

Mechanisms for adapting global digital innovation models in Algerian economic institutions: An Analytical Study of Leading Experiences and the Local Context'

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Abstract:

This study explores ways in which Algerian economic institutions can benefit from and adapt successful international models of digital innovation in light of the deep transformations imposed by the digital economy. In this context, digital innovation has become essential for the growth and sustainability of institutions. The study examines the characteristics of innovation models in leading countries — Germany and South Korea — in order to draw actionable conclusions, before diagnosing the current situation of Algerian institutions in the face of digital challenges.

Using a descriptive-analytical approach, the study compares the digital gap between global models and the local context, highlighting the structural and technical obstacles confronting Algerian institutions. It concludes that achieving sustainable growth requires building an integrated innovation ecosystem that connects universities, economic institutions and the legislative/regulatory environment, rather than relying solely on importing technology.

Keywords: digital innovation, economic growth, international experiences, Algerian institutions, digital transformation.

Introduction

The global economy is currently undergoing profound structural changes, driven by the growth of the digital economy. In this context, digital innovation has evolved from a strategic option for improving operational efficiency to an essential requirement for achieving sustainable growth and maintaining the competitiveness of economic institutions. Digital innovation now encompasses more than just the adoption of modern technologies; it also involves reshaping business models, production processes and value chains, thereby enabling the creation of significant added value and the expansion of markets beyond traditional boundaries.

Against the backdrop of these rapid changes, Algerian institutions must balance adopting successful global models with the specificities of the local environment and the structural and technical obstacles this entails. Leading global models, such as the German “Industry and Structural Partnership 4.0” initiative and the South Korean “learning for innovation” model, which emphasises intensive investment in human resources and infrastructure, serve as reference frameworks for achieving comprehensive digital transformation. However, replicating or transferring these models without a process of strategic adaptation that considers the characteristics of the local environment and addresses its structural challenges cannot accomplish the intended objectives.

Today, the Algerian economy is at a pivotal stage. Despite the quantitative gains recorded in digital indicators and telecommunications infrastructure in 2024 and 2025 — such as the significant rise in

internet subscribers, growth in electronic payments and the emergence of start-ups — a fundamental gap remains between digital consumption and production. This gap is rooted in the continued presence of regulatory obstacles, structural costs, and limited integration between the academic ecosystem and the production sector.

This study focuses on a central research problem: What mechanisms and strategies can enable the adaptation and localisation of global digital innovation models within Algerian economic institutions to strengthen their competitiveness and ensure sustainable growth?

This problem is addressed through the following subsidiary questions:

- What constitutes digital innovation, and what are the dimensions and competitive characteristics that distinguish it from traditional innovation in today's business environment?
- What structural and philosophical elements contributed to the success of digital innovation models in Germany and South Korea?
- What is the current level of digital readiness of Algerian economic institutions, and what are the most significant gaps and structural obstacles facing the transformation process?
- How can a clear roadmap be developed to adapt global model tools, such as Germany's regulatory rigour and South Korea's bold investment, to create an integrated ecosystem linking legislation, universities, and economic institutions in Algeria?

Main hypothesis

Successful adaptation and localisation of global digital innovation models within Algerian economic institutions requires more than just importing technology and ready-made digital solutions. This requires the development of an integrated ecosystem linking flexible and enabling legislative frameworks, the academic and research ecosystem, and productive/industrial institutions.

Sub-Hypotheses

Digital innovation is distinguished from traditional innovation by its role as a high-speed driver of economic growth. This is enabled by features such as rapid scalability, lower marginal costs, and the creation of new business models based on the added value of data.

The success of digital innovation models in Germany and South Korea is attributed to the adoption of an integrated triple-helix partnership model — the state, universities, and the private sector — along with intensive strategic investment in advanced infrastructure and human capital.

Despite Algeria's encouraging quantitative leap in digital readiness and telecommunications infrastructure indicators during 2024–2025, its contribution to innovative production within institutions remains limited due to the structural gap between digital consumption and industrial application.

Algerian economic institutions can overcome obstacles to digital transformation by adopting the principles of reverse engineering and smart manufacturing, while activating financial inclusion mechanisms and developing dual training approaches to meet market requirements.

The importance of this study stems from its timeliness and the significant academic interest it has attracted due to its crucial role in different economies. Moreover, in light of the crises affecting many countries as a result of the excessive depletion of natural resources, digital innovation appears to offer

a means of mitigating this depletion by relying on technologies that reduce the waste of natural resources.

Objectives of the study

This study aims to:

- Analyse the digital gap and identify its determinants;
- Draw lessons from leading experiences, such as those of Germany and South Korea.
- Develop a roadmap for localising digital innovation within the national context.

Chapter One: The Concept of Digital Innovation

Digital innovation is a cornerstone of the radical transformation that economic institutions are undergoing today. It goes beyond merely using technology to involve reshaping business models and processes in order to create unprecedented added value.

1. Definition of digital innovation

Several definitions of digital innovation have been proposed, including:

Digital innovation is defined as: “The use of digital technologies to develop new products, services or business processes, or to improve existing ones in a way that changes the nature of competition and the value offered to customers”¹.

- Digital innovation is also described as: The process of using digital technologies to develop new products, services or processes to meet changing market needs and enhance institutional efficiency and effectiveness. This depends on adopting modern tools and technologies, such as artificial intelligence, big data analytics and cloud computing, with the aim of bringing about radical changes in service delivery².

Based on the above, a comprehensive definition of the digital economy can be formulated as an economic system that is built on the imagination, mobilisation and deployment of digital solutions, tools and practices, and the use of information technology to develop traditional business models. This economy is not limited to technological progress or the provision of software products, but also extends to the reorganisation of service delivery, improving efficiency and reducing the gap between institutions and their customers through intelligent platforms and applications that address needs that traditional market offerings were unable to fulfil.

2. Dimensions of digital innovation

Digital innovation has several dimensions, including:

Technical: Reliance on technologies such as artificial intelligence (AI), the Internet of Things (IoT) and cloud computing³.

- The organisational component involves changing administrative structures to make them more flexible and responsive to the requirements of the digital environment.
- Strategic component: creating a new business model that generates profits in non-traditional ways, such as through digital platforms⁴.

3. The advantages of digital innovation

Digital innovation differs from traditional innovation in that it is a high-speed driver of economic growth, particularly in a competitive environment such as that in which Algerian institutions seek to operate and expand.

- Scalability: unlike physical innovation, which requires significant investment in factories and equipment to increase production, digital innovation (e.g. platforms and applications) can serve millions of new users with minimal additional costs once the software infrastructure is in place⁵.
- Lower transaction and production costs (cost efficiency): digital innovation supports automation, reducing human error and lowering operating costs. For example, cloud computing can eliminate the need for Algerian institutions to purchase expensive servers⁶.
- High agility and flexibility: Digital technologies enable institutions to adjust their products or services based on customer feedback in real time. This is often referred to as ‘flexible innovation’, where software can be updated and new features added without stopping production⁷.
- Mass customisation: Thanks to big data, digital innovation enables the institution to understand each customer’s behaviour and offer personalised proposals. This increases customer loyalty and strengthens competitiveness — an aspect that reflects the essence of the South Korean experience mentioned earlier.
- Breaking geographical barriers (global reach): digital innovation enables Algerian economic institutions to easily market their services and products beyond national borders, contributing to the diversification of exports beyond hydrocarbons by exporting digital services⁸.
- Open and collaborative innovation (open innovation): Digital platforms enable collaboration between institutions, universities and consultants. This facilitates knowledge transfer and supports the adoption of global models, as seen in Germany where research centres are linked with factories⁹.

4. Comparison Table

A comparison table of traditional and digital innovation will follow.

The Advantage	Traditional innovation	Digital Innovation
Execution speed	Slow, relying on physical models	Very fast, driven by software
Marginal cost	High cost, increasing with each additional unit	Very low marginal cost, approaching zero
Interaction with customers	One-sided post-sale interaction	Interactive and continuous through data
Geographic reach	Local/regional, often limited in scope	Global and cross-border

Chapter Two: Leading International Experiences in Digital Innovation

There are many leading experiences in the field of digital innovation, and one of the most prominent is the German approach.

1. The German Experience

The German approach to digital innovation, known internationally through the “Industry and Structural Partnership 4.0” (Industrie 4.0) initiative, is widely regarded as one of the most rigorous and advanced models for integrating digital technology into physical production processes¹⁰.

A. The core philosophical idea of the German model (Smart Factory)

In the German approach, digital innovation is not limited to providing internet-based services. Rather, it represents a re-conceptualisation of the traditional factory model based on cyber-physical systems, where each spare part or machine has a digital identity that enables communication with other components throughout the factory.

- Design principles of the model

The model relies on several design principles:

- Operational interoperability: the ability of machines, equipment and people to connect and communicate with one another through the Internet of Things (IoT).
- Information transparency: creating a virtual replica of the real world by collecting sensor data, which enables accurate analysis of each production step.

Technical assistance involves systems that support humans by collecting data, solving complex problems or performing dangerous tasks through robots.

Decentralised decision-making: Cyber systems can make simple, independent decisions without referring back to a central unit, increasing responsiveness speed¹¹.

B. Pillars for adaptation in the German model

Upon analysing the model, three essential pillars that explain its success were identified:

- Standardisation: establishing unified standards to ensure that all machines from different companies communicate in the same digital language.
- Information security: protecting intellectual property and industrial data from attacks is a central concern of this model.
- Vocational training: updating educational curricula to produce ‘digital workers’ who are capable of working with intelligent machines.

Overall, the German model is a prime example of public–private partnership. Rather than acting as a manager, the state serves as a catalyst and sets standards, while the private sector handles implementation and innovation.

C. The role of the public sector (the state and federal ministries)

In Germany, the government plays the role of architect of the innovative environment through the following measures:

- Strategic funding for R&D: The German government invested billions of euros in initiatives such as the “High-Tech Strategy 2020” to promote digital research.
- Setting standards and metrics: The government collaborated with technical agencies to unify the machine-to-machine communication language, such as the RAMI 4.0 standard, to ensure technology compatibility across different companies.

- Bridging academia and industry: Research institutes such as Fraunhofer — public institutions that function as technology-transfer intermediaries — support the transfer of technology from university laboratories to private manufacturing firms.

- Legislation and cybersecurity: The introduction of strict legislation to protect industrial data has helped to reassure private companies and encourage investment in industrial cloud computing.

D. The role of the private sector (large firms and SMEs): The German private sector drives innovation in this field by:

- Investment in implementation: Large companies such as Siemens, Bosch and SAP convert theoretical concepts into smart production lines.

- Support for small and medium-sized enterprises (SMEs): The German model is characterised by large firms acting as a ‘locomotive’ for smaller companies, providing them with digital solutions to integrate into the smart supply chain.

- Dual vocational training: The private sector contributes to training workers and students in the latest digital technologies inside factories, thereby narrowing the gap between education and work.

- Development of open innovation platforms: Competing companies collaborate to develop shared core software, reducing costs.

The interaction model (Triple Helix): Germany’s success relies on a triangle comprising the state, universities and the private sector.

2. South Korea’s experience of innovation and digital transformation

South Korea’s experience, known as the ‘digital Han River miracle’, is widely regarded as one of the clearest models demonstrating the transition from a post-war, agriculture-dependent economy to a globally competitive technological power. This experience closely aligns with the objectives of the forum, which are to analyse the digital divide and overcome structural obstacles.

A. A learning strategy for innovation

Korea did not limit itself to importing technology. Initially, it emphasised reverse engineering. It then moved towards indigenous innovation. This shows that success does not depend solely on importing technology, but rather on building an integrated economic and digital ecosystem¹².

- Economic and digital conglomerates: Large firms such as Samsung and LG played a central role in driving digital transformation. The government supported these companies on the condition that they achieve specific export- and innovation-related targets, thereby fostering internationally competitive economic institutions.

Intensive investment in research and development: South Korea devotes around 4.8% of its GDP to research and development. This is one of the highest proportions globally and is specifically aimed at closing the digital divide.

B. Technological focus: emphasis on digital infrastructure as a foundation for faster institutional growth, supported by the world’s fastest internet networks¹³.

- Korea was one of the first countries to launch 5G, and it is currently planning to lead the deployment of 6G by 2030.

- Korea has one of the highest rates of broadband penetration, creating a fertile environment for start-ups and digital services.

Project-based learning has replaced rote instruction in curricula, with students now solving real-world problems faced by major technology companies such as Samsung and LG.

- Direct linkage with the industrial sector: the Korean Ministry of Education has launched an initiative to encourage collaboration between universities and leading companies. This initiative aims to design joint curricula in which companies participate in defining course content to ensure that what students learn aligns with what firms actually need.

- Mandatory on-the-job training in smart factories: factories have incorporated long-term training periods in digital companies as an integral part of the credited hours required for graduation.

- Academic flexibility: rather than rigid four-year degrees with little change, Korean universities allow students to obtain short, intensive qualifications such as micro-degrees (i.e. smaller secondary specialisations) in areas such as cybersecurity or blockchain, alongside their primary specialisation. This also supports the combination of fields such as economics or law, removes barriers between departments and encourages interdisciplinary studies.

These transformations are intended to ensure that students graduate with practical skills that can be applied immediately in an era of comprehensive digitisation. This helps to explain why South Korea has consistently led the way in global innovation indicators for consecutive years.

The third axis: applying the lessons to the Algerian context

It is not possible to discuss adapting global models without first conducting an accurate diagnosis of local figures and indicators that constitute the ‘supporting environment’ for innovation. Data from 2024 and the first months of 2025 indicate a surge in access to technology. However, this is accompanied by the challenge of converting these figures into productive innovations that serve economic enterprises.

Table: Digital and financial indicators in Algeria (2024/2025).

Digital indicators	Numbers (2024 estimates)	Numbers (2025 estimates):	Analytical notes
Total internet subscribers	59.10 million subscribers	60.2 million subscribers	It reflects the market's readiness for digital consumption.
Mobile internet subscribers (4G)	52.42 million subscribers	54.1 million subscribers	It confirms the need for institutions to move towards mobile applications to foster innovation.
Fibre optics	FTTH: 2.25 million subscribers	3 million subscribers	The core infrastructure supports remote work and cloud computing.

Payment cards (gold/bank cards)	16 million cards	17.5 million cards	Payment systems are a necessary tool for the growth of e-commerce.
Start-up institutions	Labels: ~836 institutions	2,000 institutions	It provides a real laboratory for adapting global innovation locally.

An analysis of the statistical indicators presented in the above table shows that Algeria now has a well-developed infrastructure for internet connectivity. The number of internet subscribers surpassed 59 million at the beginning of 2025. This digital momentum provides Algerian economic enterprises with a large Big Data base and a technological platform, enabling them to adopt technologies derived from the global model, such as artificial intelligence (AI) and the Internet of Things (IoT)—as demonstrated by countries such as Germany and South Korea.

However, there is a discrepancy between the extent to which consumers adopt digital technology and its utilisation in innovative processes within traditional institutions. While the start-up sector is growing, exceeding 800 entities, large economic enterprises are still in the early stages of adopting end-to-end digitisation. Consequently, there is a clear need for adaptation mechanisms centred on digital financial inclusion, supported by 16 million cash cards as a key lever for transforming innovation from a technical concept into economic value.

Before attempting to emulate any model, it is essential to understand the ground on which it will be built. While there has been a noticeable improvement in fibre-optic connectivity, the quality of service and stability of data flow still fall short of global competitiveness. In terms of human resources, although Algeria has a large pool of graduates in technical specialisms, there is still a significant mismatch between academic curricula and the requirements of the global market.

Finally, in terms of the legal framework, the issuance of the start-up law represents an excellent step forward. Nevertheless, administrative bureaucracy and the traditional banking system continue to impede the inflow of foreign investment and financial and digital transformation.

Firstly, how can Algeria benefit from the German experience?

Algeria could apply German-style regulatory rigour to develop its industrial sector by:

- providing a digital identity for machines within firms, by building smart factories and leveraging the concept of cyber-physical systems in Algerian industry. This would enable decentralised decision-making and operational interoperability.
- Activating coordination among the state (as an enabler), universities (as sources of research) and the private sector (as implementers), by adopting the ‘golden triangle’ model — similar to German institutes that transfer technology from research labs to factories.
- Updating Algerian educational curricula to produce ‘digital workers’, by training students in artificial intelligence and Internet of Things (IoT) technologies at economic institutions through dual vocational training.
- Standardising the language of communication among Algerian institutions by ensuring technological compatibility and protecting industrial information security through standardisation and conformity-assessment mechanisms.

- Strategic comparison:

Axis	Required actions
Legislation	Adopt a clear regulatory framework for electronic payments and facilitate entry and exit procedures, as well as ensuring access to hard currency for technology companies.
Infrastructure	Transition to sovereign cloud computing to protect national data.
Digital culture	Promote digital culture in schools from an early age, not merely as a tool, but as an innovative way of thinking.

Secondly, how can Algeria benefit from the Korean experience?

The focus here is on speed and boldness in digital transformation.

Start by adapting imported technologies and developing them locally, rather than merely adopting them for consumption. This corresponds to a ‘learning for innovation’ strategy implemented through reverse engineering and indigenous innovation.

Encourage major Algerian institutions to act as ‘locomotives’ for digital innovation, supported by the state in meeting clearly defined innovation and export targets through a mechanism for supporting economic conglomerates/clusters.

- Adopt intensive, short credential (micro-credential) systems across various fields, such as cybersecurity or blockchain, to integrate digital skills with humanities specialisations, such as economics and law. The goal is to ensure that graduates leave with immediately applicable skills.
- Continue developing 5G infrastructure to create a fertile environment for start-ups, mirroring South Korea’s approach of benefiting from the world’s fastest internet networks, through a policy of advanced digital infrastructure.

- Strategic comparison:

Axis	The Korean Experience	Prospects for application in Algeria
The Role of the State	A strategic plan and incentive mechanism for innovation	Transition from administrative management to economic management.
Funding	Based on investment and risk-sharing funds.	Activating the role of the stock exchange and investment funds.
Exports	A deliberate orientation towards global markets	Leverage the African Continental Free Trade Area (AfCFTA).

Challenges facing Algeria

Despite the quantitative leap, Algeria encounters several obstacles, including:

- Structural and technical obstacles, which hinder full transformation and create a ‘consumption–production gap’. In other words, there is consumer-driven digital momentum, such as browsing and communication, paired with limited use of these technologies in the production processes of traditional institutions.

- Structural and legislative obstacles: Algeria needs a more integrated legislative environment that regulates cybersecurity and strengthens the protection of industrial intellectual property with greater rigour.
- Weak linkage between universities and enterprises: A continuing gap remains between academic outputs and the competencies that companies currently require, particularly in terms of applied digital skills.
- Upfront costs for infrastructure transformation: Although cloud computing is relatively inexpensive, transitioning to ‘smart factories’ requires substantial investment and organisational restructuring to make administrative frameworks more flexible.
- The challenge of export diversification: Algeria must shift from reliance on hydrocarbons towards exporting digital services by overcoming the geographic barrier, which can be reduced through digital innovation.

Recommendations: Based on the study, the following recommendations were made:

1) Legislative and regulatory dimension:

- Reform the banking system to implement a genuine shift towards digital financial inclusion and facilitate the movement of capital for technology and start-up companies to reduce bureaucracy.
- Activate sovereign cloud computing by establishing a legal framework that protects national and industrial data, ensuring information security — an essential pillar of the German model.
- Protect intellectual property: Strengthen laws related to digital patents and intellectual property rights to encourage genuine innovation within institutions, rather than limiting them to technology consumption.

2) Academic and training dimension:

- Adopt the dual vocational training model: Conclude mandatory partnerships between universities and economic institutions to provide students with hands-on training in artificial intelligence and the Internet of Things (IoT). Allow students to pursue intensive technical specialisations (e.g. cybersecurity or blockchain), alongside micro-credentials issued in parallel with their main specialization, to increase their flexibility in the labour market.
- Update curricula: Shift from rote instruction to problem-based learning centred on real industrial challenges.

3) The technical and institutional dimension

- Support reverse engineering by encouraging national institutions to adapt and develop imported technologies locally until they reach the stage of genuine innovation, following the approach used by South Korea. This creates a work environment that enables advanced production applications and supports remote working.
- Encourage economic clusters/conglomerates: Incentivise large firms to drive innovation and support small and medium-sized enterprises by integrating them into unified digital supply chains.
- Move towards digital exports: Leverage the African Continental Free Trade Area to export Algeria’s digital services, thereby reducing dependence on hydrocarbons.

Conclusion

This study concludes that digital innovation is not merely a passing technological trend, but rather a comprehensive reconfiguration of Algeria’s economic institutional structures, aiming to ensure their

sustainability within a knowledge-based economy. The German experience demonstrated the importance of regulatory rigour and standardisation in building smart factories, while the South Korean experience provided an inspiring model for investing boldly and quickly in human capital and advanced infrastructure.

Despite Algeria's positive indicators in 2024 and 2025, particularly in terms of internet user and cash card expansion, the country's challenge lies in transitioning from importing technology to building an integrated ecosystem. This ecosystem should connect universities to factories through flexible, incentive-based legislation.

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