

Enhancing Higher Education Standards in Algeria as A Strategic Necessity for the Transition to a Knowledge-based Economy In Light of Successful International Experiences

تعزيز معايير التعليم العالي في الجزائر كضرورة حتمية للتحويل نحو اقتصاد المعرفة في ضوء التجارب الناجحة

BOUDJELLA Imane¹

¹ Ibn Khaldoune University, Tiaret, Algeria, imane.boudjella@univ-tiaret.dz

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Abstract:

The study aims to highlight the higher education prerequisites for Algeria's transition to the knowledge economy; it employs a comparative analytical approach to assess key indicators of higher education and the knowledge economy, as well as to draw lessons from leading countries that have made major advances in the knowledge economy. It was found that Algeria's higher education sector remains far behind in terms of scientific education, research, and innovation despite tireless attempts to enhance this sector. Furthermore, Algeria's position in the global rankings for higher education, competitiveness, technological progress, creativity, and innovation highlights the challenges it confronts in terms of its willingness to successfully integrate into the knowledge economy. Finally, drawing inspiration from the California higher education system and Singapore's research and development initiatives, Algeria could adopt a successful model, prioritizing the establishment of flagship research universities, nurturing research talent from an early age, and raising R&D spending to at least 1% of GDP by 2030. Additional priorities include developing a national research strategy focused on key sectors and creating scientific oases and regional innovation centres to decentralise research and foster local entrepreneurship; such initiatives would significantly accelerate the process of the transition to a knowledge-based economy.

Keywords: Higher Education; R&D; Knowledge Economy; Research University; Algeria.
Jel Classification Codes: I23/ I28/ O32

Introduction:

The knowledge economy is a major driver of innovation and economic development in the modern era, as it is defined by a shift in the economy's reliance from natural resources and simple labor to specialized knowledge, information, and skills, thereby generating new knowledge and applying it in innovations and technology, and transforming knowledge into a tradable and marketable product, which contributes to enhancing productivity, improving quality, and boosting profitability. The knowledge economy encompasses a wide range of sectors, led by scientific research, technology development, and information industries; the promotion of innovation and entrepreneurship; and the development of human skills and competencies. As a result, higher education institutions, particularly those concerned with scientific research and innovation, are regarded as the beating heart of the economy, working to generate and disseminate knowledge, develop technologies and innovations, and improve the cognitive capabilities of students, researchers, and local, regional, national, and international communities. Despite Algeria's tireless attempts to enhance this sector, the higher education sector remains far behind and much below the required level. Regardless of Algeria's efforts to spread the Internet and information and communication technology in order to keep up with knowledge-based economies, the country has made little progress and ranks very low on the global scale, particularly in terms of scientific education, research, and innovation. Based on the aforementioned, our **Problem of the study** centers on the following fundamental question:

In Light of Successful International Experiences, how can higher education institutions contribute to Algeria's transition to a knowledge-based economy?

As an answer to the problem, we proposed the following **hypothesis**: in light of lessons derived from leading countries, Algeria could adopt a successful model, which would significantly accelerate the process of transition to a knowledge-based economy.

The study's goal is to emphasize the higher education-related prerequisites for Algeria's integration into the knowledge economy. Consequently, the following objectives can be identified:

1. Emphasis on the concept, significance, and pillars of the knowledge economy.
2. A description of the relationship between higher education institutions and the knowledge economy.
3. Illuminating the most important indicators of higher education and knowledge economy in Algeria.
4. Investigate the California higher education system and its impact on the state's knowledge economy.
5. Highlighting Singapore's endeavors and achievements in the transition to a knowledge-based economy, resulting in its top ranking in knowledge economy and research & development metrics.
6. Draw findings and lessons that can be applied in Algeria to help with integration into the knowledge economy.

The importance of the study stems from the fact that higher education is the foundation of research, creativity, and innovation, which is at the heart of the knowledge economy, and that no country can integrate into the knowledge economy unless it prioritizes education, research, and innovation, and thus Algeria's interest in the knowledge economy and higher education system is an imperative for achieving development and breaking new ground.

The present study employed scientific methods commonly utilized in economic research. Specifically, we employed a descriptive approach to elucidate the fundamental postulates and theoretical concepts of the study. Additionally, an analytical approach was employed to analyze the significant results, indicators, statistics, and reports issued by international, regional, and national economic institutions. Furthermore, a comparative analytical approach was utilized to analyze the key indicators of a leading country that has made significant advancements in the knowledge economy. This analysis aimed to explore the feasibility of implementing similar strategies in Algeria.

Literature review:

The twenty-first century witnessed a significant technological revolution, leading to a remarkable surge in the utilization of information and communication technology. This, in turn, resulted in a fundamental increase in interest towards scientific research and innovation. Education plays a crucial role in fostering the development of skills, knowledge, and innovation, thereby contributing to the reinforcement of the knowledge economy. Conversely, the deficiency in providing high-quality education significantly hampers countries' capacity to foster innovation and transition towards a knowledge-based economy. Numerous studies have endeavored to elucidate this correlation, with particular emphasis placed on the following prominent works:

- Finegold, in his study entitled: *The Roles of Higher Education in a Knowledge Economy*, aimed to examine the role of higher education in the knowledge economy, specifically exploring how higher education institutions can effectively meet the demands of the economy. He found that the knowledge economy greatly relies on the contribution of higher education, prompting the formulation of a series of recommendations for higher education institutions. Among these recommendations, the foremost one emphasizes the necessity of enhancing collaboration with industry and government, augmenting investments in research and development, and prioritizing entrepreneurship and innovation (Finegold, 2006).
- The study carried out by BUŠÍKOVÁ ALENA, aimed to analyze the relationship between higher education and knowledge economy indicators in selected countries in the European Union in addition to Japan and the United States of America. The author employed panel data analysis to examine the potential correlations between two distinct sets of indicators: knowledge economy indicators and indicators pertaining to higher education within a specific country. The research revealed a robust association between various indicators of the knowledge economy and higher education. The study's findings indicate that nations with more robust university education systems exhibit greater readiness for a knowledge-based economy (BUŠÍKOVÁ, 2012).
- Slimane Zouari and Benaouali Djilali in their study: "The reality of the higher education sector in light of the requirements of establishing the parameters of the knowledge economy- Algeria case study" sought to emphasize the actuality of higher education within the context of the demands imposed by the knowledge-based economy. Their findings revealed that the limited connection between universities and productive sectors, substandard research quality, and various other factors have contributed to a decline in the global ranking of the Algerian higher education system (Zouari & Benaouali, 2021).

In summary, existing research supports the notion that higher education plays a crucial role in laying the foundation and enhancing the necessary elements for fostering a knowledge-based economy. This, in turn, serves as the primary catalyst for sustainable economic growth, wealth generation, enhanced individual well-being, advancements in various sectors such as healthcare, environmental conservation, transportation, communication, and the development of sustainable solutions to address economic, social, and environmental challenges. The current study differs from

previous studies in that it focuses on Algeria's integration into the knowledge economy based on universities' role in promoting the knowledge economy and uses the California higher education system and Singapore's R&D efforts as a model.

1- The theoretical framework of the knowledge economy

The knowledge economy is a subfield of economics that focuses on the importance of knowledge and innovation in the economy and economic progress. It is frequently used in conjunction with other terminology to stress various aspects of knowledge, such as the information society, the digital economy, the new economic network, and the information revolution.

1-1 The concept of knowledge economy

According to the World Bank, it is an economy that uses knowledge effectively to accomplish economic and social growth, which involves bringing and implementing foreign information as well as modifying and developing knowledge to fulfill its own needs. (Al-Shammari & Al-Laithi, 2007, p. 87), whereas the Organization for Economic Cooperation and Development (OECD) defines it as an economy based on the creation, dissemination, and application of knowledge and information (Al-Hashemi & Al-Azzawi, 2010, p. 15), and Castel believes it is an economic system in which knowledge development and exploitation have a prominent role in wealth creation. (Castells, 1996, p. 3).

Alyan provides a definition of the knowledge economy as an economic system centered on the acquisition, engagement, utilization, employment, innovation, and production of knowledge. The objective of this system is to enhance the overall quality of life across various domains through the application of advanced technologies. This approach values the human intellect as a valuable form of knowledge capital and relies on scientific research to drive transformative developments. The proposed approach aims to address the economic climate by implementing measures to enhance its adaptability and alignment with the demands posed by globalization and advancements in information and communication technology (Alyan, 2010, p. 114).

Based on the preceding analysis, it is possible to argue that the knowledge economy is characterized by the significant contribution of knowledge acquisition and investment to the generation of wealth. This economic paradigm relies heavily on the accessibility of information and communication technologies, as well as the utilization of innovation and digitization. In contrast, the conventional economy primarily hinges on production, with knowledge playing a comparatively diminished role, and growth being propelled by traditional factors of production. In the knowledge economy, the most valuable assets are qualified and highly skilled human resources, commonly referred to as human capital. These resources encompass a range of attributes such as know-how, creativity, intelligence, and information.

According to the United Nations, knowledge-based economies currently contribute to approximately 7% of the global Gross Domestic Product (GDP) and are experiencing an annual growth rate of 10%. It is noteworthy to mention that the utilization and manufacturing of Information and Communication Technologies (ICTs) directly contribute to 50% of the productivity growth observed in the European Union. The assertion made by Nobel laureate economist Robert Solow in 1987 supports this notion, as he argued that 34% of economic growth can be attributed to the advancement of knowledge, while an additional 16% of economic growth stems from investments in human capital through educational endeavors. Accordingly, about half of the economic growth can be attributed to knowledge (Berrouche & Dehimi, 2016, p. 160).

1-2 Characteristics and requirements of the knowledge economy

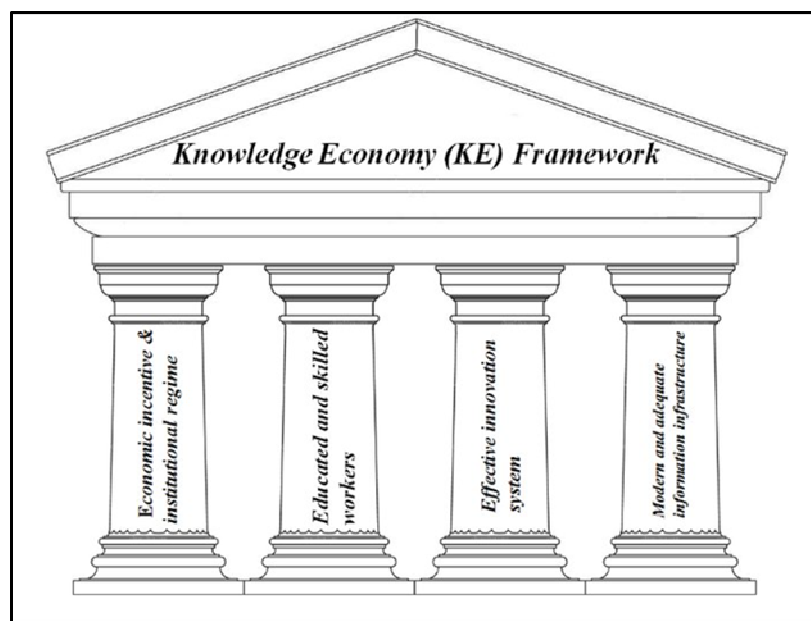
According to (Ahmed Ali, , 2014, pp. 107-109) (Badir, 2013, pp. 152-153) (Chen & Dahlman, 2006, pp. 5-6) , it can be summed up as an inference that includes, but is not limited to, the following elements:

- Investing in knowledge and innovation as the primary drivers of economic growth, which necessitates the development of a strong infrastructure for research, development, and technology, through which information can be generated and distributed and competent human resources can be formed.
- The ability to learn and adapt to quick changes in information and communication technologies as well as market conditions.
- Innovation in operations and management, particularly in production, marketing, and distribution, is based on investing in human resources and qualified and well-trained workers in science, technology, and management, as they are the intellectual and knowledge capital on which this economy is built.
- Reliance on data and information collection, analysis, and use to make choices and enhance operations
- Investing in infrastructure, including high-speed Internet and communications networks, renewable energy, and public transportation.
- Developing the education sector, fostering innovation, research, and development, and making money more accessible
- Increasing openness and accountability, as well as strengthening the business climate, rules, and regulations, to foster innovation and growth
- Increasing collaboration among government, businesses, universities, and civil society to foster innovation, infrastructural development, and economic progress.

1-3 Knowledge Economy Index

It is an indicator developed by the World Bank, it assesses a country's complete capacity and willingness to develop and succeed in the knowledge economy. Depicted it in the following figure:

Figure n°1: The World Bank Four Pillars of the Knowledge Economy



Source: (Summad, Al Kindi , Ahm, Sujan, & Muhammad, 2018)

It is founded on four pillars that are regarded as the fundamental pillars of the knowledge economy, It assesses a variety of factors for these pillars, including education systems, innovation capabilities, information and communication technology infrastructure, research activities, development, and an enabling environment for knowledge-based industries; it is used to compare country performance and identify areas for improvement in promoting knowledge-based economic growth (Chen & Dahlman, 2006). (Summad, Al Kindi , Ahm, Sujan, & Muhammad, 2018).

These pillars are explained below:

A - *Economic incentives and institutional regime*: this refers to providing an economic framework and incentives for the business community, as well as other conditions that work to raise the knowledge economy, in addition to the actual performance of the economy, and include sub-indicators such as economic freedom, ease of doing business, organizational quality, political stability, corruption control, and so on.

B- *Effective innovation systems*: this is a measure of the amount of technical R&D that represents the ability to innovate and deploy new technologies. It includes various sub-indicators, such as the percentage of high-tech exports, the total number of workers in research and development, and overall R&D expenditure as a percentage of national products, and the total annual average number of patents granted.

C- *Educated and skilled workers*: the key entry points for the knowledge-based economy are education and human resources. It focuses on human capital and contains sub-indicators such as total education spending per capita, secondary enrolment, university enrollment, educational quality, and student-teacher ratio.

D- *Modern and adequate Information infrastructure*: This is a component that includes everything related to the dissemination of information through the media and communication, and it includes several sub-indicators such as the amount of investment in communication means, phones used per thousand residents, telephone subscriptions per thousand residents, television and radio per thousand inhabitants, periodicals and daily newspapers for every thousand inhabitants, and periodicals and daily newspapers for every thousand inhabitants.

2- Higher education institutions and the knowledge economy

Higher education institutions play a crucial role within the knowledge economy, serving as a significant incubator and primary driver for the production and generation of knowledge. The pivotal significance of universities lies in their contribution to scientific research and the advancement of the knowledge economy. This is achieved through the establishment of scientific research centers and the implementation of development models within knowledge parks, alongside the provision of educational services. A novel perspective has arisen, wherein universities and research institutions are positioned as pivotal actors in the process of development.

The notion of universities has undergone transformation over time. In the nineteenth century, universities primarily emphasized the provision of academic education to students, with limited engagement in scientific research. This research was conducted in a restricted manner and confined to specific disciplines such as medicine and engineering. However, a new type of institution known as research universities has emerged, which have progressively shifted their focus towards a greater emphasis on research activities. The institution aims to enhance its involvement in scientific research and knowledge dissemination, broaden the range and variety of its research endeavors, and foster research activities and technological advancements as integral components of its academic mission. Furthermore, it endeavors to create an optimal scientific setting for scholars and experts specializing in diverse academic disciplines.

2-1 Research university concept

A research university is defined as a university that devotes a large portion of its resources and material capabilities to scientific research purposes from the Bachelor level to the Doctorate level, whether private or governmental; students with outstanding and high scores are frequently enrolled in university entrance examinations, and doctors from the faculty must be researchers before they are teachers, and are required to conduct research and disseminate it (Khoja, 2019, p. 7). Kerr characterized it as academic institutions dedicated to the development and dissemination of knowledge across a wide range of topics and fields, and it includes labs, libraries, and other infrastructure that allows for the highest level of teaching and research. While some research universities are large and interdisciplinary, others are smaller and specialize on a narrower variety of areas. These universities educate students at all levels of education and primarily employ full-time academics with doctorates (Kerr, 2001).

The main tasks of research universities in the academic system are to provide an appropriate research environment and to provide financial and technical support for research, experience, training, and qualification of students to engage in research; most research is carried out in collaboration with, funding and sponsorship from non-university sources (Altbach P. , 2009)

In 1994, the American Carnegie Corporation published a categorization that classifies universities in the United States based on their degrees of scientific research. A research university, according to (Al-Mutairi, 2012, p. 51) has the following characteristics:

- Provides a diverse choice of undergraduate degree programs;
- Have a commitment to postgraduate education up to a Ph.D;
- Prioritize scientific research;
- More than 50 Ph.D. degrees are awarded each year (at the time);
- And get annual federal financial support of more than 40 million dollars (at the time).

According to (Weerts, State Funding and the Engaged University: Understanding Community Engagement and State Appropriations for Higher Education, 2014), the Carnegie Foundation reported in 1994 that 59 universities in the United States of America completed these requirements.

According to the Carnegie Foundation's most recent classification, universities are grouped into three major categories (Kosar & Scott, 2018):

a. Major research universities (R1): The universities with the highest levels of scientific research are primarily supported by the US Federal Government and big private companies.

b. Comprehensive research universities (R2) undertake high-quality scientific research, receive less funding than R1, and focus on basic and applied research.

c. Basic research universities (R3): universities that do small-scale scientific research and primarily focus on university education.

Although some educational systems have developed clear mechanisms to distinguish higher education institutions from research and teaching universities, many still suffer from a misunderstanding of educational institutions and their respective roles (Al-Ghabban & Zaman, 2013, p. 12).

2-2 Research university missions:

The research missions of universities are diverse and many, and include the following (Kerr, 2001):

- Provides a proper educational environment for students and researchers, as well as the academic programs required to qualify students and provide them with academic and scientific skills and knowledge.
- Supports scientific research, technological development, and the generation of new information in a variety of sectors of science, technology, and the humanities
- Publishes and presents scientific and technology research and results in reputable scientific journals and at worldwide and national scientific conferences.
- Increases the breadth of scientific and technology research in the community and developing the university-community partnership through the organization of events, conferences, seminars, training, and the provision of scientific and technical assistance.
- Enhance collaborations with institutions, businesses, and public and commercial organizations in order to share information and experiences and develop technology and new solutions in a variety of disciplines.
- Provides an appropriate research environment as well as the financial and technical support required to conduct research and applied experiments and achieve scientific and technological progress.
- Provides opportunities for continuing education and professional training for university researchers, faculty, and staff.

2-3 Research university success factors:

According to (Weerts & Ronca, 2008) and (Research and Consulting Institute, 1427 AH, pp. 53-56), the following factors sum it up:

2-3-1 Funding: The success of a research university depends on its ability to fund research as well as its infrastructure needs, such as laboratories, equipment, research libraries, advanced computer centers, Internet facilities, and the financial means to attract top students scholarships and hiring Ph.D. researchers to focus on research without teaching. Additionally, to build the foundations of research universities, it takes a lot of work to secure a stable income and obtain the necessary income from various sources without relying on grants and research contracts, which are subject to fluctuations outside the control of university administrators. This is in addition to managing the annual budget and research expenses according to contracts and grant criteria.

2-3-2 Rational management and strategic vision: Even with the necessary funding and other components, the research university will fail if it does not have rational management and a strategic vision that define clear goals, provide effective organizational structures, direct resources effectively, develop and manage the working team in a distinguished manner, implement strong control procedures, and take strategic decisions.

2-3-3 Human capital: The research university must attract the brightest professors and researchers in diverse subjects, create a good work environment, improve their skills, and motivate them to produce scientific research.

2-3-4 Students: A research university must attract outstanding students and great researchers, choose them using reliable criteria, create an adequate learning environment, and motivate them to be creative and scientifically productive.

2-3-5 Intellectual climate: Research universities can benefit from the intellectual climate, or research culture. Increasing scientific meetings, conferences, and demos and encouraging researchers to compete constructively creates the right intellectual climate for the university's research objective.

2-3-6 Academic freedom: Without academic freedom, research becomes fruitless. Academic freedom means scholars can pick their field of research, techniques, and direction without pressure, taking into account research-supporting agencies' needs.

2-3-7 Infrastructure: The research university must supply current academic facilities, hardware, software, smart systems, and other scientific research and production needs.

2-3-8 Partnerships: Research universities should collaborate with other universities and institutions, industrial and commercial partnerships, joint ventures, and local and international governmental and scientific entities.

3- Algeria's higher education and knowledge economy

3-1 An examination of the key indicators of the higher education sector:

Despite efforts to improve its indices, Algeria's higher education sector, like other state sectors, suffers from low productivity and competitiveness. The following is a summary and analysis of the most important higher education indicators:

3-1-1 The scientific output of Algeria

Table 1 illustrates the progressive and substantial growth of Algeria's scientific output, with the number of articles increasing from 547 in 2000 to 10,675 in 2023.

Table n°1: The evolution of Algerian scientific output in the Scopus database

Year	Number Of Published Papers	% Of The Arab World	% Of The World
2000	547	4.91	0.04
2001	645	5.49	0.05
2002	689	5.52	0.05
2003	906	6.19	0.06
2004	1194	7.55	0.07
2005	1311	7.43	0.07
2006	1844	9.06	0.09
2007	2045	9.03	0.1
2008	2499	9.47	0.11
2009	3131	9.88	0.13
2010	3159	8.68	0.13
2011	3596	8.41	0.14
2012	4265	8.53	0.16
2013	4882	8.7	0.17
2014	5232	8.4	0.18
2015	5891	8.75	0.21
2016	6623	8.56	0.22
2017	7317	8.81	0.24
2018	7950	8.71	0.26
2019	8013	7.22	0.24
2020	8206	6.4	0.23
2021	9625	6.5	0.25
2022	10680	6.23	0.27
2023	10675	5.81	0.27

Source: (Scimago, 2023)

This development is noteworthy; however, it is important to acknowledge that the global average scientific publication rate for researchers stands at 1.5 papers per year, whereas the corresponding rate in the Arab world does not exceed 0.3 research papers annually per researcher. Considering the significant number of professors and researchers in Algeria, this surpassed 57,000 according to the Ministry of Higher Education's 2023 statistics, the scientific publication rate amounts to 0.2 per year. This equates to one research paper for every five researchers, indicating a notably low percentage and highlighting the inadequate level of scientific research in Algeria.

3-1-2 Algeria's higher education budget

The provided table below illustrates the allocation of funds in Algerian dinars to the higher education sector from 2010 to 2023. It is observed that this budget remained below 7 percent of the overall government budget and did not surpass 0.5 percent of the gross national product. These figures indicate a notably low percentage, reflecting the overall inadequacy of the Algerian university system and the limited level of research, innovation, and development within universities.

Table n°2: Algeria's higher education budget for the years 2010-2023

Year	Total expenditure (*1000 DZA)	% of total government expenditure
2010	173 483 802	6.11
2011	291 441 690	6.79
2012	277 173 918	6.01
2013	564 582 513	6.10
2014	270 742 002	5.74
2015	300 333 642	6.04
2016	312 145 998	6.49
2017	310 791 629	6.77
2018	313 336 878	6.83
2019	317 336 800	6.41
2020	364 283 132	7.44
2021	370 600 000	6.97
2022	400 051 187	6.33
2023	466 490 000	4.78

Source: (Algerian official press, Several years)

The following table greatly enhances this result, revealing that 47.60% of the budget is allocated to higher education, in terms of management, public utilities, infrastructure, laboratories, wages, student grants, and so on, in addition to 37.23% allocated to university services, such as transportation, food, and housing costs. Consequently, the aforementioned services and fees account for over two-thirds of the higher education expenditure.

Table n°3: The allocation of the 2023 higher education budget

Sub-sector	Expenditure Amount (*1000 DZA)	% Of The Expenditure
Higher Education	222 066 000	47.60
University Services	173 688 000	37.23
University publication office (OPU)	20 000 000	4.28
Scientific Research Agencies and Centers	10 650 000	2.28
Higher Education Subsidies	6 000 000	1.28
Processing programs and others	34 086 000	7.30

Source: (Algerian official press, 2023)

The table also shows that only 2.28% is allocated to research centers and agencies, indicating that the Algerian university continues to focus on its traditional role in pedagogical training and

directing graduates to the labor market, and is far from its role in research, development, and innovation, which explains Algeria's low index of research and innovation and its occupation of the last positions in it.

3-1-3 Number of patents

Based on the available data from the Directorate-General for Scientific Research and Technological Development, the current number of domestically registered patents exhibits a noteworthy advancement, although falling short of the desired threshold.

It was observed that the total count of patents recorded in the year 2015 amounted to a mere 200. This figure stands in stark contrast to the single patent registered for Algeria within the US Patent and Trademark Office (USPTO) during the corresponding timeframe. This discrepancy suggests a relatively limited degree of creativity, innovation, and invention within Algeria.

Nevertheless, the data reveals a notable and accelerating increase in patenting activity in Algeria, particularly from 2020 onward. The sharp rise in 2022 may be attributed to several factors, including strengthened national intellectual property frameworks, increased involvement of universities and Algerian researchers abroad, or a broader integration into global patenting trends. However, despite this progress, the overall level of patent registrations remains below the expected threshold—especially when compared to the number of international patents filed by Algerian expatriate researchers.

Table n°4: Number of patents registered in Algeria

Year	Number of patents	Office
2011	116	DGRSDT
2012	134	
2013	168	
2014	174	
2015	200	
2016	237	
2017	254	
2018	275	
2020	331	
2021	420	
2022	691	

Source: (DGRSDT, 2016, p. 8), (DGRSDT, 2023)

It is worth mentioning that the problem is not with scientific competencies or the elite, but with their neglect, a lack of investment in these elite, and a lack of funding and infrastructure for research and innovation. The table below clearly shows the number of patents registered by Algerians living abroad. In 2015, over 3036 patents were registered globally, which was 15 times the number of patents registered nationally in the same year. Unfortunately, Algeria is regarded as the first Arab country to export scientific competences and minds to other countries.

Table n°5: Number of international patents registered by Algerian expatriate researchers

Years	Number of patents granted	Country of residence of Algerian researchers	Granting Offices
2011	2744	USA, France, Switzerland, Denmark, Singapore	Patent Cooperation Treaty PCT / European Patent Office EPO / United States Patent and Trademark Office USPTO / National Institute of Industrial Property INPI / JAPAN PATENT OFFICE JPO / The Intellectual Property Office U.K / The Intellectual Property Office Denmark DK / The Intellectual Property Office South of Korea KR
2012	2833		
2013	2872		
2015	3036		

Source: (DGRSDT, 2016, pp. 14-16)

3-1-4 Algerian university rankings based on higher education performance reports:

A- *The QS higher education ranking*: it was launched in 2004 and focuses on four major components of higher education: scientific research, employability, educational efficiency, and globalization. In its last report for the years 2022 and 2023, it did not list any Algerian universities among the top 1,000 universities.

B- *The times higher education ranking*: this evaluates the best international institutions based on four main variables and 13 supplementary indicators. Algeria has 24 universities in the overall Times Higher Education World University Rankings. The highest-ranking university in Algeria is Ferhat Abbas Sétif University 1, which is ranked at number 401–500.

C- *The Shanghai university ranking*: Launched in 2002, it is based on four major indicators: faculty quality, education quality, per capita productivity, and research output. In its most recent edition, no Algerian university was listed among the top 500 in the world.

D-*ARWU ranking*: According to the most recent data, no Algerian university is among the top 1000 in the world.

According to the data presented above, the transformation of Algeria into a knowledge economy is difficult, if not impossible, due to the Algerian university's traditional role in academic education, the deterioration of education and training quality, the absence of modern technologies in teaching, the fragility of the research infrastructure and development, and the lack of cooperation between research and development. All of these problems have a negative impact on Algeria's ability to integrate into knowledge economy.

3-2 An examination of the key indicators of Algeria's knowledge economy:

Algeria is attempting to transition away from its reliance on oil and toward a knowledge economy, but its efforts have been insufficient, resulting in extreme delays in the indicators of knowledge and the knowledge economy of Algeria, and the following is a brief presentation of the most important of these indicators:

3-2-1 The knowledge economy index:

According to the World Bank's 2012 report¹, Algeria scored 96th out of 146 countries, with a score of 3.79 out of 10, ranking seventh in the Arab world behind the United Arab Emirates, the Sultanate of Oman, the Kingdom of Saudi Arabia, Qatar, Kuwait, and Tunisia.

The following table compares the main indicator and the sub-indicators from the 2000 and 2012 reports:

Table n°6: Algeria's knowledge economy index for the years 2000/2012

ICT		EDU		INN		EIR		KEI	
2000	2012	2000	2012	2000	2012	2000	2012	2000	2012
110	89	92	71	105	99	138	115	110	96

Source: (KEI Rankings, 2000)(KEI Rankings, Knowledge Economy Index (KEI) Rankings, World Bank Data, 2012)

Based on the tabular data, it is evident that Algeria has made notable strides in enhancing its main indicator as well as the sub-indicators. This progress can be attributed to the concerted endeavors aimed at enhancing performance and bridging the gap with more advanced nations. However, it is important to note that these efforts remain limited and inadequate, failing to fully realize the desired objectives. Consequently, Algeria continues to occupy relatively low rankings in comparison to other countries.

3-2-2 The Global knowledge index

Regarding the Global Knowledge Index, Algeria also received extremely low scores in the years 2018 and 2020², and its position was very low. It was ranked 104 out of 134 countries in 2018 with a score of 39 out of 100, and ranked 103 out of 138 nations with a score of 37.5.

Upon examination of the constituent elements of this indicator, it becomes evident that the innovation sector bears the greatest responsibility for the observed decline in the index's value. Specifically, the sector's value was estimated to be 24.8 in 2018, yet experienced a significant decrease to 14.2 in 2020, indicating a notably feeble performance.

The rest of the sectors had very low results, with the exception of higher education, which had an average value of 47.2 out of 100. Examining the causes behind this, we see that the drop in government spending on higher education is the most important, and the average number of students per professor in higher education is very low. Algeria was placed 102 with a rating of 53.8, with a drop in collaboration between universities and sectors in the domains of research and development, as well as a decrease in enrollment rate in internationally ranked universities. The last value and indication were recorded by technical and vocational education and training sector, where Algeria ranked 133 out of 138, a relatively late rank. (MBRF, The future of Knowledge: A foresight report, 2018)

The most essential feature of this index is that it focuses on the most critical shortcomings that must be addressed in order to enhance Algeria's rank and metrics in the global knowledge index.

¹ The last version was expected to be released in August 2023.

² Algeria did not receive a ranking in either the 2022 or 2023 editions of the report.

Table n°7: Algeria's Global knowledge index for the years 2018/2020

Year	Rank/Index	Pre-university education	Technical and vocational education and training	Higher education	Innovation	ICT	Economy	General enabling environment	GKI
2018	Rank	85	122	80	58	107	115	117	104
	Index	50.6	38	36.6	24.8	37.2	36.1	47.4	39
2020	Rank	82	133	37	114	106	112	114	103
	Index	57.3	30.7	47.2	14.2	37.5	32.3	46.5	37.5

Source: (MBRE, The future of Knowledge: A foresight report, 2018) (Global knowledge index, 2020)

3-2-3 Global Competitiveness Report Indicators

The World Economic Forum's Global Competitiveness Report for 2017-2018³ found that Algeria rated relatively low in each of the following sub-indicators: higher education and training, innovation, and technical readiness, which we shall address in depth below:

3-2-3-1 Higher education and training: Algeria's ranking in secondary education enrollment is 47th globally, while its ranking in tertiary education enrollment is 74th. However, the country's performance in other indicators is relatively low, particularly in terms of education quality, which scored 3.2 out of 10. This indicates a lack of fundamental elements necessary for the success of the higher education infrastructure. By harnessing its potential to drive economic progress, particularly in the realm of knowledge-based economy, the entity in question assumes a proactive stance in accelerating the pace of economic development.

3-2-3-2 Innovation: According to the report, a significant hindrance to the progress of the innovation sector is the limited collaboration between universities, research centers, and the industrial sector. This is evidenced by a low index score of 2.6 out of 10, and a rank of 125. Additionally, the index measuring the proportion of expenditure allocated to research has declined to 2.9 out of 10. In the aforementioned scenario, the ranking stands at 104, accompanied by constraints in strategic foresight and limited capacity for idea generation. Furthermore, there exists a notable inadequacy in the allocation of financial resources towards research and development endeavors within companies.

3-2-3-3 Technological readiness: Algeria's performance in this indicator was found to be the lowest in terms of the firm-level technology absorption, the availability of advanced technologies in production activity, and the limited impact of foreign investment in transferring advanced technology. These findings strongly suggest a weakened enabling environment and a decline in the foundations of the knowledge economy in Algeria.

³The 2020 Global Competitiveness report is dedicated to elaborating on the priorities for recovery and revival, and considering the building blocks of a transformation towards new economic systems that combine “productivity”, “people” and “planet” targets. The 2021 report reverts to a benchmarking exercise that provides a new compass for the future direction of economic growth.

Table n°8: Algeria's Global Competitiveness Report Indicators

	Components	Rank	Index
Index	Higher Education and training	92	4.0
Sub-indexes	Secondary education enrollment rate (gross %)	47	99.9
	Tertiary education enrollment rate (gross %)	74	36.9
	Quality of education system	97	3.2
Index	Innovation	104	2.9
Sub-indexes	University-industry collaboration in R&D	125	2.6
	Company spending on R&D	104	2.9
Index	Technological readiness	98	3.4
Sub-indexes	Availability of latest technologies	119	3.8
	Firm-level technology absorption	121	3.8
	FDI and technology transfer	114	3.7

Source: (Global Competitiveness Report, 2017, p. 45)

3-3 Higher education-related impediments to Algeria's transition to a knowledge economy

Based on the aforementioned factors, Algeria faces numerous challenges hindering its integration into the knowledge economy, most notably (Zouari & Benaouali, 2021):

- One of the shortcomings of higher education is its weakness in effectively utilizing human resources. Additionally, there is a lack of efficient technical equipment, which hampers research and innovation efforts. Furthermore, the government's strategies in the field of research and innovation are unclear, further exacerbating the challenges faced by higher education institutions.
- The substandard quality of higher education and the limited effectiveness of local teaching systems in comparison to those of developed nations, along with the insufficient quantity of patents registered domestically and the near absence of international patent registrations.
- The insufficient quantity and inadequate quality of scientific publications, as well as the limited incorporation of study and research findings by facilitators and decision-makers in the formulation of economic activity mechanisms.
- Insufficient financial resources allocated towards research and innovation.
- The limited capacity for innovation and failure to effectively harness creative potential resulted in the emigration of local talents to more advanced nations.
- Algeria's position in higher education, competitiveness, innovation, technological progress, creativity, and knowledge society is relatively low. Additionally, there is a lack of collaboration in research between Arab and international entities. Statistical data reveals that only a mere 0.1% of scientific papers are published in collaboration with Arab Maghreb countries, with the majority of these collaborations being focused on the field of medicine.

4- California's higher education system as a model

4-1 An overview on the system:

It was established in 1960 by the merger of three separate educational systems: the University of California system, the California State University system, and the California state college system. The administrative linkage of the entity in question is established through legislation enacted by both the United States government and the state government of California, resulting in a hierarchical structure comprising three discernible levels.

In order to attain exceptional higher education, it was imperative to consolidate endeavors within the realm of higher education, enhance operational efficiency and efficacy, realize cost reductions, foster research and advancements, and deliver public services to the community.

The administration of the program is under the purview of the University Of California Board Of

Regents. The funding patterns for the program vary across three levels, with different sources of funding including the federal government, state government, private organizations, and commercial and research institutions. These entities collaborate through partnerships, donations, training programs, and cooperation in the realm of research and innovation to secure additional funding (Douglass, 2000, p. 139).

Clarke Kerr, the system's primary architect, envisioned the fundamental attributes of a research university. All of these resources are accessible through the University of California, with the first being that the university's internal administration is primarily overseen by the faculty, and major decisions must be made by academic personnel. Rigorous criteria for the selection and advancement of faculty members, as well as the admission of students; Advanced scientific research is characterized by a strong focus on scientific investigation and innovation, as well as the provision of essential infrastructure and resources to support scientists and researchers across various disciplines. The institution offers a wide range of academic programs across multiple disciplines, providing students with the opportunity to explore diverse educational and research avenues aligned with their individual interests and aspirations. In summary, research and teaching are fundamental responsibilities within universities, with research being regarded as of paramount importance and given top priority (Kerr, 2001).

This system is comprised of the University of California system, the California State University system, and the California Community Colleges system. Following is a breakdown of each individual system:

- The University of California system, led by the Berkeley campus, is an R1-level research university with 10 campuses among the best universities in the world. It focuses on research and innovation and attracts 1/8 of the best high school students in the state who have a research mission or research inclinations and are innovative (Altbach P. , 2013).
- California State University, with 23 campuses, enrolls approximately 457,992 students and offers affordable educational programs in various disciplines (The California State University, 2022). These institutions focus on enhancing learning outcomes, developing students' abilities, and facilitating practical experiences. The system also has R2/R3 research universities, but faculty members are not expected to maintain the same level of research activity as their counterparts in the University of California system.
- The California Community Colleges system, the largest free higher education system in the United States, has 116 colleges across the state with over two million students. These colleges are primarily focused on labor market training and have limited research capacity (California Community Colleges, 2020).

4-2 The Impact of Implementing the Higher Education System on the State of California:

The implementation of California's higher education system has had a transformative impact on the state's knowledge economy, driving innovation, workforce development, and global competitiveness. California's universities, attract over **\$20 billion annually** in research funding, fueling advancements in technology, biotechnology, and clean energy (UCOP, 2024). These institutions contribute significantly to the state's technology sector, which accounts for **\$520 billion** in economic output, nearly **25% of the U.S. tech GDP**(CompTia, 2023). Moreover, California's higher education system produces a highly skilled workforce, with **43% of working adults** holding a college degree (UCOP, 2024), higher than the national average. This educational pipeline supports knowledge-based industries like healthcare, where over **500,000 jobs** are linked to biotech and life sciences, sectors that contribute **\$375 billion annually** to the economy. The state's universities also serve as incubators for entrepreneurship, having generated more than **1,500 startups** since 1980 (University of California, 2022), many of which thrive in

innovation hubs like **Silicon Valley**. Through research, skilled talent, and industry collaboration, California's higher education system remains a cornerstone of its knowledge-driven economy. Consequently, California possesses the largest economy in the United States and ranks among the world's largest economies. According to 2023 statistics, California's gross domestic product amounts to **\$3.98 trillion**(BEA, 2024), equivalent to **\$102,527 per capita**. In the hypothetical scenario of being regarded as a sovereign nation, it would rank as the fifth largest economy worldwide, surpassing the United Kingdom but trailing behind India. As evidenced by statistical data, California consistently leads in terms of research publications, accounting for **14% of the total research output** in the United States of America. Additionally; California holds the highest number of patents granted by the **US Patent and Trademark Office**, has received **70 Nobel Prizes**, and has been granted **96 MacArthur "Genius" awards**(UCOP, 2024).

The research universities within the California higher education system have made significant contributions towards fostering a culture of initiative and creativity, promoting entrepreneurship, and facilitating the establishment of novel start-up ventures.

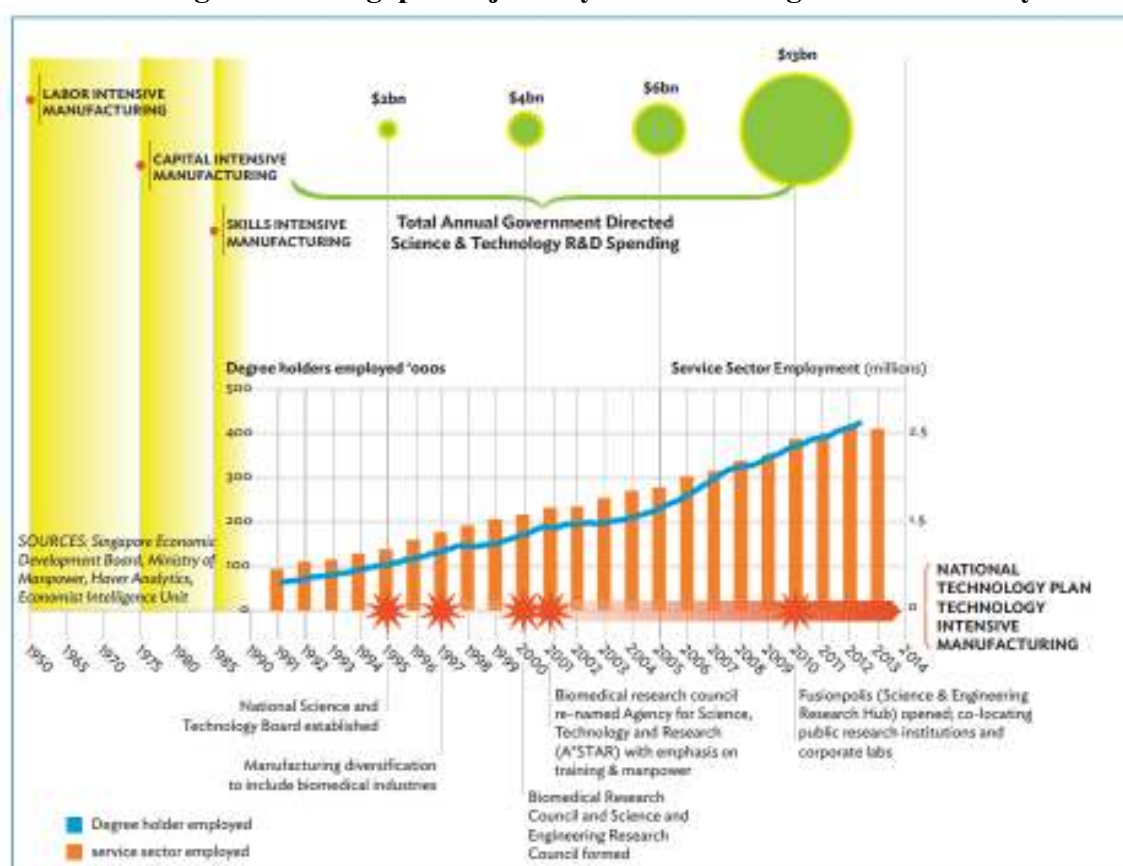
It is noteworthy that the knowledge economy in California is significantly influenced by research universities, which collaborate with prominent corporations, government entities, and academic institutions. This collaboration contributes to the growth of the knowledge economy at both state and national levels. Silicon Valley, a renowned high-tech hub, is a prime example of innovation and technological advancements in the state. Google, Facebook, Amazon, and Uber are among the companies that have embraced California's research universities and scientific institutions, fostering new technologies and enhancing existing products. Overall, the higher education system in California plays a crucial role in advancing the knowledge economy.

5- Singapore efforts in the transition to KBE as a Model

Singapore similarly has intentionally evolved beyond its traditional entrepôt functions to position itself as a hub for knowledge-based industries and innovation. It has invested heavily in R&D, higher education, and ICT. As a result, Singapore's education system has been consistently ranked as one of the highest in the world by the OECD. (The economist , 2018), furthermore, according to The Program for International Student Assessment (PISA), an influential worldwide study on educational systems, Singapore has the highest performance in international education and tops in global rankings.

The development process underwent a succession of economic transformations, each approximately a decade long: labor-intensive growth in the 1960s, skill-intensive growth in the 1970s, capital-intensive growth in the 1980s, technology-intensive growth in the 1990s, and growth based on knowledge and innovation from 2000 onward. The early years had economic expansion fueled by foreign direct investment (FDI), and in the 1990s, there was a concerted effort to emphasize technology to evolve into a knowledge-based economy (KBE). The nation first encouraged foreign direct investment to acquire advanced technologies and engage in global trade, subsequently transitioning to indigenous research and development skills. Similar to the Republic of Korea, its research and development expenditure commenced at 0.5% of GDP in the early years and has progressively increased to 2.3% of GDP. Government plans to raise it to 3.5% of GDP by 2015. The Development Board managed investments in R&D, technical education, and high-tech businesses to strengthen Singapore's economy (Asian Development Bank, 2014).

Figure 2: Singapore's journey to a Knowledge-Based economy



Source: (Asian Development Bank, 2014, p. 15)

The economy emphasized technical education, facilitated MNC training, and actively fostered collaborations with leading universities to enhance KBE talent pools.

Singapore has systematically cultivated an educational environment that promotes the advancement of science and technology, consequently developing indigenous talent. In 1991, Singapore founded the National Science and Technology Board to enhance its scientific and technological capabilities. The quantity of research scientists and engineers increased from 28.2 per 10,000 in 1990 to 87.9 per 10,000 in 2001.

In 2000, the Biomedical Research Council and the Science and Engineering Research Council were established. In 2002, the National Science and Technology Board was renamed the Agency for Science, Technology, and Research (A*STAR) to emphasize the training of research people for the shift to a Knowledge-Based Economy (KBE).

In 2003, the public and commercial sectors established the \$500 million Biopolis to offer premier biomedical research and development facilities with collaborative research, and in 2008, they introduced Fusionopolis, a research and development complex located at the one-north business park, which is a hub for scientific and engineering research. The co-location of public sector research institutions and corporate laboratories has significantly benefited the economy.

To sum-up, Singapore has exerted considerable effort to transition to a knowledge economy, primarily by prioritizing the importation of technology through the facilitation of foreign direct investment in advanced technological sectors. Subsequently, substantial financial resources have been allocated to establish research and development centers across various domains, alongside

enhancements in the quality of higher education, which includes fostering collaborations with leading universities around the world, equipping institutions with research facilities, modern technologies, and most importantly, providing the necessary funding to support scientific research.

6- Insights for Algeria from the experiences of California and Singapore

- To strengthen Algeria's research universities and advance its integration into the knowledge economy, it is essential to establish a sustainable funding model beyond short-term grants. Creating a National Endowment for Research Universities would provide long-term financial stability, while diversifying income sources—such as industry partnerships, consulting services, alumni contributions, and commercializing patents—would reduce dependence on public funding. Strategic investment in modern research infrastructure and the creation of PhD-only research positions would also help retain top talent. Moreover, adopting multi-year budgeting and training administrators in financial management would ensure greater efficiency and resilience.
- Even with adequate funding, success depends on competent, strategic leadership. Algeria must reform university governance to balance institutional autonomy with accountability. Leadership roles should be filled transparently and based on merit, with a focus on long-term vision and performance. Establishing clear strategic plans aligned with national development goals, alongside measurable performance indicators, will help universities focus on research outputs, innovation, and societal impact.
- The heart of any research university is its human capital. Algeria should offer competitive compensation and research support to attract both domestic and expatriate researchers. Programs designed to facilitate the return of Algerian talent abroad—through joint appointments, sabbaticals, or startup grants—will help reverse brain drain. Continuous training, mobility opportunities, and transparent systems for recognizing and rewarding excellence are also essential to motivate and retain researchers.
- High-performing students are vital to a thriving research environment. Algeria should adopt selective admission criteria for graduate programs based on academic merit and research aptitude. Offering full scholarships and integrating students into research projects early will enhance their skills and engagement. National and international mobility programs will also expose students to diverse research environments, enhancing both academic quality and innovation capacity.
- A vibrant intellectual climate fosters creativity and innovation. Algerian universities should regularly host scientific events and interdisciplinary forums to promote dialogue and collaboration. Supporting student-led research clubs, competitions, and idea labs can stimulate engagement and encourage problem-solving. Additionally, establishing specialized research clusters in priority fields such as AI, water resources, and renewable energy will consolidate expertise and promote collaboration.
- For research to thrive, academic freedom must be guaranteed. Algerian institutions should provide legal and institutional safeguards that allow scholars to pursue research freely while aligning with national priorities. Establishing independent academic review councils and promoting open-access publication will support transparency and academic autonomy, enhancing the quality and credibility of research.
- Modern infrastructure is the foundation of advanced research. Algeria should prioritize investment in digital and physical facilities, including updated laboratories, high-speed internet, and AI-enabled systems. Shared national platforms—such as supercomputing centers and online research databases—would improve efficiency and collaboration. Supporting open-science tools will also foster broader access to knowledge and data sharing.

- Collaboration is key to scaling research impact. Algerian universities must build strategic partnerships with global institutions, regional networks, and local industries. Encouraging joint degrees, research consortia, and innovation zones will connect universities with real-world challenges. Signing agreements with international organizations and public agencies can also facilitate co-funded research initiatives, enhancing both relevance and global visibility.

Conclusion:

In conclusion, the significance of research and development in higher education institutions, particularly research universities, cannot be disregarded. It plays a crucial role in advancing scientific and technological advancements, fostering innovation and economic growth, and bolstering global competitiveness. Consequently, it serves as the cornerstone of knowledge-based economies across the world. The process of incorporating Algeria into the knowledge economy presents challenges, particularly due to the limited scope of national universities' functions in their conventional structure, the decline in educational standards, the absence of contemporary teaching technologies, the insufficient financial support for scientific research, the lack of a strategic vision focused on the actual progress of this sector, and the inadequate utilization of research findings and academic outputs. Algeria must undertake measures to address the disparities and implement substantial and transformative reforms within its higher education sector. It could be inspired by the 1960 higher education system transformation, which changed California's society, economy, and demographics, making it one of the world's largest economies. It may also draw inspiration from Singapore, which boasts one of the highest R&D intensities globally (2.75% in 2021), and is acknowledged as a leading nation in scientific research expenditure, with investments escalating from 2 billion in 1995 to 19 billion in 2021, accounting for around 60% of the country's total R&D spending.

Consequently, the California higher education system and Singapore's research and development initiatives serve as exemplary models that Algeria can consider adopting to effectuate substantial and transformative changes within its own education system.

This would involve prioritizing the establishment of research universities and research centers, providing the necessary funding to support scientific research, even though the desired outcomes may be delayed by a decade or two. Nevertheless, inevitably this will significantly accelerate the process of integration into the knowledge economy compared to the current rate.

Recommendations:

Based on the transformative experiences of California and Singapore, several strategic and actionable recommendations can be applied in Algeria to advance its integration into the knowledge economy and strengthen its higher education and research landscape:

- Reform higher education by supporting university research and innovation, and moving toward the establishment of a limited number of flagship national research universities with special autonomy, differentiated missions, and clear research performance expectations.
- Foster research talent by identifying and nurturing exceptionally talented students and researchers early in their academic journey. This involves long-term mentorship, research exposure, and institutional support to build a generation oriented toward innovation.
- Set a national R&D spending target by increasing Gross Expenditure on Research and Development (GERD) to at least 1% of GDP by 2030, and establish a National Research and Innovation Fund independent of annual budget fluctuations.

- Develop a National Research and Innovation Strategy that aligns with Algeria's development goals, focusing on priority sectors such as renewable energy, agriculture, health biotechnology, artificial intelligence, and water management.
- Establish scientific oases, regional R&D centers, and technological incubators to decentralize innovation and provide infrastructure for local research and entrepreneurship.
- Engage the Algerian scientific diaspora through structured programs offering incentives, joint research projects, visiting fellowships, and reintegration support to benefit from global expertise.
- Strengthen international and regional collaboration by forming partnerships with global and Arab universities, research institutions, and international programs—drawing on successful transitions in countries like the UAE and Saudi Arabia.
- Protect intellectual property by implementing comprehensive IP legislation and robust enforcement mechanisms, encouraging patenting, and supporting the commercialization of research outputs.
- Support knowledge-based sectors such as creative industries, technological tourism, and knowledge-intensive services, linking academic research with diversified economic development.

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