge-based economy. Also, as knowledge becomes a competitive issue, the questions of intellectual property and protection of innovation are moving to the forefront of the concerns of firms and States (AMABLE & ASKENAZY, 2003).

Sound macroeconomic policies, good overall governance, and a business-friendly environment are the basis for knowledge-based strategies, as they are for almost all development strategies. Further improvements in the business climate are needed to stimulate business creation and attract foreign investment, which together promote growth and competitiveness. Several countries have made considerable progress, as reflected in the World Bank's Doing Business surveys, under pressure from the business community and with the help of international institutions (World.Bank, 2011).

3.the knowledge economy, a vector of contribution to economic development :

The global market is well aware of the pre-eminent role of intellectual assets in economic growth. Intellectual assets encompass a variety of intangible assets: research, data, software, and design skills that reflect or express human ingenuity. The creation and application of knowledge enables companies to grow in a competitive global economy, and to create high-paying jobs. Intellectual assets improve the comparative advantage of countries and companies, and enable them to position themselves in higher value-added sectors, activities and segments of the global market. Indeed, in global value chains, most of the value of a product or service is generated upstream, at the product design, R&D and basic component production stage, or completely downstream, at the marketing and branding stage. In many OECD countries, and for many years, business investment in intellectual assets has grown faster than investment in machinery, equipment and buildings. This is particularly the case in the United Kingdom and the United States, where this has been accompanied by productivity growth. China and Brazil are also making concerted efforts to develop intellectual assets to fill higher value-added segments of global production chains (OECD, 2013).

Since the OECD diagnostic report (2001), it has been known that contemporary economies have gradually become knowledge-based economies (Bresnahan, Brynjolfsson, & Hitt, 2002). The role of knowledge as a factor of development is now better and better taken into account: "the notion of knowledge economy has become an obligatory framework of reflection for most developed economies but also for many developing

countries". Following the new growth theories, which integrate the contribution of innovation, research and development and education, knowledge is now recognized as one of the key elements of growth and development (BENNAGHMOUCH, 2008). This is evidenced by the numerous research programs launched since the beginning of the century by the Institute of Research for Development (IRD), the World Bank and the United Nations (UN) system. The experience of Asian countries since the 1960s and the more recent experience of other emerging countries is there to remind us of the conditions for a sustainable overcoming of underdevelopment and poverty. But if the broad outlines of the problem have been identified, the details of the applications remain to be put in place, and this is the challenge of research on the knowledge economy in countries that are not among the leading scientific and technical countries. "If it is still possible to transfer information, formatted and structured data sets..., it is more difficult to transfer knowledge, a product of the cognitive economy based on the production of knowledge from the collection of information, as well as on the appropriation, sale and use" (Nordhaus, 2001).

The reduction of the North-South digital divide is at the top of the international agenda. International development institutions expect it, as in the case of South East Asian countries, to spread a process of emergence that would extend to all peripheral countries. Indeed, a study carried out by United Nations Conference on Trade and Development (UNCTAD) on the use of ICT concludes that the use of ICT for developing countries could have repercussions on productivity at the same level as that measured in developed countries. Thus, UNCTAD specifies that, theoretically, the introduction of ICTs should improve the productivity of enterprises, provided that they make the appropriate organizational changes. The gains are linked to a better reactivity of the company to the evolution of its environment: management of suppliers and customers, enlargement of the product range, personalization of the services offered and, globally, a better consideration of the specificities of the demand and optimization of production (UNCTAD, 2007-2008).

UNCTAD's assessment of the impact of ICT on productivity was carried out in Thailand. This case shows a significant difference in productivity for firms that use information technology and in proportions that are close to those observed in developed countries. The diffusion of ICT reduces transaction costs and creates a better match between supply and demand, thus stimulating the growth of new markets. Externalities and spillover effects are also invoked to explain the importance of comparative ICT. But these induced effects are particularly difficult to assess. In the context of development economics, ICTs should allow the emergence of new economic opportunities by facilitating the diversification of production and exported goods, and by contributing to a move up the value chain. An improvement in the banking system could be authorized by the adoption of ICTs, which could improve customer information and allow part of the financial sector to leave the informal sector, which generates transaction costs. This reduction in costs would also allow an increase in the amount of money devoted to investment. A last element consists in the production of collective knowledge and the use of collective knowledge thanks to free software. This element of free access is a favourable element for the catching up of poor countries. On the other hand, the question of property rights on proprietary software arises and the need to adopt a derogatory regime for poor countries. But the agreement on TRIPS (Trade-Related Aspects of Intellectual Property Rights) may allow for such a situation. Nevertheless, all these potential improvements do not come without new problems: the new services generated may be the source of new difficulties, such as the generation of trust in the context of computerized transactions and their security. Moreover, the very decreasing costs of these devices may constitute an obstacle to their diffusion,

which is why UNCTAD plans to take this issue into account in the implementation of its development policy (UNCTAD, 2007,2008).

4. Algeria's position on the scale of the knowledge economy:

In 2002, the World Bank Institute launched a reflection and consultation process on the theme of the Knowledge Based Economy (KBE) and Knowledge for Development (KFD) and the prospects for a number of developing countries to join this process. For the MENA region, a work program continued to identify the challenges of the knowledge economy, to identify the needs in terms of diagnosis on the position of the countries of the MENA sub-region and to contribute to the implementation of programs for the establishment of the knowledge-based economy (KBE). Algeria has fully participated in this process of reflection and implementation of the KBE in the subregion (World.Bank, 2004).

The process in Algeria began at the Marseilles I conference in 2003 where a large delegation took part in the event. The public institutions represented included the Center for the Development of Advanced Technologies (CDAT), and a representative of the Prime Ministry. Other participants were either from the private sector, training institutions, or individuals associated in some capacity. In 2003, a conference organized by the Ministry of Posts and **ICTs** will focus on e-Governance supported by the World Bank (Borrás & Edquist, 2013).

The second meeting of Marseille II in 2004 will give rise to a beginning of institutionalization of the process. It was also during this meeting that the first study on the Knowledge Economy in Algeria: state of the art was presented. The institutional dimension was more prominent: in addition to training institutions, the private sector, the National Economic, Social and Environmental Council (NESC) was also represented. At the initiative of the World Bank Algiers office, a meeting was organized between the participants of the Marseille II meeting. It aimed essentially at setting up an informal think tank for follow-up activities. In 2004, the NESC decided to take up the issue of the knowledge-based economy and prepared a report that was presented and debated at its 25th ordinary session on 7-9 December 2004 (DJEFLAT, 2010).

The third step is the one that followed the Tunis meeting, the Algerian group for the knowledge economy, which was formed in 2005 and outlined a work program, one of the major objectives of which was to prepare the first national conference on knowledge-based economy.

In May 2006, the first national conference on the Knowledge-Based Economy was held at the University of Mostaganem. It was co-organized by the Maghtech network and the Algerian Association for Technology Transfer (A2t2) and had as its precise theme: "the knowledge-based economy at the service of growth and sustainable development: what challenges and opportunities for Algeria?" on April 29/30/2006, which was attended by several stakeholders: training and research institutions, entrepreneurs, university researchers, Algerian experts at the national level and those of the diaspora. Also present were Mrs the Minister delegated to research and Mr. the Minister delegated to rural development (DJEFLAT, 2010).

4.1.Openness driven by the dynamics of the knowledge economy :

The opening arranged by the association agreements and the free trade areas with the European Union is a space largely integrated into the logic of operation dictated by the knowledge-based economy since Lisbon. The forthcoming accession of Algeria to the

World Trade Organization (WTO) requires the mobilization of a mass of knowledge comparable to competing countries at least. At the African level, the prominent role of Algeria in the NEPAD program (New Partnership for Africa's Development) requires a massive mobilization of knowledge and innovative approaches. The opening up of the market will bring into competition not only companies with different levels of efficiency and preferences, but also economies that are differently inserted in the globalized knowledge. However, there are a number of questions about the "how to" of effectively integrating the KBE (Philippe, 2006).

4.2. The pillars of the knowledge economy in Algeria :

We will examine the state of the art of the different pillars of knowledge and the position of Algeria on the knowledge scale. Several systems of knowledge measurement are currently proposed in the literature. But the most developed barometer today is the one proposed by the World Bank. This one proposes a methodology of knowledge measurement (Knowledge Assessment Methodology) based on 109 variables grouped in four dimensions or in four pillars of knowledge (education and training, research and development, ICT and infrastructure and institutions and incentives) (Fagerberg, Srholec, & Verspagen, 2010).

- **Education:**

Algeria spent 4.5% of its gross domestic product on education in 1999. Although it is important, this share of GDP devoted to education remains lower. It should also be noted that the share of GDP devoted to education seems to have been in constant decline during the 1990s. This decline was much more marked in compulsory education, where operating expenditures measured as a percentage of gross domestic product fell by 0.7 percentage points between 1993 and 1999, than in secondary education, where they fell by only 0.2 percentage points between 1993 and 1996 and stabilized at 0.9% in 1996 and 1999 (DJEFLAT, 2000). The quasi-permanent weakness of state resources, particularly in the 1990s, has put social sectors such as health, social protection and education in a situation of competition for funding. In 2001, the share of GDP devoted to education was 3.9 %, which corresponds to 11.3 % of the national budget. The funds reserved for operations represent 15.01% of the State's operating budget and increase by 15.34% annually (NESC, 2002).

In its distribution of budgets for the year 2020, the Ministry of Finance has kept the same priorities as the year 2019, reserving the lion's share to the Ministry of National Defense, followed by the Ministry of National Education and the Ministry of Interior and Local Government in third place. The education sector, which saw its budget decline in 2019, has managed to obtain an increase of + 2.13% for the budget of 2020, which will allow him to improve in particular its subsidies to public institutions, as well as the launch of several projects of educational institutions and necessary maintenance (LITAMINE, 2019).

Education is the foundation of a knowledge-based economy. Considerable progress has been made by Algeria in recent years to expand access to education. But even though Algeria has invested a significant share of their gross domestic product (GDP) in education, these efforts have not yielded the expected results in terms of quality. In most Arab countries, more education has not been synonymous with more learning, and the link between education and employment has not yet been established. Efforts are needed to provide students with practical life skills to act effectively as productive economic actors and responsible citizens.

The Algerian government must take steps to reform the entire education system so that education is more closely linked to employment. Forging this link starts with early childhood development and basic education, moves to secondary and higher education that provide the fundamental skills required for creative and critical thinking (including through technical education and vocational training, TVET), and ends with the development of an effective system of lifelong learning. The Skills toward Employment and Productivity (STEP) approach offers a simple but comprehensive way of thinking about skills development as an aid to creating more jobs and more productivity. Overall, Algeria needs to adjust the governance, management, financing, and performance-related incentives of their education systems to produce better learning conditions (DJEFLAT, 2010).

- Research and innovation:

The construction of a knowledge economy supposes the installation of a system of innovation and technological development. Algeria is still in logic of effort and not in logic of result, in order to establish such a system. The public policy as regards scientific research and technological innovation aims at mobilizing the means and the human and material resources in order to multiply the number of centers and research units, to boost the technological parks, to increase the number of researchers and to work out specific programs of research and development to promote the development of the industrial sector.

It is difficult to speak of an innovation policy in the strict sense in Algeria because of the late awareness of public authorities of the importance of innovation and R&D activities in the construction of a competitive economy. It is the accentuation of certain problems related to the mass unemployment of higher education graduates, to the endemic brain drain towards the countries of Europe and North America, as well as the massive flow of students who arrive on the benches of the universities which play the role of alarm signal with the public authorities to undertake measures to promote the innovation and the technological development (ARVANITIS, M'HENNI, & TSIPOURI, 2010). Beyond the above-mentioned local observation, it is at the level of the contemporary economic evolutions (increased competitiveness, technological race, energy and environmental challenges) that the will of the public authorities to set up policies of innovation in order to stimulate the activity of innovation and to direct the action of the actors of the Algerian national system of innovation (SNI) is understood.

Algeria, like the Maghreb countries, promotes a centralizing approach in the implementation of its research and technological development policy. This takes the form of state institutions (ministries, state secretariats and specialized agencies) responsible for promoting research and technical progress. Laws have also been enacted to accompany this approach such as the framework law 98-11 of August 22, 1998 on scientific research and technological development. This law was amended and supplemented by Law 08-05 in February 2008 (Edquist & Zabala, 2012).

Although many studies agree that R&D is not the only source of innovation, the fact remains that R&D is at the very heart of the innovation process. It is necessary to launch new products or processes, to produce incremental improvements, but also to develop the capacity to absorb new emerging technologies. For the year 2005, the share of R&D expenditure in GDP was around 0.1% in Algeria against 1% in Tunisia (FOUCHET & MOUSTIER, 2010). In 2017, the GERD (Domestic Expenditure on Research and Development) as a percentage of GDP reached 0.54%, against 0.14% in 2012 (World.Bank, 2021), which reflects a political will to establish a national innovation system.

The number of researchers effectively involved in R&D reflects the capacity of each economy to mobilize a research potential. They are part of what is commonly called the

scientific and technical potential (STP). This is not an indicator of any R&D performance, but it does measure the effort made by the state in this area. If we take the total number of full-time and part-time researchers, the actual data show that Algeria has mobilized an increasing number of researchers. It goes from 11484 in 1996 to 37000 researchers in 2021. The part-time research staff is supposed to be mobilized among university teachers, and the mobilized staff within the public and private sector industry.

According to the Director General of Scientific Research and Technological Development (RSDT), at the Ministry of Higher Education and Scientific Research, Algeria has several types of researchers, namely academics, permanent researchers, research support staff, engineers, and researchers in companies, which are, according to him, the weak point of our national research system. "We have 180 researchers in companies. This is really a paltry number". Describing the permanent researchers as the "linchpin" of scientific research, the director general said it is imperative today to review their status to move from academic research to research and development. According to him, this category of researchers is unfortunately marginalized by the national research system. "So the biggest challenge for the development of research is to promote and encourage the establishment of a status of researcher in the company, which is imperative in the development", For him, it is imperative to create an ecosystem for companies to be productive of knowledge, since Algeria has researchers who can accompany them (AOURAG, 2021).

Another way to reflect a country's technological capacity is to look at exports of high-tech products. Trade in high-tech products reflects both a capacity to absorb high-tech products (imports) and to produce innovative and competitive products on the international market (exports). Algeria is one of the largest importers of machinery and transport equipment in the Arab region. Like all MENA countries, it has a large export deficit in relatively high-tech manufactured goods, which did not exceed 03% of total exports in the 1990s. In 2002, they represented 12.36 % of GDP (DJEFLAT, 2015).

An export of high-tech products in the total exports of manufactured goods between 2007 and 2010 is between 1.20% and 1.16%, which is quite low. The analysis of exports of high-tech products (HT) shows a continuous decline in this category of products, especially after 1999, a date coinciding with the movement of restructuring and privatization of public enterprises under the injunctions of the International Monetary Fund (IMF), reaching the rate of 0.54% in 2011. This reflects the process of continuous deindustrialization that affects the Algerian economy, and globally the lack of a coherent development strategy to lay the groundwork for a strong and competitive economy. In 2017, Exports of high-tech products in the total exports of manufactured products represented 0.96% (World.Bank, 2021).

There are many main problems to explain these weaknesses, but they are generally mentioned:

- A still relatively weak industrial base.
- The lack of sufficient mastery of technologies and the difficulties of mobilizing the scientific and technical potential.
- A rather introverted attitude towards the global market compared to newly industrialized countries, and a fear of openness.

The central problem of the Algerian economy is the dramatic weakness of the nation's production capacity. The national demand is satisfied in very large part by the importation. It follows quite naturally that the strategic objective is the creation of a national production

capacity. The revival of the production requires investments, expert human resources, the resumption of the production requires the introduction of processes of innovation immediately operational and a new institutional scheme which makes an essential place to the territory.

If investment and human resources have been the subject of sustained attention, innovation, in fact and despite repeated speeches, has never been a concern of Algeria. Yet, innovation is the essential factor of productivity and competitiveness of the company. It is unfortunately something that is absent from the concerns of companies and the government. It is understandable because innovation is costly and requires a historical accumulation. Algeria no longer has the means to implement a strategy that requires time and significant resources. The global landscape of innovation has evolved from a systems-based innovation to what is called "frugal innovation". The lack of resources is not a source of deprivation but a source of emancipation to produce better and cheaper by designing sustainable solutions, affordable and of good quality. And this is the case in Algeria. Frugal innovation is far from the innovation schemes designed and developed by Western countries involving capital-intensive R&D structures, substantial financial means and natural resources, which have become increasingly scarce. Frugal innovation based on the principle of "Doing more with less" has resulted from the intersection of the ingenuity of citizens of what were then called underdeveloped countries with the global networks of researchers in the open source world (these networks emerged in the early 2000s).

The Algerian industry will have to take advantage of this transformation which is still within its reach. This new approach will have to root the policy of change in the Algerian industry as a process of continuous improvement of the productivity of its companies. The frugal innovation is within the reach of our companies as far as the competence and ingenuity are not lacking in young Algerians. It should be launched within the framework of a national policy led by the government and with the full participation of employers' and professional associations. But it is clear that frugal innovation requires two essential supports: the development of digital networks and a committed territorial policy (CHETTAB, 2020).

- Information and Communication Technology (ICT):

According to the Ministry of Post and Information Technology and Communication (MPTIC), the overall turnover of the ICT market in Algeria would have exceeded 5 billion dollars in 2011, including 4.5 billion dollars for the telecom sector alone. **ICTs** contribute to 4% of the country's GDP and employ around 140,000 people (1.46% of the working population). According to a 2017 McKinsey report, the Internet contributes 0.8% of GDP (Chironga, Grandis, & Zouaoui, 2017).

The 2012 edition of the United Nations Conference on Trade and Development (UNCTAD) report on the development of the information economy states that Algeria invested \$4586 million in 2011 in ICT, including \$144 million in software development and \$228 million in computer services. However, greater financial efforts are needed, especially in content development (software and applications), if Algeria is to take advantage of the digital economy. According to the World Economic Forum's ranking on ICT, Algeria has the 118th position in 2012. In 2014, it is 129th out of 143 countries. Three criteria are the basis of this ranking, the political and economic environment of the country, the level of technological development and the degree of use of ICT (Kwilinski A. , 2018).

Algeria has made further progress in the field of information technology and communication (ICT), particularly in terms of adoption of ICT, telephony and mobile broadband and the number of Internet users, according to the report of the World Economic

Forum (WEF) on global competitiveness for the year 2019, Algeria is ranked 76th in the world in terms of adoption of ICT, gaining, in one year, 7 places in this ranking after occupying the 83rd place in 2018. This result reflects the qualitative leap recorded in the main indicators taken into account for the establishment of the ranking, said the Ministry of Post, Telecommunications, Technology and Digital in a statement, citing the report (Klaus, 2019).

Regarding the indicator on cell phone subscription, Algeria is ranked 61st globally in 2019, after being 66th in 2018 and 109th in 2016, an advancement of 48 positions since 2016. In addition, Algeria is ranked 35th in mobile broadband in 2019, after being 44th in 2018 and 98th in 2016, an advance of 63 positions since 2016. Regarding the number of internet users, Algeria has moved from 106th place in 2016 to 91st in 2018 and 83rd in 2019, an advancement of 23 positions since 2016. This new ranking reflects the efforts made by Algeria to develop the information society and improve access to the Internet for all citizens (Algérie Presse Service, 2019).

The contribution of the ICT sector to GDP has been stagnating for some years at 4% and is mainly made up of telecommunications, mobile telephony and internet in particular, far from the world average of 6.5%. In 2016, the export value of ICT goods increased sharply compared to 2015, according to UNCTAD data, after stagnating around 1 million dollars (at current prices) since 2012, Algerian exports of ICT goods that include various categories such as computers and peripheral equipment, communication equipment, consumer electronics and electronic components, reached 6 million dollars in 2016. This trend continued in 2017 where these exports had reached 10 million dollars. At the same time, the import of ICT goods has declined significantly, according to the same statistics, from 2.787 billion dollars in 2015, they fell to 2.44 billion in 2016 and 2.243 billion in 2017 (KHALED, 2018).

Exports of ICT goods as a percentage of total goods exports represented only 0.03% in 2017 compared to 0.02% in 2015 and 0.22% in 2016. While imports of these goods accounted for more than 4.8% in 2017 against 5.1% in 2016 (World.Bank, 2021).

Despite the interest of the approach put in place and its importance for the economic and social development of the country, it has remained at the project stage. Its implementation has fallen far short of what was announced, despite some successes such as the widespread use of the Chifa electronic card. This is due, according to experts, to an insufficient use of the infrastructure put in place, to the weakness of the contents and services developed but also to the weaknesses of the legal, institutional and economic environment of the country. The development of an ambitious strategy for the digital must be accompanied by reforms in the economic, social and institutional sphere of the country.

5. Conclusion

The knowledge economy, envisaged as the massive mobilization of knowledge and communication tools to ensure an ideal and material production, requires an economic and institutional framework and an important intellectual and technological environment. Thus, in order to benefit from ICTs, it is necessary to have achieved a prior accumulation of physical and human capital.

Algeria can claim an honorable place in this economy if its human potential and intellectual capital is well mobilized. At the time when the European Union, conscious of its delay compared to the United States in particular, opens great building sites in the matter in order to fill it, it is important in our opinion that the upgrading of the productive sector as

a whole, public and private companies, is made by mobilizing the tools and instruments which offers the economy of the knowledge.

In examining the state of the art of knowledge in Algeria, through the knowledge pillars, it was concluded that considerable progress has been made in the direction of the knowledge-based economy. However, it was detected that some delays compared to the MENA countries as well as to the emerging countries exist. In terms of knowledge competitiveness, the level is low and it is inferior not only to advanced countries but also to MENA countries, which are directly competitive. In this context, the company is the main place of knowledge creation (intangible asset). Competitiveness results from the firm's investment in non-physical assets such as research and development (R&D), data, software, patents, new organizational processes, and the firm's own skills.

Public initiatives to support R&D and innovation seem to have multiplied in recent years, which shows a real willingness to move towards an economic model based on technological development and innovation. However, the lack of determination of these initiatives as well as the gap between rhetoric and facts strongly limit their scope. The rentier character of the Algerian economy and the bad governance seem to slow down all the steps of appropriation and valorization of local knowledge or imported from abroad. Algeria's prospects for overcoming the crisis require a return to a rational use of its hydrocarbon resources within the framework of a global and transparent strategy. And also, by strengthening its national system of innovation to work towards a real diversification and thus curb this curse of natural resources.

It is important that R&D be valued. R&D spending has increased significantly since the implementation of the 98/11 law, but it remains low and private sector spending negligible. Moreover, the absorption capacity of this expenditure is a problem due to the existence of certain bureaucratic practices. It is important to intensify the research-innovation relationship, in particular by promoting national research that meets the needs of the economy. University-industry partnerships are more and more the pivot of any innovation system.

ICT infrastructure is not sufficiently developed. This is due to a number of obstacles: limited household income, public governance failures, and lack of specialized skills. As a result, a lot of work needs to be done, especially in terms of regulation. The progress made in recent years is essentially the product of a policy of liberalization of the sector. Regulatory reform should encourage the arrival of new entrants, lower costs, and the rapid diffusion of technology and innovation. However, the need for increased competition is not limited to telecommunications alone but must be extended to the provision of ICT services and equipment. The promotion of the culture of the ICT is also essential, it is thus necessary to generalize their use in particular in the schools and in the companies.

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