

The knowledge-based economy and economic development in Algeria: A comparative approach based on international indicators

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Abstract :

The transition to a knowledge-based economy is a major determinant of contemporary development trajectories. This study assesses Algeria's position in relation to the four pillars of this economy: human capital, innovation and R&D, information technology, and institutional framework. Using a comparative approach based on international indicators (KEI, GII, HDI, OECD data), the results highlight significant progress in education and digital infrastructure, but also point to persistent lagging in R&D efforts, innovation performance, and governance. The gaps observed with emerging and advanced economies can thus be explained by incomplete integration of the foundations of the knowledge economy. The analysis shows the need to strengthen national innovation capacities in order to support a sustainable economic diversification strategy.

Keywords : knowledge-based economy, economic development, human capital, innovation, ICT, institutions and governance

JEL Classification Codes : O30, O32, O47, O55, I25, O57, F63

Introduction

From the 1990s onwards, the rise of the knowledge economy became apparent and marked structural and organizational transformations in the production and growth process : the value of intangible capital exceeded that of physical capital, heralding the transition to a new form of economy, described as the knowledge economy, the immaterial economy, or even cognitive capitalism (Dominique Foray, 2009) . These terms stem from the recognition of the importance of knowledge as a capital asset in its own right (intangible) in economic development. From this perspective, the competitiveness of national economies increasingly depends on their ability to produce, disseminate and use knowledge, as knowledge, education and innovation have thus become the central indicators of economic development (Maha Mohamed Alsebai Mohamed, 2022) .

The economies of developing countries, in a logic of catching up, are seeing a new development trajectory emerge based on the integration of the various pillars of the knowledge economy (Haq, 2012). This represents a break with traditional models and the linear view of

development, according to which all societies follow a similar path through the same successive stages of growth (Jacques Brasseul, 2016). However, strong integration of the pillars of the knowledge economy has enabled certain countries to achieve remarkable economic performance over several decades (Åkerman, 1959). With this in mind, the Algerian government is seeking to accelerate the development of the information technology sector.

In this context, several projects have been launched and numerous reforms adopted to give this sector a fundamental boost. This is what we will attempt to clarify through an analysis of the knowledge economy, a study of its reality and prospects in the Algerian economy, and a search for ways to integrate and adapt the Algerian economy to information and communication technologies.

This is based on the consideration that knowledge is now the most important factor in moving from underdevelopment to progress in the various sectors of the state, particularly in order to free itself from dependence on oil, which has made the Algerian economy vulnerable to fluctuations in crude oil prices. With this in mind, we posed the following question: To what extent does the asymmetric integration of the pillars of the knowledge-based economy explain the divergent development trajectories, and where does Algeria stand in this comparative configuration? To answer our question, we formulated the following hypotheses: The first hypothesis states that the relatively low level of integration of the pillars of the knowledge-based economy (R&D, innovation, institutional framework, ICT) is associated with Algeria's lower economic position compared to emerging countries and OECD economies. The second hypothesis is formulated as follows: The impact of educational investment in Algeria on economic development remains limited due to insufficient innovation capacity and a less efficient institutional environment, both of which explain a significant part of the gap between Algeria and the countries used for comparison. Research methodologies In order to conduct our research effectively, we adopted a rigorous methodological approach to highlight economic development gaps through the prism of the knowledge-based economy. Our study follows a positivist paradigm, given that our subject matter requires objective analysis of quantitative data to enable reliable international comparison. We took a deductive approach. The hypotheses formulated are based on the four pillars of the KBE, following the World Bank model. These hypotheses are then empirically verified

The rough a comparative analysis between Algeria and a panel of countries. The study is based on a comparative approach using quantitative data on the main dimensions of the knowledge economy (GDP per capita expressed in PPP, HDI, R&D, enrolment rate, level of innovation, Internet access, ease of doing business, number of patents filed). The series cover the period 2010-2025 and concern Algeria, the MENA region, emerging countries and OECD countries. In order to ensure the comparability of indicators, values have been standardised and represented in graph form. This approach highlights Algeria's strengths and weaknesses based on observed differences and compares its performance with that of other countries.

I. The knowledge economy and its pillars

The knowledge economy refers to the structural transformation of contemporary economies, marked by the rise of intangible capital and the centrality of knowledge production and dissemination (Foray, 2009). Since the 1990s, knowledge has accounted for more than half of GDP in OECD countries (OECD, 1996), fueling the thesis of cognitive capitalism succeeding industrial and market models (Machlup). From this perspective, knowledge is both an economic factor—whose production,

dissemination, and appropriation obey mechanisms analyzed in particular by Howitt (2004)—and an indicator of structural transition reflecting a country's ability to generate value through innovation.

The analysis of this economy is based on several complementary dimensions. The first concerns the role of human capital, defined as the set of skills and qualifications that determine the productivity of an economy (Becker, 1964; Stiglitz, 2014). Countries that invest sustainably in education and training have an increased capacity to produce, absorb, and use knowledge, which is a major lever for competitiveness (OECD, 1996).

A second dimension lies in the functioning of innovation systems. These, according to Freeman, correspond to all public and private institutions that interact to produce and disseminate technology. Their effectiveness depends on the quality of links between universities, research centers, and businesses, as well as on the ability of actors to transform ideas into productive applications, as Nelson (1993) also points out. The knowledge economy also relies on a set of institutions and incentive mechanisms that regulate the circulation of knowledge. The work of North (1990) and Acemoglu & Robinson (2012) shows that regulatory stability, property rights, governance, and administrative efficiency are key determinants of innovation and investment. In economies where institutions are weak or not very inclusive, the dissemination and exploitation of knowledge remain limited. Finally, the spread of information and communication technologies is a major driver of the transition to a knowledge-based economy. Technological advances, connectivity, and the productive use of digital technology facilitate access to information, reduce transaction costs, and accelerate learning processes, as illustrated by the changes brought about by the spread of the Internet and the emergence of modern digital infrastructure (Loilier, 2001).

II. Theoretical approaches to development gaps

Development gaps between countries can be analyzed using several theoretical frameworks that converge on the idea that the ability to produce and use knowledge is a major determinant of growth. The broadened neoclassical approach emphasizes that differences in investment in human capital explain a significant part of the divergences in productivity and income (Solow, 1956; Mankiw, Romer & Weil, 1992). Countries with a skilled workforce are thus better placed to adopt and integrate innovations.

Endogenous growth theories emphasize the internal production of knowledge. Romer (1990) and Aghion & Howitt (1992) show that R&D, innovation, and the accumulation of ideas are central drivers of growth. Differences between countries therefore reflect differences in their ability to produce or absorb technologies, which directly relates to the role of innovation systems and technological infrastructure. Furthermore, institutional economics shows that the quality of institutions has a strong influence on economic performance. Inclusive institutions promote entrepreneurship, competition, and innovation, while extractive institutions hinder the creation and dissemination of knowledge (North, 1990; Acemoglu & Robinson, 2012). Finally, the theory of absorptive capacity (Cohen & Levinthal, 1990) explains why countries exposed to the same global knowledge flows do not reap the same benefits. This capacity depends on the level of skills, international openness, the quality of scientific and digital infrastructure, and the density of interactions between actors.

III. Comparative approaches based on the knowledge economy

In a context of accelerated globalisation and profound technological change, knowledge has become a central factor in economic, social and technological development. This evolution marks the

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gradual transition from an economy based on natural resources and physical capital to a knowledge economy, where innovation, research, education and information technologies play a key role in value creation. In response to these changes, comparative approaches have multiplied to analyse how different countries or regions integrate and exploit knowledge as a lever for competitiveness and growth. These approaches are based on international indicators that measure the performance of economies in terms of knowledge production, dissemination and use. They thus provide a better understanding of:

- The development gaps between advanced and emerging countries.
- The success factors of the most innovative economies.
- Effective public policies in education, R&D and digital technology.

From this perspective, the study of international indicator models (such as the Global Innovation Index, the World Bank's Knowledge Economy Index, and the OECD indicators) becomes an essential tool for comparing the development trajectories of nations in the era of the knowledge society.

IV International Indicator Models

These are analytical tools used to evaluate, measure, and rank the economic, technological, and social performance of countries, particularly in the context of the knowledge economy. They rely on both quantitative indicators (e.g., % of GDP spent on R&D) and qualitative indicators (e.g., quality of institutions), often grouped into composite indices. Their main objectives are to compare countries based on their capacity to produce, sell, innovate, and utilize knowledge. They are also used as decision-support tools at various levels.

The table below presents an integrated summary of the main international indicator models used in the analysis of the knowledge economy, highlighting their objectives, areas covered, methodological specificities, as well as their alignment with country typologies and the structuring factors of the knowledge-based economy (KBE).

Table 01: Key Indicators and Structuring Factors of the Knowledge Economy: Typology, Criteria, and Gaps Between Countries

Indicator / Factor	Institution / Reference	Objective / Description	Criteria / Dimensions	Typical Gaps Between Countries	Examples / Category
Knowledge Economy Index (KEI)	World Bank	Measure a country's ability to produce, disseminate, and use knowledge	Institutional environment, education, R&D, ICT	Advanced countries: strong integration / Developing countries: multiple gaps	OECD, MENA
Global Innovation Index (GII)	WIPO + partners	Measure innovation capacity and outputs	R&D spending, researchers, patents, technological production	Advanced: >2% of GDP in R&D / Emerging: 0.5–1% / Low-income: <0.2%	South Korea, China, Algeria
Global Competitiveness Index (GCI)	WEF	Assess overall economic competitiveness	Institutions, infrastructure, education, innovation, macroeconomic environment	Advanced: strong and attractive institutions / Developing: bureaucracy and instability	Germany, Turkey, Algeria
Human Development Index (HDI)	UNDP (UN)	Measure overall human development	Education (schooling), health (life expectancy), standard of living (income)	Developed: high levels of education and health / Developing: limited access and quality	Finland, Morocco, Egypt

OECD Indicators – Innovation & Knowledge Society	OECD	Evaluate innovation performance	R&D spending, human capital, patents, public-private partnerships, digitalization	OECD: strong education–R&D synergy / Developing countries: innovation lag	OECD countries, MENA
Human Capital (Education)	—	Quality and level of education, skills	Enrolment rates, lifelong learning	Advanced countries: high level / Developing countries: structural weaknesses	Germany vs. Algeria
ICT Infrastructure	—	Access to and quality of digital technologies	Internet, mobile, ICT equipment	Wealthy countries: access >90% / Poor countries: <30%	Singapore vs. Sub-Saharan Africa
Institutional Environment	—	Stability, legal framework, governance	Property rights, transparency, innovation support	Advanced: stable and supportive framework / Unstable: corruption and weak protection	Finland vs. Algeria
General Economic Development	—	Wealth and economic diversification	GDP per capita, diversification, access to finance	Rich countries: diversified economy / Poor countries: resource dependency	South Korea vs. Algeria
Innovation Culture	—	Attitudes toward creativity and risk	Networks, research valorisation, academic freedom	Advanced: strong culture / Conservative: limited innovation	USA vs. MENA

Source: By Researches

The integrated table highlights three complementary dimensions of the knowledge-based economy.

First, international indicator models such as the Knowledge Economy Index (KEI), the Global Innovation Index (GII), the Human Development Index (HDI), the Global Competitiveness Index (GCI), and the OECD innovation indicators appear as essential tools for measuring countries' performance and degree of integration into the knowledge economy. These tools combine quantitative dimensions (such as the share of GDP devoted to R&D, number of researchers, patent applications, school enrolment rates, and level of digital connectivity) and qualitative dimensions (such as the quality of institutions, governance, and entrepreneurial climate). They systematically reveal significant gaps between developed countries, emerging economies, and developing nations. Advanced countries are marked by a strong coherence between education, innovation, and robust institutions, whereas developing countries often show structural imbalances.

Second, the typology of countries based on their level of integration of the pillars of the knowledge-based economy (KBE) highlights a clear differentiation between several profiles.

- Leading countries, represented by OECD economies and some Asian nations (South Korea, Singapore, Finland), are characterized by a strong synergy between highly skilled human capital, massive investment in R&D, and innovation-friendly governance.
- Transition countries, such as China, Turkey, and Malaysia, show an upward trajectory, marked by rapid progress in education and ICT, but still face institutional and technological limitations.
- Countries in the MENA region and Africa, including Morocco, Tunisia, Egypt, and Algeria, occupy an intermediate position: they have made notable efforts in schooling and digital connectivity, but still struggle to capitalize on these achievements in terms of innovation and competitiveness.
- Finally, low-integration countries remain dependent on primary resources and have not yet initiated a real transition toward a knowledge-based economy.

Third, the structuring factors of the knowledge economy — human capital, research and development, ICT infrastructure, institutional environment, economic diversification, and innovation culture —

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confirm that the observed gaps are not merely due to levels of equipment or education, but more critically to the ability of countries to coordinate these dimensions and transform them into drivers of growth. Advanced countries succeed in creating a synergy between these factors, thereby generating an innovative and competitive economy. In contrast, in developing countries like Algeria, the analysis reveals an unbalanced profile: significant progress in education and ICT diffusion, but persistent lag in scientific research, innovation valorisation, and improvement of the business environment.

Ultimately, the synthetic table clearly illustrates the interdependence between the level of integration of the knowledge economy pillars and economic development trajectories. It thus provides a solid methodological foundation for positioning Algeria within a regional and international comparative framework, and for identifying strategic levers to be mobilized in order to close the gap with high-performing emerging economies and advanced countries.

V. The integration of the knowledge economy in Algeria:

current situation and international comparison the integration of the knowledge economy is a major challenge for Algeria, whose growth remains largely dependent on hydrocarbons. Despite reforms in education, research and information technology, results remain limited. To determine the country's position, a set of international indicators is used (GDP per capita, HDI, R&D, school enrolment, innovation, ICT, patents, etc.), with a comparison to developed countries (OECD), high-performing emerging countries (South Korea, China, Malaysia, Turkey) and regional neighbours (Morocco, Tunisia, Egypt, South Africa, Costa Rica).

1. Knowledge-based economy in Algeria

The assessment is based on five main indicators: the Human Development Index (HDI), research and development (R&D) expenditure, researcher density, the share of high-tech exports and the Global Innovation Index (GII). Monitoring these indicators over the period 2010-2022 provides an understanding of national developments and allows Algeria to be compared with its peers.

Table 2: Algeria's performance on knowledge economy indicators from 2010 to 2022 compared to the OECD average

Indicator	Source	Year	Algeria	OECD Average (approx)	Algeria's Evolution (%)	Gap
Human Development Index (HDI)	UNDP	2010	0.721	~0.85 (est.)	–	High
		2015	0.736	~0.88 (est.)	+2.08% (2010–2015)	High
		2022	0.745	~0.90		High
R&D Expenditure (% of GDP)	UNESCO/OECD	2010	~0.50% (est.)	~2.2% (est.)	–	Very High
		2015	~0.60% (est.)	~2.4% (est.)	+20.00% (2010–2015)	Very High
		2022	~0.65% (est.)	~2.5% (est.)	+8.33% (2015–2022)	Very High
Researchers per million inhabitants	UNESCO/OECD	2010	~300 (est.)	~3,500 (est.)	–	Very High
		2015	~400 (est.)	~3,800 (est.)	+33.33% (2010–2015)	Very High
		2022	523 (est.)	~4,000 (est.)	+30.75% (2015–2022)	Very High
High-tech exports (% of	World Bank	2010	~0.8% (est.)	~18% (est.)	–	Very High
		2015	~1.0% (est.)	~19% (est.)	+25.00% (2010–2015)	Very High

manufacturing exports)		2022	1.20%	~20% (est.)	+20.00% (2015–2022)	Very High
Global Innovation Index (GII)	WIPO	2010	Not ranked in top 100	Top 20	–	High
		2015	Not ranked in top 100	Top 20	No progress	High
		2022	Not ranked in top 50	Top 20	Relative improvement	High

Source: compiled by us based on collected data

Despite the efforts made, the EFC remains at very low levels. Algeria is making slight progress on the HDI. Algeria is making slight progress (from 0.721 in 2010 to 0.745 in 2022), but remains below the OECD average. This reflects an improvement in human capital, without however reaching the standards of developed countries. Progress on this indicator is primarily reflected in improved access to and free healthcare, thereby increasing life expectancy. This is a major factor in the improvement of this indicator. Secondly, education, measured by average years of schooling and enrolment rates, has also seen tangible progress. This is due to the government's efforts to universalise education (high enrolment rates, construction of schools and universities), which has automatically improved this indicator. More children are attending school for longer. Research and development has seen a significant increase of around 30% between 2010 and 2022 (from 0.50% to 0.65% of GDP). However, this growth remains insufficient and below the OECD average. The number of researchers rose from 300 to 523 per million inhabitants between 2010 and 2022, an increase of around 74%. The low density of researchers is the result of insufficient national capacity due to the institutional under-resourcing of scientific research activities. As for high-tech exports (calculated as a percentage of total manufacturing exports), they rose slightly from around 0.8% in 2010 to 1.0% in 2015, reaching 1.2% in 2022. There has been steady progress, but levels remain low. Regarding the Global Innovation Index (GII), Algeria remains poorly ranked despite a slight improvement (relative improvement), and is not ranked in the global top 100.

1. Comparative assessment and positioning of Algeria in the knowledge economy

Having presented the evolution of the KBE in Algeria, it is necessary to situate its position through a comparative analysis. The indicators used and the panel of countries have already been justified in the previous section (Tables 4 and 5). The following table summarises the data used to position and compare Algeria with advanced countries, countries in transition and countries in the MENA/Africa region, as well as with regional and international averages. This comparison will serve as a basis for assessing performance gaps and identifying Algeria's strengths and weaknesses.

Table 03: Average indicators of determinants of the knowledge economy and economic development - International comparative analysis (2010-2025)

Country / Region	GDP per capita (PPA, \$)	HDI	R&D Expenditure (% of GDP)	Tertiary Enrollment (%)	Internet Users (%)	Innovation Index	Ease of Doing Business (Score)	Patents (per million population)
Algeria	12,289	0.752	0.60	63.0	71.2	29.4	49.9	1.6
South Korea	48,863	0.916	4.46	97.3	99.6	89.1	85.5	149.0
Finland	43,5	0.930	3.95	96.5	97.0	91.5	86.5	165.0
Germany	46,5	0.934	3.03	92.8	91.3	89.6	82.8	145.0
Singapore	72,5	0.939	2.85	94.8	99.1	87.9	90.8	125.0
Malaysia	30,544	0.819	1.34	50.4	91.5	49.4	81.4	32.9
Turkey	23,339	0.789	1.04	73.6	87.4	42.9	76.5	20.6

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China	16,25	0.750	2.28	48.8	68.8	57.5	67.0	32.5
Costa Rica	15,125	0.795	0.65	70.0	77.5	43.8	73.0	6.5
Morocco	8,243	0.676	0.70	43.5	93.6	33.7	76.9	2.8
Tunisia	10,933	0.743	0.84	70.4	90.7	33.7	69.6	3.4
Egypt	11,75	0.728	0.68	60.0	67.5	33.5	63.5	2.3
South Africa	13,5	0.723	0.88	64.3	77.0	38.5	68.5	6.5
MENA AVerage	17,181	0.744	0.78	62.0	67.0	38.9	63.5	6.7
OECD Average	45,582	0.884	2.49	81.8	89.8	79.6	81.5	52.7

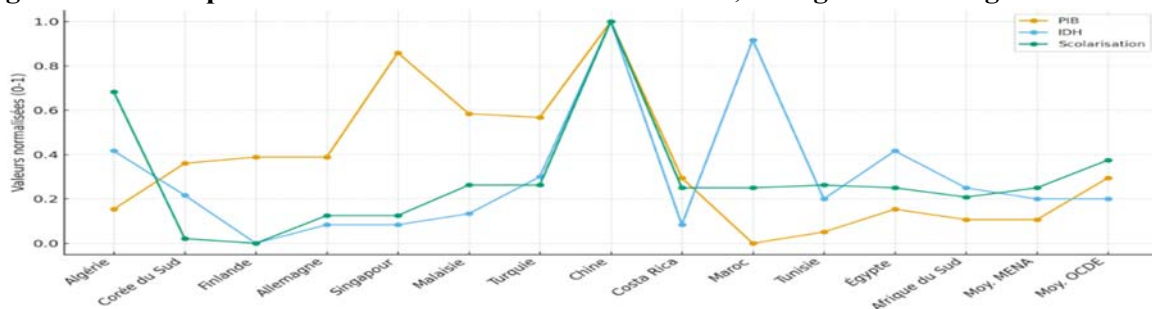
Source: calculated by us based on data collected

In order to make the analysis more readable, the data initially presented by year (2010, 2015, 2022, 2025) has been summarised using a weighted average. This method gives more weight to recent years, thus reflecting the current dynamics of the countries. The coefficients applied are: 0.1 for 2010, 0.2 for 2015, 0.3 for 2022 and 0.4 for 2025. The following table presents the consolidated values of the main economic and social indicators for each country. Comparison by major dimensions of the knowledge economy In order to facilitate reading and highlight the main differences between countries and regions, we have chosen to break down the analysis into key dimensions of the knowledge economy. The use of graphs and radar charts allows us to visually represent the differences and dynamics, providing a clearer understanding than a simple table.

The socio-economic dimension:

The graph below brings together all the indicators related to the measurement of the first pillar of the knowledge economy. In order to be able to compare indicator , expressed in very different units (currency, index, percentage) and orders of magnitude (GDP/capita ranges from a few thousand to over £70,000, HDI ranges from 0.6 to 0.95, and school enrolment ranges from 20% to nearly 100%), we have applied a min-max normalisation: each indicator is calculated according to this formula: $X_{norm} = \frac{X - X_{min}}{X_{max} - X_{min}}$. Where X is the observed value, X_{min} is the minimum value of the indicator in the sample, and X_{max} is the maximum value of the indicator in the sample. Using this method, all values are converted to a common scale from 0 to 1. 0 corresponds to the lowest performance, 1 to the highest performance. This operation allows us to balance the visual weight of the variables, prevent GDP from overshadowing the other dimensions, and highlight the relative differences between countries, which is essential for a clear reading of the comparative graphs and radar profiles.

Figure 1: Comparison of socio-economic indicators, weighted averages 2010–2025



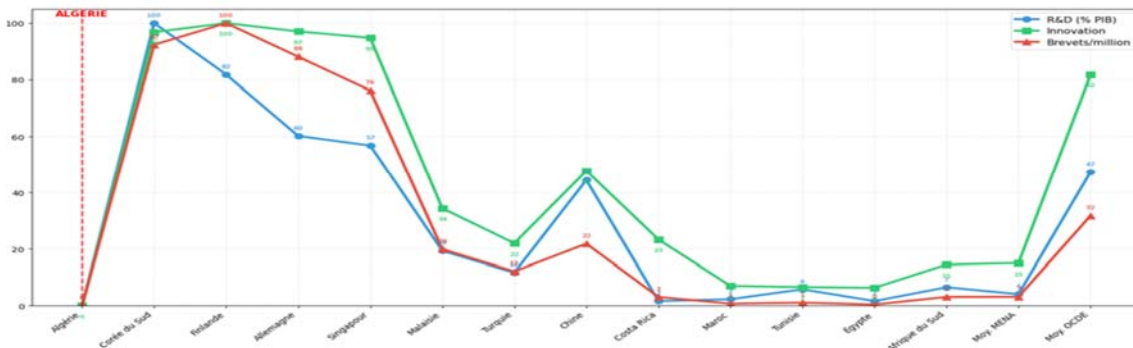
Source: compiled by us based on data from Table 02

The graph shows that Algeria presents a contrasting profile, with notable progress in higher education enrolment. However, the country continues to lag behind in terms of GDP per capita and

HDI. Compared to the performance of the MENA region, Algeria outperforms Morocco and Egypt in terms of enrolment, but remains close to the regional average in terms of GDP and HDI. As for its position relative to emerging countries, it lags behind, particularly in terms of GDP and HDI, and is not keeping pace with the rapid catch-up observed in China, for example. Finally, when compared with the OECD and world leaders, the gap remains very wide in all areas; education is improving but still falls far short of international standards. **Comparison of scientific and innovation indicators**

In the graph below, we have adopted the same approach of normalising and standardising data (in order to compare heterogeneous indicator data

Figure 02: comparison of innovation indicators - Weighted averages 2010-2025

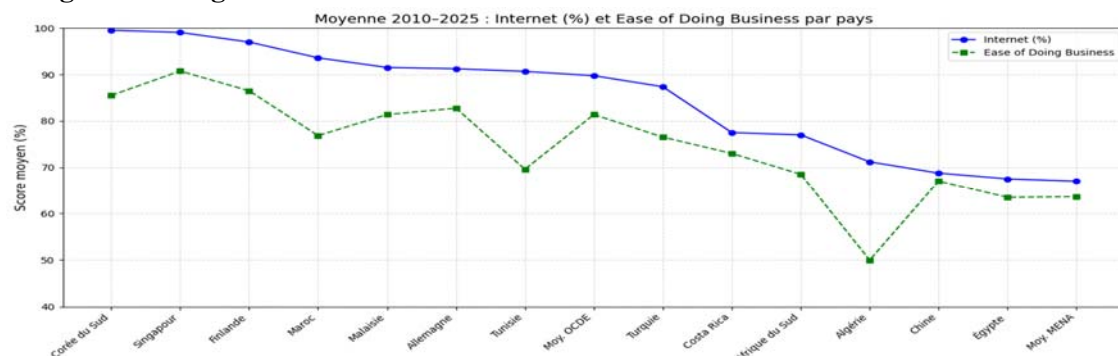


Source: compiled by us based on data from Table 02

Looking at the graph, we can see that Algeria ranks relatively low in terms of innovation and scientific research. Despite an increase in R&D spending and the number of researchers, levels remain far below international standards. The country thus performs significantly worse than emerging economies such as Malaysia and Turkey. Compared to other countries in the MENA region, Algeria does not stand out: its innovation indicators remain close to the regional average, sometimes slightly higher than Morocco or Egypt, but without any real comparative advantage. On the other hand, there is a considerable gap with OECD countries and world leaders (South Korea, Finland, Germany, Singapore), whose performance in terms of patent filings, R&D investment and entrepreneurial dynamism reflects a much more advanced integration into the knowledge economy. These results highlight an unbalanced profile: Algeria is making progress in terms of education and human capital, but is struggling to transform this capital into tangible results in terms of innovation and technological competitiveness. This structural deficit contributes to a persistent lag in economic development and limits the prospects of catching up with emerging and advanced economies. **Comparative analysis of average internet access and ease of doing business**

The same normalisation and standardisation process is used to analyse two indicators.

Figure 03: Comparison of average indicators for internet access and ease of doing business – Weighted averages 2010–2025



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Source: compiled by us based on data from Table 02

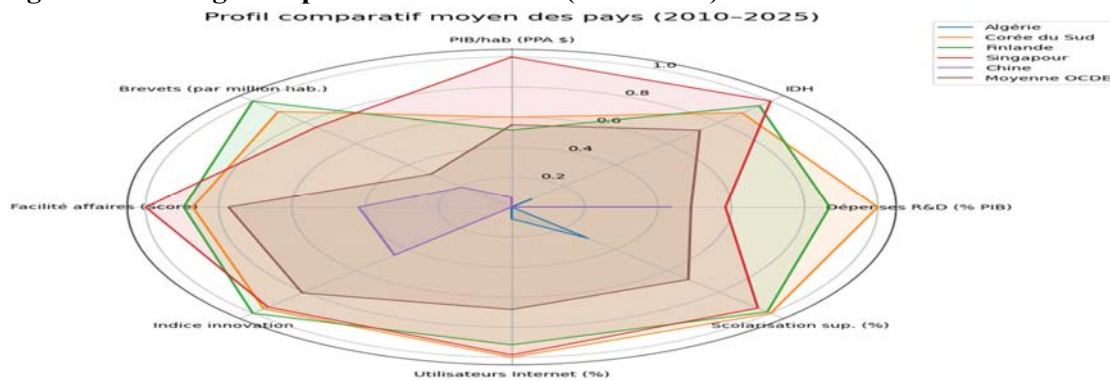
The graph highlights a marked contrast for Algeria between Internet penetration and the business climate. Access to ICT is progressing significantly, with a relatively high Internet usage rate compared to some countries in the MENA region, such as Egypt and Tunisia. However, Algeria still lags far behind the standards observed in OECD countries or among Asian leaders (South Korea, Singapore, Finland), where Internet coverage is almost at saturation point. On the other hand, Algeria's score for ease of doing business ranks it among the lowest performing countries in the sample. It is below the MENA average and lags far behind dynamic emerging economies such as Malaysia and Turkey, which combine good digital connectivity with a favourable investment environment. This gap reflects the structural constraints on entrepreneurship and innovation in Algeria, where bureaucracy, regulatory burdens and lack of market openness hinder the development of human and technological capital.

The analysis thus reveals an unbalanced situation: despite catching up somewhat in terms of ICT, Algeria is failing to transform this digital potential into gains in economic competitiveness, unlike successful emerging countries. This confirms the need for structural reforms to strengthen the business environment and fully exploit the opportunities offered by digital transformation.

Summary analysis of Algeria's position in the integration of the pillars of the knowledge-based economy

The following radar chart shows all the indicators representing the pillars of the KBE, providing a summary view of Algeria's performance compared to different groups of countries (MENA, emerging economies, OECD)

Figure 04: average comparison of countries (2010–2025)



Source: compiled by us based on data from Table 02

The chart shows the gaps in development and innovation between industrialised countries (OECD, developed Asia) and developing countries. It also reveals that Algeria's position in the EFC is marked by a significant lag and a low degree of integration of the essential pillars. This weakness, which is palpable across all dimensions, highlights a critical interdependence: the country's economic development remains limited because these pillars, far from being isolated, reinforce each other to stimulate growth and competitiveness. In Algeria, the economic environment is characterised by low investment in research and development, combined with an education system that, while improving, is not geared towards contemporary development objectives, and an underdeveloped digital infrastructure. All of these factors create a vicious circle that slows down economic progress. Algeria's position on the graph therefore illustrates that without balanced integration of the pillars of the EFC, it is difficult to achieve an advanced level of development. This observation highlights the

need to adopt a comprehensive strategy that addresses these issues simultaneously in order to sustainably integrate its economy into the global knowledge dynamic.

Conclusion

Based on our research, we can conclude that the degree of integration of the EFC pillars largely explains the development gaps between countries. Our analysis of the case of Algeria has enabled us to draw the following conclusions for each of the EFC pillars:

Education and human capital: Algeria performs relatively well in terms of higher education enrolment, comparable to some emerging countries and superior to that of neighbouring countries. This performance is the result of decades of public policies aimed at universalising access to education, particularly higher education, through free tuition and investment in infrastructure. However, despite expanded access, the performance of education and higher education remains limited in terms of the quality of training, the relevance of courses and their suitability for the needs of the labour market. Training in Algeria remains detached from the productive sphere and current requirements. Indeed, the majority of students are oriented towards fields with low economic added value, to the detriment of scientific and technological disciplines.

Information and communication technologies (ICT): Algeria has seen a steady increase in Internet usage, placing it above the regional average. Although Algeria is not on a par with advanced countries (Singapore, South Korea), it stands out slightly from some emerging or neighbouring countries in terms of its rate of connected users. This improvement reflects the volume of public investment in basic infrastructure (networks, mobile coverage, data centres), enabling rapid expansion of access. Despite this spread, Internet access is not yet a lever for innovation and competitiveness, mainly due to a poorly structured digital environment and a very low level of ICT integration in the economy, which has little impact on innovation and productivity. In short, Algeria finds itself in a paradoxical situation: Internet penetration is increasing, but economic use is limited, revealing a partially activated pillar in the dynamics of the knowledge economy. **Research, development and innovation:** Algeria remains well behind emerging countries such as Turkey and Malaysia, which have been able to transform their investments into levers for growth and vectors of international competitiveness, despite the progress made over the last two decades. This lag is more pronounced when compared to countries that are very advanced in the integration of the EFC (South Korea, Singapore, OECD countries), whose share of GDP allocated to research and development is very significant. Thanks to these R&D investments, these countries are achieving tangible results in terms of patents, scientific publications and technology transfer. This stimulates innovation through targeted incentives and develops an ecosystem that promotes the commercialisation of scientific results. **Institutions and business environment:** the most notable weakness concerns the entrepreneurial and institutional climate. The Algerian ecosystem is weighed down by heavy and highly restrictive bureaucracy, which hinders the efforts of entrepreneurs.

Added to this is a low level of attractiveness for foreign direct investment (FDI), linked to an unstable regulatory framework, a lack of transparency and insufficient investor protection. Algeria is still struggling to establish clear, predictable and incentive-based economic governance. This situation hinders the creation of businesses, particularly start-ups, limits partnerships in industry and blocks the country's integration into global value chains.

The results of our analysis confirm the first hypothesis: the partial integration of the pillars of the knowledge economy in Algeria largely explains its economic lag, particularly in terms of R&D, innovation and the institutional climate. Empirical analysis also allows us to validate the second

hypothesis. Indeed, the stronger the link between the four pillars of the KCE, as is the case in OECD countries and developed Asia, the higher the economic performance.

The findings of this analysis show that the human capital trained in Algeria remains under-exploited, leading to brain drain and low valuation of local skills. The development of ICT is a positive step, but it has not yet been accompanied by a structured digital transformation. Finally, the lack of innovation and technological competitiveness largely explains the stagnation of GDP per capita and the lag in HDI. To strengthen its integration.

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