CORPS&PSYCHISME

P-ISSN:2496-4476E-ISSN:2273-157

Volume13/Issue1/2026

Requirements for the Success of the Fourth-Generation University (4.0) in Light of the Available potentials of the Algerian Universities

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Received:14/10/2025; Accepted:14/03/2026; Published: 18/05/2026

Abstract:
This descriptive study aims to uncover the relationship between the available potentials within Algerian universities and the essential requirements for the success of the Fourth-Generation University model. The study employs the Structural Equation Modeling (SEM) approach by establishing a connection between descriptive data pertaining to two key variables: the existing capabilities on one side, and the success requirements on the other. These data were gathered through two purpose-designed questionnaires distributed to a sample of 131 faculty members. Both instruments met the necessary validity and reliability standards for the purposes of this study. The results obtained from the integrated AMOS model indicate that the available capabilities, namely human, research and scientific, organizational, financial and logistical, and technological resources, exert a significant impact on the requirements for establishing the Fourth-Generation University. These requirements include organizational culture and governance, the digital infrastructure environment, research and innovation, training and qualification, relationship with the socio-economic environment, and international cooperation. Notably, the model also demonstrated an indirect influence of these capabilities through the mediating variable of overall requirements, suggesting that the relationship between the two variables is interactive and dynamic. Rather than a simple linear influence, the findings point to a more intricate structural interaction.
Keywords: success requirements, Fourth-Generation University, available capabilities, Algerian university.

1. Research Problem:

The higher education and scientific research sector is undergoing profound transformations in both its organizational structure and academic practices. These changes are reflected in the emergence of what is now referred to as the generations of digital universities, a paradigm shift that directly responds to the multifaceted technological, intellectual, and economic transformations reshaping the contemporary world. As a result, universities have evolved from traditional, simplistic institutions into more open and socially embedded organizations, deeply aligned with the dynamics of digital development.

This evolution has led to the emergence of Fourth-Generation Universities (4.0), Fifth-Generation Universities (5.0), and Sixth-Generation Universities (6.0), representing the highest

stages of integration among innovation, entrepreneurship, quality assurance, and operational efficiency across academic and administrative dimensions. These are universities characterized by their innovative and entrepreneurial nature, guided by a clear strategic vision encompassing social, economic, and educational priorities, and focused on transforming knowledge into added economic and societal value.

Fifth-generation universities have advanced even further by incorporating artificial intelligence, big data, and smart governance into their educational and administrative processes. Meanwhile, sixth-generation universities are defined by complete digital transformation and intelligent cyber systems, turning education into an open, adaptive ecosystem in harmony with the demands of the global knowledge economy.

Amidst these sweeping changes, Algerian higher education institutions have come to the realization that transitioning to the Fourth-Generation University model is no longer a mere option, it has become a strategic imperative, driven by the accelerated transformations in both regional and global contexts, and in response to labour market demands, competitiveness, and the development of scientific research (Taleb et al., 2024).

In response, Algerian universities have, in recent years, launched a series of initiatives and policies aimed at fostering digital transformation and embracing modern technologies in education, research, and institutional management. Within this context, new specialized schools and institutes in fields such as artificial intelligence, computer science, programming, and cloud computing have emerged. These disciplines have become key drivers in revitalizing the university system and restructuring it in accordance with the needs of the digital economy. Such reforms are also intended to overcome the rigidity traditionally associated with university training, and to strengthen the integrative approach between theoretical knowledge and practical skill development.

This project, the Fourth-Generation University initiative in Algeria, is grounded in the digital university model, which serves as the cornerstone for embodying the principles of this new generation in education, research, and innovation. It seeks to achieve this through the development of digital management systems, the promotion of blended learning and distance education, and the activation of innovation and entrepreneurship centers within the university, particularly through startup initiatives, in addition to encouraging community engagement and service (Zaid Al-Khair, 2025, p. 412). The project also aspires to foster a new dynamic in the relationship between the university and its broader socio-economic environment, stimulate the filing of patents, and enhance the valorization of scientific research outputs in ways that directly support sustainable development.

To ensure the effectiveness of this initiative and to guarantee its successful implementation, Decision No. 046, issued on 19/01/2025, established a national committee within the Ministry of Higher Education and Scientific Research. This committee is responsible for supporting, monitoring, and evaluating higher education institutions as they transition toward the Fourth-Generation University (4.0). Its mission includes the coordination of efforts among universities, the continuous monitoring of their progress in achieving generation-specific indicators, and the provision of both technical and institutional support. Furthermore, the committee is tasked with assisting universities in the formulation of digital transformation

P-ISSN:2496-4476E-ISSN:2273-157
Volume13/Issue1/2026

plans and defining performance indicators that reflect each institution's readiness to transition to the new model.

Discussing the requirements for the success of the Fourth-Generation University necessitates a thorough examination of the actual capabilities currently available within Algerian universities, as these serve as the essential foundation for any reform initiative. Over recent years, Algerian universities have undergone a broad reform policy that appears to have contributed to the availability of a substantial base of material, human, organizational, and technological capabilities. These, in turn, could serve as an initial platform upon which progress toward the Fourth-Generation University model can be constructed.

On the human resources front, recent years have witnessed the implementation of continuous training programs for faculty members and researchers, along with initiatives aimed at enhancing the qualifications of administrative staff in university leadership and digital governance. From a material and technical perspective, Algerian universities have also seen significant expansion in basic infrastructure, accompanied by progressive improvements in the equipment and functionality of scientific laboratories and research centers. Within this framework, emerging innovative and organizational capabilities are increasingly evident through the establishment of university incubators, innovation hubs, and entrepreneurship development programs. These efforts are also aligned with strengthening the relationship between universities and the economic and social sectors. Such capabilities constitute fundamental pillars for the implementation of advanced generational university models, including the Fourth and Fifth Generations. Accordingly, a preliminary assessment suggests that Algerian universities possess foundational elements upon which further development can be based, particularly in the context of implementing the Fourth-Generation University model.

The Algerian university's growing focus on this project represents a rational response to a convergence of scientific, economic, technological, social, and human imperatives at both the national and international levels. There is now an urgent need to invest simultaneously in physical infrastructure and intellectual capital to activate the university's creative and innovative potential. This shift moves the institution beyond its traditional and classical roles, teaching, research, and community service, toward innovation, entrepreneurship, the valorization of knowledge, and full integration into a smart digital ecosystem that permeates all societal sectors and remains closely connected to economic and social realities.

In this evolving role, the university is transformed into a developmental agent and strategic partner in shaping public policy, while also providing a nurturing environment for emerging initiatives through the establishment of incubators and innovation laboratories within its institutional framework.

The Algerian university's undertaking of its new role as a smart, knowledge-generating institution necessitates the presence of an integrated system of organizational, technological, human, and pedagogical conditions, all of which must converge to fulfill the objectives set forth in the strategy of the Ministry of Higher Education and Scientific Research. Among the most significant of these conditions, or more precisely, requirements, is the modernization of the digital infrastructure of Algerian universities and the provision of the necessary equipment and software to manage learning and scientific research. This also entails the development and

qualification of human capital, alongside the encouragement of a culture of innovation and entrepreneurship within the university. Such goals are to be realized through the establishment of centers for technological creativity, applied research laboratories, and university incubators designed to support startup projects. These mechanisms play a critical role in transforming research ideas into tangible products and services that contribute directly to national development.

Additionally, the adoption of a sound organizational culture within universities, one that ties institutional performance to indicators of quality and efficiency, is indispensable. Just as crucial is the establishment of an effective partnership between the university and its surrounding economic and social environment. It is, in fact, inconceivable to envision a Fourth-Generation University operating in isolation from economic institutions or the private sector. These collective requirements form the foundational base upon which the Fourth-Generation University project is constructed, and simultaneously define the extent to which adopted policies can succeed in achieving the targeted transformation.

Within this context, it becomes essential to examine the nature of the relationship between the requirements needed to transition to the Fourth-Generation University model and the actual capabilities currently available within Algerian universities. This transformation must be approached in light of a university landscape marked by significant disparities in digital infrastructure, management approaches, and the preparedness of both faculty members and students to engage with innovative modes of education, not to mention the differing levels of research capacity across institutions.

No matter how important these requirements may be, they cannot be evaluated in isolation from the broader university environment in which they are to be implemented. Their success is intrinsically tied to the availability of qualified human resources, robust organizational frameworks, advanced digital capacities, openness to economic and societal actors, and the institution's ability to adapt to rapid changes within the global academic landscape. Although the capabilities currently available vary from one Algerian university to another, they may either facilitate the realization of these requirements or act as barriers to the implementation of Fourth-Generation standards and the corresponding new functions of the university.

Within this framework, university faculty members stand as a central pillar in the transformation process toward the Fourth-Generation University, not only as executors of pedagogical and research policies, but as active participants in shaping and evaluating them. Their perspectives and attitudes serve as qualitative indicators of the anticipated success of the project, especially when measured against the capabilities currently in place within Algerian universities. The positions held by faculty members reflect their level of conviction in the policies of digital and innovative transformation, as well as their readiness to embrace modern teaching methods grounded in creativity, interactivity, and intelligent evaluation. Furthermore, their active participation in continuous training programs, particularly those related to artificial intelligence, digital transformation, and entrepreneurship, is a determining factor in ensuring the success of this ambitious transition.

In light of these perspectives, the present study poses the following fundamental question: **What is the proposed model that can explain the relationship between the requirements**

P-ISSN:2496-4476E-ISSN:2273-157
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for the success of the Fourth-Generation University and the available capabilities within Algerian universities?

2. Study Objectives:

This study seeks to explore and understand the relationship between the requirements for the success of the Fourth-Generation University and the available capabilities within Algerian universities. It also aims to examine the impact of these capabilities on those requirements by analyzing the structure and mechanisms of this model within its internal framework. Ultimately, the study aspires to offer a comprehensive perspective on the views of faculty members concerning this relationship and its implications, especially since their perspectives are regarded as highly significant and play a crucial role in shaping the contours of future academic education policies.

3. Study Significance:

The importance of this study is reflected in several key aspects:

- The strategic value of the Fourth-Generation project within Algerian academic education, as it stands as a developmental cornerstone for future educational models. This is especially critical given that artificial intelligence indicators are inherently embedded in this project and serve as foundational elements for all subsequent initiatives.

- The essential need to understand faculty members' perceptions concerning the details of the available capabilities within universities, laboratories, and other academic institutions, insights which clearly indicate the feasibility and extent to which the Fourth-Generation University and future projects can be realized.

- The vital role of faculty members' opinions as both experts and practitioners in academic teaching and research. Their perspectives are distinguished by a high degree of credibility and relevance, particularly as they address central issues related to the implementation of the Fourth-Generation University, and provide an informed understanding of the requirements for modern academic education in relation to the capabilities currently present within Algerian universities.

- The significance of the study is further underscored by the importance of structural models that help formulate theoretical frameworks capable of organizing and interrelating a range of variables, especially those concerning the requirements for the success of the Fourth-Generation University on the one hand, and the available capabilities within the Algerian university on the other.

4. Definition of Study Terms:

- Requirements: This term refers to a set of conditions and foundational elements that must be present within Algerian universities to ensure a successful transition to the Fourth-Generation University (4.0) model. In this study, these requirements include necessary developments in organizational culture and governance, the digital infrastructure environment, research and innovation, training and qualification, the university's connection with the social and economic environment, as well as international openness and external cooperation.

Collectively, these requirements form the general framework that enables the university to function effectively in alignment with Fourth-Generation standards.

- Fourth-Generation University (4.0): These are universities defined by their knowledge production, research orientation, digital integration, openness, and interconnectedness with their environment. They are conceived as advanced institutions that respond to the demands of the Fourth Industrial Revolution. This model leverages digitalization and technological innovation to enhance both academic and administrative functions, strengthen the knowledge economy by aligning scientific research with societal needs, and foster strong ties between the university, the community, and industry, all while utilizing modern technologies to generate sustainable social and economic impact.

- Capabilities: This concept encompasses the set of resources and capacities available within a university that serve as the cornerstone for operationalizing the requirements of the Fourth-Generation University. These capabilities span financial and logistical resources, human competencies, technological tools, research and scientific assets, and organizational systems. Together, they represent the operational basis that enables the transformation of the Fourth-Generation University requirements into a tangible, functional reality.

5. Previous Studies:

It is essential to emphasize that, to the extent of the researchers' review, prior studies that have addressed the variables related to the requirements for the success of the Fourth-Generation University and the available capabilities within these institutions remain limited. Moreover, these studies have not comprehensively covered all the indicators associated with these two variables as delineated in the current study. As such, most of the existing research closely related to the topic of this study tends to focus on only one variable or a single indicator among the various indicators representing these broader constructs.

In this regard, the study conducted by Khloufi (2025) sought to explore the requirements for developing Fourth-Generation Universities by examining the case of Eindhoven University of Technology in the Netherlands. This university was considered a pioneering model for its integration of advanced technology and strategic industrial partnerships aimed at achieving sustainable development goals. Employing a descriptive-analytical approach, the study formulated hypotheses to investigate the influence of modern technologies on the quality of education and scientific research, as well as the university's capacity to meet the demands of the labor market.

Based on the analysis of Eindhoven University's experience, the study confirmed the institution's ability to adopt effective strategies for curriculum development and infrastructure enhancement, while also reinforcing its collaborations with industry and society. The findings concluded that the Fourth-Generation University model significantly amplifies the impact of universities both locally and globally, offering a comprehensive framework for institutions to adopt sustainable strategies and align with current global transformations.

In a similar vein, the study conducted by Wagdi, Abouzeid, and Fathy (2021) addressed the restructuring and transformation of Arab academic institutions into Fourth-Generation Universities. This was done through an extensive review of literature related to technological advancement in education and the defining characteristics of Fourth-Generation Universities.

The study characterized these institutions as dynamic entities that actively engage with their surrounding environments through four principal mechanisms: the transfer of knowledge, the production of knowledge, the application of knowledge, and leadership in initiating change at both the local and international levels.

A structured questionnaire was developed and distributed to a sample of 463 faculty members from various Arab universities. The results revealed that the requirements of Fourth-Generation Universities within Arab contexts are generally categorized into technological and digital requirements, pedagogical and instructional requirements, organizational and administrative requirements, and research and scientific requirements. However, the study found that these areas still require considerable development and enhancement. Moreover, the research identified the critical conditions necessary for the transition of Arab universities to the Fourth-Generation model, thereby supporting their competitive positioning from the perspective of academic staff.

Meanwhile, the study by Angeliki et al. (2023) focused on digital tools, technologies, and instructional methodologies within the broader framework of Education 4.0. This survey-based research targeted the disciplines of science, technology, engineering, and mathematics, and confirmed that digital tools which assist students in transforming information into actionable knowledge play a pivotal role in shaping contemporary pedagogical practices. The study emphasized that open access to both hardware and software resources constitutes a foundational pillar for enhancing science education, particularly in disciplines where laboratory-based experiments form an essential component of the curriculum. Moreover, it demonstrated how laboratory tools can be accessed remotely by integrating simulation technologies with real laboratory equipment distributed across various geographic locations.

On this basis, the model of education adopted by Fourth-Generation Universities (4.0) establishes an innovative educational paradigm that corresponds with the requirements of the digital Fourth Industrial Revolution. In this context, university graduates are expected to possess advanced, interdisciplinary problem-solving skills within academic programs specifically designed to cultivate competencies related to the Internet of Things. As a result, the digital transformation of university campuses, including the development of intelligent infrastructure supported by the Internet of Things, information and communication technologies, and fifth-generation (5G) networks, is regarded by researchers as an urgent and non-negotiable necessity.

6. Study Methodology:

6.1. Study Approach:

The study adopted a descriptive-analytical approach, as it aligns with the study's objective of identifying and exploring the perspectives of university faculty members regarding the impact of the available capabilities within the Algerian university on the requirements necessary for developing the Fourth-Generation University.

6.2. Study Sample:

The study sample consisted of 131 male and female faculty members from the University of Jijel, all of whom hold permanent academic positions within the institution. The participants

represented various academic disciplines and were distributed across four faculties as follows: Humanities and Social Sciences (47), Economic, Commercial, and Management Sciences (27), Arts and Languages (20), and Law and Political Sciences (37).

6.3. Study Instrument:

The empirical component of the study was based on two primary data collection instruments developed by the researchers: the Questionnaire on the Requirements for the Success of the Fourth-Generation University, and the Questionnaire on the Available Capabilities within the Algerian University.

The first questionnaire, which focuses on the requirements for the success of the Fourth-Generation University, is composed of two sections. The first section gathers demographic and professional data related to the study sample. The second section encompasses six dimensions that evaluate the perceived importance of these requirements. These dimensions include organizational culture, the digital infrastructure environment, research and innovation, training and qualification, the university's relationship with the social and economic environment, and international openness and external cooperation.

The second questionnaire is designed to assess the available capabilities within Algerian universities and includes five dimensions: financial and logistical capabilities, human capabilities, technological capabilities, research and scientific capabilities, and organizational capabilities.

In the development of both instruments, the relevant theoretical literature was extensively reviewed to ensure the conceptual grounding and relevance of the items. Following this, the questionnaires were submitted to a panel of expert reviewers for evaluation. Necessary revisions and adjustments were made based on established indicators of item quality to enhance their validity and reliability.

A three-point Likert scale was employed to measure response levels, assigning a score of (3) to responses indicating high importance, a score of (2) to responses reflecting moderate importance, and a score of (1) to responses denoting low importance.

6.4. Factorial Structure of the Study Instruments:

The factorial structure of the study instruments was validated using the outputs of the Statistical Package for the Social Sciences (SPSS V26) and the Analysis of Moment Structures (AMOS V22) software, through the application of confirmatory factor analysis. Based on the results obtained from the main sample, both the validity and reliability of the instruments were confirmed. It is worth noting that during the verification process of the factorial structure, certain measurement errors among some indicators were correlated, as shown in the table below.

Table No. (01): Factorial Structure of the Study Instrument

Domain	Factor Loading (FL)	Average Variance Extracted (AVE)	Composite Reliability (C.R)	Cronbach's Alpha (α)	McDonald's Omega (Ωω)
Benchmark value	> 0.50	> 0.50	> 0.70	> 0.70	> 0.70

Success requirements	0.867	0.697	0.920	0.950	0.920
Available capabilities	0.821	0.574	0.889	0.964	0.889
Result	**Achieved**	**Achieved**	**Achieved**	**Achieved**	**Achieved**

Source: Prepared by the researchers based on outputs from AMOS v22

The results clearly indicate that the study instruments possess a high degree of validity and reliability, as all calculated values exceeded the standard benchmarks commonly accepted in quantitative research. This confirms the instruments' adequacy for measuring the intended study variables. These validated indicators serve as strong support for adopting the hypothesized model in the structural study and enhance the credibility of the findings related to the analysis of causal relationships between the variables.

6.5. Statistical Methods Used:

To analyze the data, both the Statistical Package for the Social Sciences (SPSS V26) and the Analysis of Moment Structures (AMOS V22) software were utilized. The analytical procedures and techniques drawn from these programs included the following:

- Testing for normal distribution.
- Hoelter's test for determining the adequacy of the sample size.
- Confirmatory factor analysis for assessing construct validity.
- Implementation of the integrated AMOS model.

These analyses relied on a comprehensive set of statistical indicators generated by the AMOS software, including:

- Absolute (predictive) goodness-of-fit indices, such as the Chi-square (χ^2), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR).
- Relative (incremental) goodness-of-fit indices, including the Tucker–Lewis Index (TLI), Normed Fit Index (NFI), and Comparative Fit Index (CFI).

6.6. Conditions for Using Structural Equation Modeling:

To employ structural equation modeling effectively, it was necessary to verify a set of conditions that determine the appropriateness of the estimation method used for the study model. These conditions are as follows:

- Verification of the normal distribution of study data: This was tested using the Kolmogorov–Smirnov test. The test values for the two instruments ranged between (0.115–0.161), with a degree of freedom of (131) and a significance level of (0.001). These results indicate that the data do not follow a normal distribution.

- Verification of sample size adequacy: In structural equation modeling, numerous goodness-of-fit indices are sensitive to sample size, which is a prerequisite for conducting exploratory factor analysis. The Hoelter critical sample size index was utilized at the first-order level to assess the adequacy of the sample size. Results indicated that the maximum required

sample size at the (0.05) significance level is (114), and at the (0.01) level is (130), thereby confirming the adequacy of the sample used in this study, which totaled (131) participants.

- Missing values: These refer to data points left unanswered by respondents on certain indicators in the study instrument. In this study, both instruments were administered electronically using Google Forms, which includes a mandatory-response feature for all items. This ensured that all responses were complete and free of missing data.

- Reliability: The reliability of the two instruments was assessed through analysis of their factorial structure. The findings demonstrated that both instruments possess a high degree of validity and reliability, as evidenced in Table No. (01) (Tighza, 2012).

Within the framework of these verified conditions, the Maximum Likelihood (ML) estimation method was employed. This technique is one of the most widely used methods for estimating structural equation models. It is based on the assumption that data are normally distributed, multivariate, and measured on a continuous scale. However, these assumptions are not always fully met, particularly the assumption of normality. Violation of this assumption can inflate the value of the Chi-square statistic and lead to an underestimation of several key fit indices, such as the Tucker–Lewis Index (TLI) and the Comparative Fit Index (CFI). It can also result in underestimating the standard errors associated with parameter estimates (Baldwin & Caldwell, 2003, pp. 139–140).

6.7 Confirmatory Factor Analysis of the Study Variables:

The factorial structure of the study variables was verified by assessing the level of fit between the hypothesized model and the empirical model.

A. Goodness-of-Fit Indices for the Variable of the Requirements for the Success of the Fourth-Generation University:

The factorial structure of the variable representing the requirements for the success of the Fourth-Generation University was thoroughly examined. As a preliminary step, it was necessary to assess the adequacy of the model's fit indices in order to determine whether the multi-factorial model, which underpins the theoretical basis of this study, was superior to a single-factor model representing the same variable.

The results of the confirmatory model based on a single factor indicated that most of the adopted fit indices failed to meet the established thresholds typically used in structural equation modeling. Both the absolute and incremental fit indices fell below accepted standards, signaling a need for refinement. Consequently, modifications were introduced to improve model fit by analyzing the modification indices suggested by the AMOS software. These modifications recommended adding correlations between certain measurement errors to minimize variance and enhance internal consistency.

Following the application of these adjustments, a clear improvement was observed across the relevant fit indices. The final confirmatory (measurement) model for the multi-factor structure is presented in Figure No. (01).

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P-ISSN:2496-4476E-ISSN:2273-157

Volume13/Issue1/2026

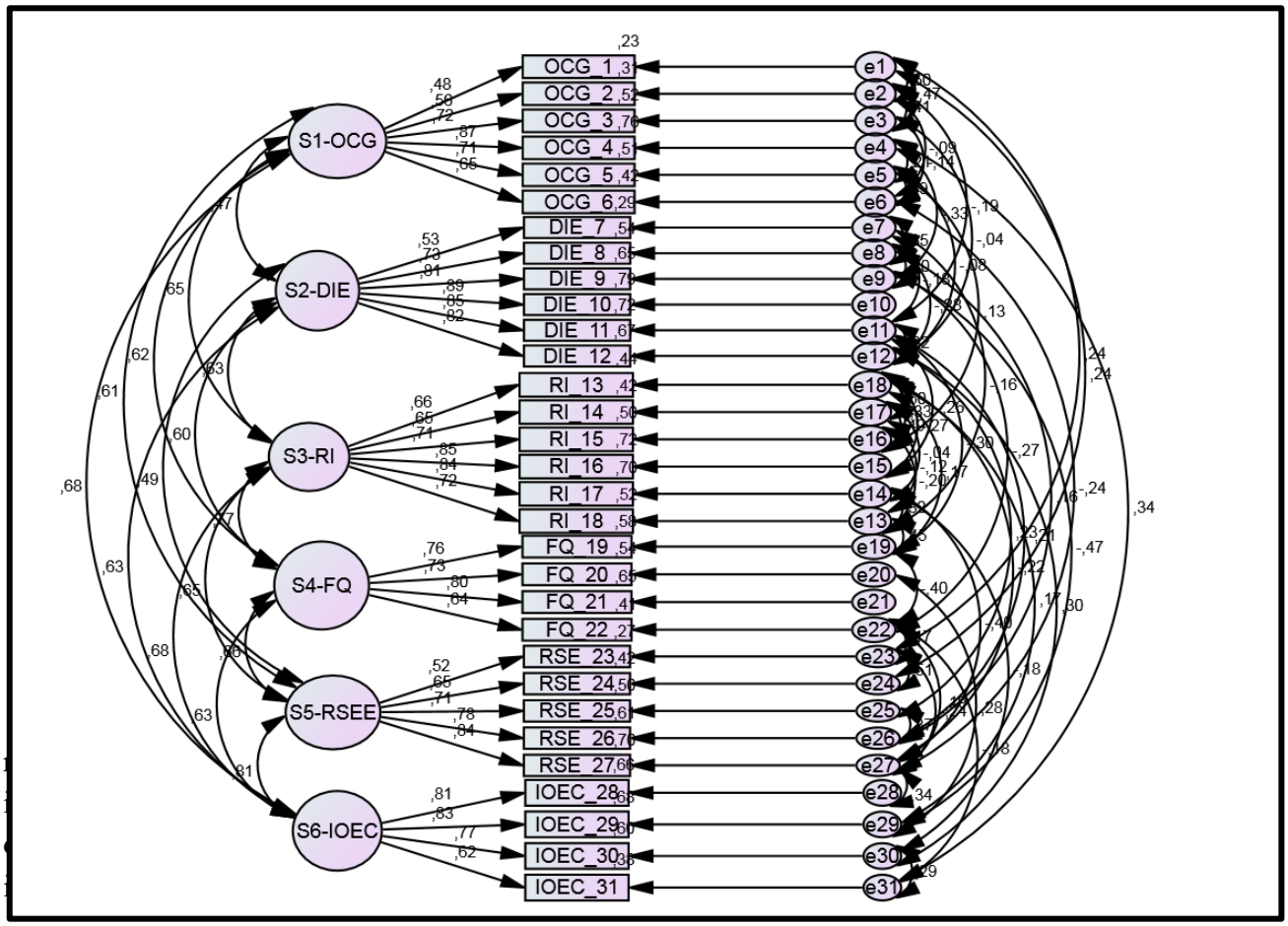


Table No. (02): Goodness-of-Fit Indices for the Multi-Factor Measurement Model of the Variable of the Requirements for the Success of the Fourth-Generation University

Index		Good values	Acceptable values	Calculated values	Evaluation
Absolute (predictive) indices	Chi-square (χ^2) or CMIN	$df \geq \chi^2 \geq 0$	$df \geq \chi^2 \geq df$	503.39	Not available
	p-value	$0.01 \geq p \geq 0.05$	$0.01 \geq p \geq 0.05$	0.00	Significant
	df	$2 \geq df \geq 0$	$3 \geq df \geq 2$	365	Not available
	CMIN/df	$2 \geq CMIN/df \geq 0$	$3 \geq CMIN/df \geq 2$	1.37	Good
	GFI	$1.00 \geq GFI \geq 0.90$	$0.90 \geq GFI \geq 0.80$	0.81	Acceptable
	AGFI	$1.00 \geq AGFI \geq 0.90$	$0.85 \geq AGFI \geq 0.85$	0.74	Acceptable
	RMSEA	$0.08 \geq RMSEA \geq 0$	$1.0 \geq RMSEA \geq 0.09$	0.05	Good
	SRMR	0 to 0.05	0.05 to 0.08	0.07	Acceptable

Incremental indices	TLI	1.00 ≥ TLI ≥ 0.95	0.95 ≥ TLI ≥ 0.90	0.93	Good
	NFI	1.00 ≥ NFI ≥ 0.95	0.95 ≥ NFI ≥ 0.90	0.94	Acceptable
	CFI	1.00 ≥ CFI ≥ 0.95	0.95 ≥ CFI ≥ 0.90	0.95	Good

Source: Prepared by the researchers based on outputs from the Amos v22 program and according to benchmark values adopted by (Schermelleh-Engel & Moosbrugger, 2003, p. 52) and (Tetik, 2016, p. 231).

It is clear from Table No. (02) that all goodness-of-fit indices, after the improvement of the model, remained above the accepted threshold values, except for the Chi-square (χ^2) statistic, which recorded a value of 503.39 with 365 degrees of freedom. This outcome is attributed to the well-established sensitivity of the Chi-square index to sample size, which often makes it challenging to obtain statistically acceptable results. In such situations, the ratio of Chi-square to degrees of freedom (CMIN/df) serves as a more robust and stable indicator. In this case, the CMIN/df value was calculated at 1.37, which is well below the benchmark threshold of 2, thereby indicating a good model fit.

Furthermore, the most critical absolute (predictive) fit index, the Root Mean Square Error of Approximation (RMSEA), achieved a value of 0.05, placing it comfortably within the range considered indicative of a good fit. Similarly, the Standardized Root Mean Square Residual (SRMR) yielded a value of 0.07. While slightly exceeding the ideal threshold of 0.05, this value still reflects an acceptable level of model fit. Based on these indicators, it can be concluded that the absolute goodness-of-fit criteria for the model representing the requirements for the success of the Fourth-Generation University have been satisfactorily met.

Regarding the incremental or comparative fit indices, the Comparative Fit Index (CFI) was recorded at 0.95, the Tucker–Lewis Index (TLI) at 0.93, and the Normed Fit Index (NFI) at 0.94. These results indicate that all indices fall within acceptable ranges, with the overall quality of fit ranging from good to very good. Collectively, these values confirm that the model demonstrates strong structural integrity and that the confirmatory factor analysis achieved a fit level that is both acceptable and convincing, thus supporting the validity and adequacy of the measurement model in relation to the data.

B. Goodness-of-Fit Indices for the Variable of Available Capabilities at the Level of the Algerian University:

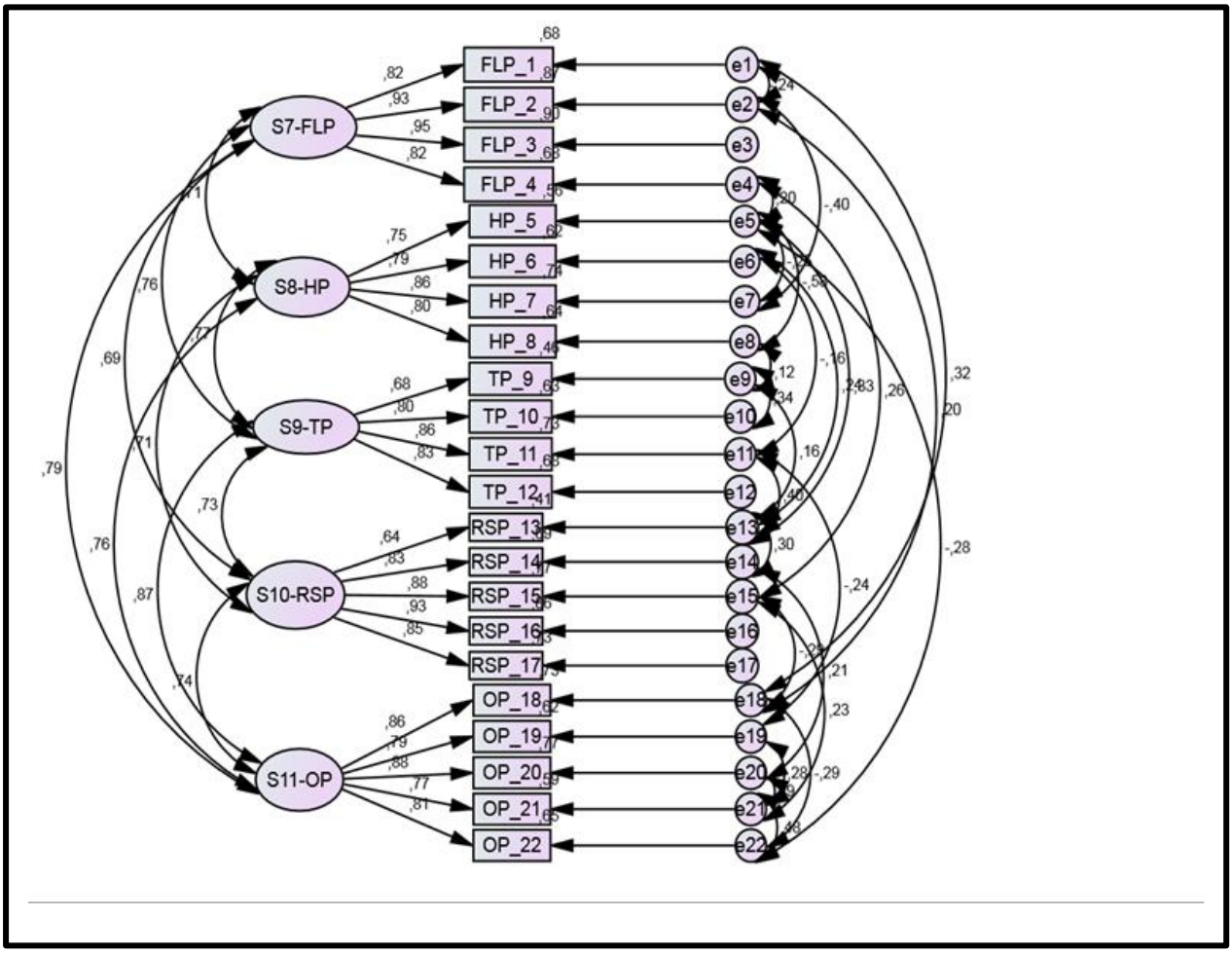
To confirm the factorial structure of the variable representing the available capabilities within the Algerian university, it was essential first to assess the adequacy of the goodness-of-fit indices in determining whether the multi-factorial model used in the study was superior to a single-factor model for the same variable.

The results of the single-factor confirmatory model revealed that most of the goodness-of-fit indices adopted in the analysis did not meet the standard thresholds typically employed in structural equation modeling (SEM). Both absolute and incremental fit indices were below the levels required for model acceptability. This led to the necessity of introducing improvements

to the model through modifications guided by the AMOS software's modification indices. These suggested the addition of correlations between specific measurement errors to minimize unexplained variance and strengthen the internal coherence of the model.

After applying the necessary modifications, the resulting indices showed noticeable improvements, confirming a better model fit. The refined multi-factor confirmatory (measurement) model is depicted in Figure No. (02)

Figure No. (02): The Multi-Factor Confirmatory (Measurement) Model for the Variable of Available Capabilities at the Level of the Algerian University



available capabilities within the Algerian university, it is evident that all measurement indicators are statistically significant at a significance level of $\alpha = 0.05$. The results of the confirmatory factor analysis for this model also yielded the following goodness-of-fit indices, which are presented in the table below.

Table No. (03): Goodness-of-Fit Indices for the Multi-Factor Measurement Model of the Variable of Available Capabilities at the Level of the Algerian University

	Index	Good values	Acceptable values	Calculated values	Evaluation
	Chi-square (χ^2) or CMIN	$df \geq \chi^2 \geq 0$	$df \geq \chi^2 \geq df$	214.58	Not available

Absolute (predictive) indices	p-value	0.01 ≥ p ≥ 0.05	0.01 ≥ p ≥ 0.05	0.29	Not significant
	df	2 ≥ df ≥ 0	3 ≥ df ≥ 2	174	Good
	CMIN/df	2 ≥ CMIN/df ≥ 0	3 ≥ CMIN/df ≥ 2	1.23	Good
	GFI	1.00 ≥ GFI ≥ 0.90	0.90 ≥ GFI ≥ 0.80	0.87	Acceptable
	AGFI	1.00 ≥ AGFI ≥ 0.90	0.85 ≥ AGFI ≥ 0.85	0.82	Acceptable
	RMSEA	0.08 ≥ RMSEA ≥ 0	1.0 ≥ RMSEA ≥ 0.09	0.04	Good
	SRMR	0 to 0.05	0.05 to 0.08	0.05	Good
Incremental indices	TLI	1.00 ≥ TLI ≥ 0.95	0.95 ≥ TLI ≥ 0.90	0.97	Good
	NFI	1.00 ≥ NFI ≥ 0.95	0.95 ≥ NFI ≥ 0.90	0.92	Good
	CFI	1.00 ≥ CFI ≥ 0.95	0.95 ≥ CFI ≥ 0.90	0.98	Good

Source: Prepared by the researchers based on outputs from the Amos v22 program

It is clear from Table No. (03) that all goodness-of-fit indices, after the model was refined, remained above the minimum acceptable thresholds, with the sole exception of the Chi-square (χ^2) statistic, which reached a value of 214.58 with 174 degrees of freedom. This elevated value is primarily attributed to the known sensitivity of the Chi-square test to sample size, making it inherently difficult to obtain statistically acceptable values under such conditions. Consequently, greater reliance was placed on the ratio (CMIN/df), which serves as a more stable and interpretable indicator. In this study, the CMIN/df value was calculated at 1.23, well below the threshold value of 2, indicating a very good model fit.

In addition, the most critical absolute (predictive) fit index, the Root Mean Square Error of Approximation (RMSEA), recorded a value of 0.04, which falls within the range typically considered indicative of a strong fit. Similarly, the Standardized Root Mean Square Residual (SRMR) reached a value of 0.05, also signaling a good model fit. Based on these results, it can be concluded that the absolute fit indices for the model related to the requirements for the success of the Fourth-Generation University meet the expected standards.

Regarding the incremental (comparative) fit indices, the Comparative Fit Index (CFI) achieved a value of 0.98, while the Tucker–Lewis Index (TLI) was recorded at 0.97, and the Normed Fit Index (NFI) reached 0.92. These values confirm that all indices are within the acceptable range, with overall quality of model fit rated as good. Together, these goodness-of-

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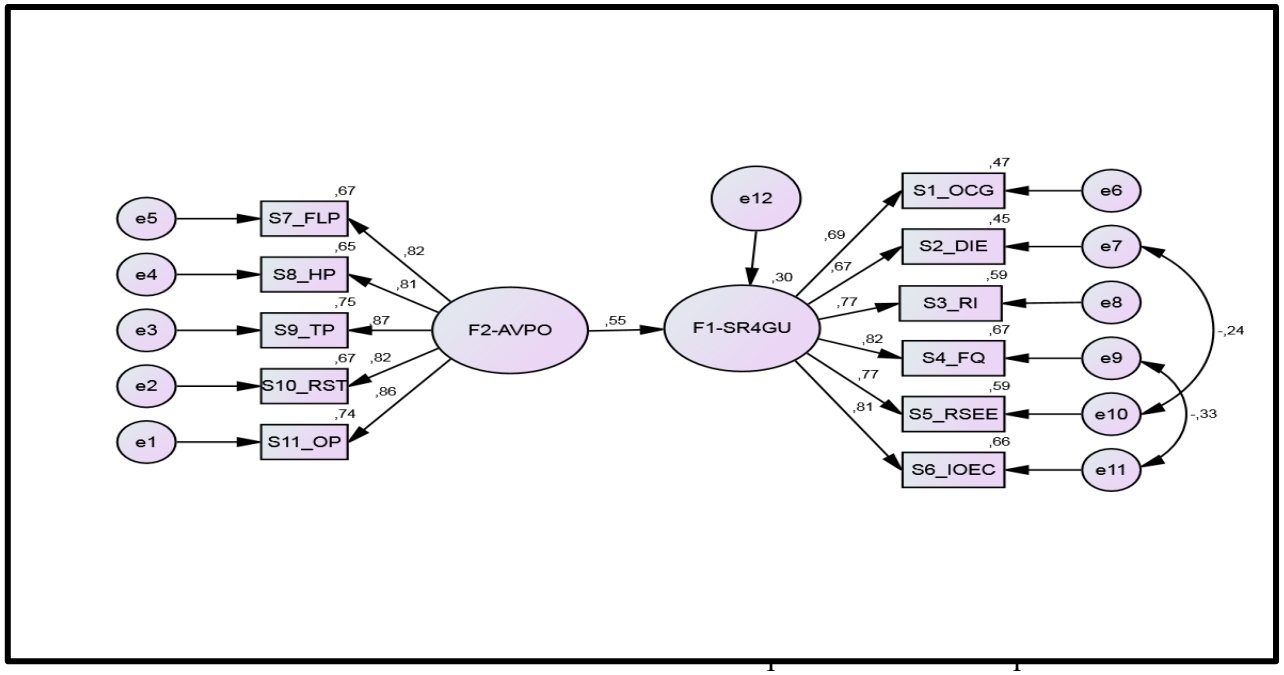
fit indicators further reinforce the notion that the model exhibits a high level of adequacy and that the confirmatory factor analysis has achieved favorable levels of fit, thereby confirming both the validity of the measurement model and its appropriateness for the analyzed data.

6.8 The Integrated AMOS Model:

Following the validation of the construct validity for the various dimensions of the model and confirmation of the statistical significance of the relationships among them, it becomes possible to examine the integrated structural model that illustrates the relationship between the primary study variables. These variables are represented by 11 dimensions, which in turn are measured through 53 indicators. Accordingly, an integrated structural model was constructed using the AMOS software to visualize the direct causal relationship between the independent variable and the dependent variable. This model serves as the applied framework for addressing the study's main research question, using the Structural Equation Modeling (SEM) approach, as depicted in the figure below.

Figure No. (03): Illustrates the integrated model of causal relationships between the study variables



success of the Fourth-Generation University, with a structural weight of (0.55). This value is considered a strong indicator, representing both the strength and the effectiveness of the relationship within the structural model. It is a statistically and practically significant value that reflects a high degree of impact from an applied standpoint.

The integrated model also yielded the following goodness-of-fit indices, which are detailed in the table below.

Table No. (04): Goodness-of-Fit Indices for the Integrated AMOS Model

Index	Good values	Acceptable values	Calculated values	Evaluation

Absolute (predictive) indices	Chi-square (χ^2) or CMIN	$df \geq \chi^2 \geq 0$	$df \geq \chi^2 \geq df$	85.59	Not available
	p-value	$0.01 \geq p \geq 0.05$	$0.01 \geq p \geq 0.05$	0.00	Significant
	df	$2 \geq df \geq 0$	$3 \geq df \geq 2$	41	Good
	CMIN/df	$2 \geq CMIN/df \geq 0$	$3 \geq CMIN/df \geq 2$	2.00	Good
	GFI	$1.00 \geq GFI \geq 0.90$	$0.90 \geq GFI \geq 0.80$	0.90	Acceptable
	AGFI	$1.00 \geq AGFI \geq 0.90$	$0.85 \geq AGFI \geq 0.85$	0.85	Acceptable
	RMSEA	$0.08 \geq RMSEA \geq 0$	$1.0 \geq RMSEA \geq 0.09$	0.08	Good
	SRMR	0 to 0.05	0.05 to 0.08	0.02	Good
Incremental indices	TLI	$1.00 \geq TLI \geq 0.95$	$0.95 \geq TLI \geq 0.90$	0.93	Good
	NFI	$1.00 \geq NFI \geq 0.95$	$0.95 \geq NFI \geq 0.90$	0.91	Good
	CFI	$1.00 \geq CFI \geq 0.95$	$0.95 \geq CFI \geq 0.90$	0.95	Good

Source: Prepared by the researchers based on outputs from the Amos v22 program

Table No. (04) shows that all goodness-of-fit indices for the integrated AMOS model, after applying improvements, reached levels indicative of good model fit, permitting its adoption for testing the structural relationships among the studied variables. None of these indices fell below the minimum acceptable thresholds. The Chi-square (χ^2) value reached 85.59 with 41 degrees of freedom. Although this result is statistically significant, it is widely recognized in the structural equation modeling literature that the Chi-square statistic is sensitive to sample size. Therefore, relying solely on this index is not sufficient for assessing model quality. As a more stable alternative, the ratio (CMIN/df) was considered, and its value reached 2.00, which is considered good and within acceptable bounds, confirming the model's adequacy.

In addition, the Root Mean Square Error of Approximation (RMSEA), considered the most critical absolute (predictive) fit index, recorded a value of 0.08, which falls within the acceptable range for models that include multiple latent variables, thus confirming good model fit. The Standardized Root Mean Square Residual (SRMR) recorded a value of 0.02, reflecting a good fit and indicating a low level of discrepancy between the theoretical and observed covariance matrices.

Regarding the comparative (incremental) indices, the model also demonstrated good fit. The Comparative Fit Index (CFI) reached 0.95, the Tucker–Lewis Index (TLI) was recorded at 0.93, and the Normed Fit Index (NFI) reached 0.91. These values confirm that all indices fall within accepted ranges, and collectively, they suggest that the structural model provides a high

degree of representativeness for the relationships among the study variables. Based on these outcomes, it can be concluded that the integrated AMOS model meets the essential goodness-of-fit criteria, enabling reliable interpretation of the structural relationships between the available capabilities at the level of the Algerian university and the requirements for the success of the Fourth-Generation University within the context of the current institutional transformations.

The estimates derived from the model are presented in the table below and further reinforce the validity of this structural model.

Table No. (05): Estimates of the Integrated AMOS Model for the Study

Variables	**Path**	**Standard Estimate**	**Standard Error (S.E)**	**Critical Ratio (C.R)**	**Significance Value (P)**
F1 → F2	,	0.301	0.055	5.429	0.001
Critical ratio standard value (C.R) = 1.96					
*** Positive effect statistically significant at the 0.001 level (‰1)*					
Standardized regression coefficient (effect value) = (0.55)					

Source: Prepared by the researchers based on outputs from the Amos v22 program

The results shown in the above table, which presents the estimates for the integrated AMOS model, indicate that the calculated critical ratio (C.R) reached a value of 5.429, well above the standard threshold of 1.96. In addition, the standardized regression coefficient (effect value) reached 0.55 and was statistically significant at the 0.001 level. This is substantially lower than the significance level adopted in the study (5%), with ($p = 0.001 < 0.05$), confirming the presence of a direct and positive effect of 55% from the available capabilities within the Algerian university on the requirements for the success of the Fourth-Generation University.

This result clearly indicates that the available capabilities serve as the primary input for achieving the conditions necessary for the success of this university model. Furthermore, the standardized regression coefficient value (0.55) suggests that these capabilities explain approximately 30% of the variance in the requirements variable. The standard error (S.E), which reached 0.055, is very close to zero, indicating both the precision and the robustness of the parameter estimate within the model.

In addition to the direct effects highlighted in the estimates of the integrated AMOS model, and their statistical significance, the study also examined the indirect effects of the available capabilities at the Algerian university (AVPO) on the sub-dimensions of the requirements for the success of the Fourth-Generation University (SR4GU). The findings revealed that these capabilities exert an indirect and positive effect through the intermediary variable (F1). Specifically, the indirect effect of variable (F2) on the six sub-dimensions of the requirements variable, namely: Organizational Culture and Governance (OCG), Digital Infrastructure Environment (DIE), Research and Innovation (RI), Training and Qualification (FQ), Relationship with the Social and Economic Environment (RSEE), and International Openness and External Cooperation (IOEC), ranged between values of 0.301 and 0.437.

These results reflect the comprehensive role of capabilities in supporting the various components essential to the success of the Fourth-Generation University. The interplay between both direct and indirect effects confirms that available capabilities are not only a key determinant in a direct structural sense but also play a crucial role in amplifying the influence on the model's sub-dimensions through indirect pathways.

7. Discussion of the Study Results:

The findings of this study confirm that the structural model developed is coherent and exhibits a good level of statistical fit. It successfully explains the relationship between the available capabilities at the level of the Algerian university and the requirements for achieving success in the implementation of the Fourth-Generation University project. The results clearly demonstrated the presence of a direct and positive effect of these available capabilities on the requirements necessary for the success of the Fourth-Generation University.

In light of this outcome, it becomes evident that faculty members at the University of Jijel place considerable emphasis on the importance of available capabilities as a fundamental foundation for fulfilling the requirements associated with the Fourth-Generation University. While this result largely aligns with theoretical assumptions that emphasize the necessity of technical, logistical, human, financial, and technological capacities as essential prerequisites for the success of Fourth-Generation initiatives, whether in industrial, educational, or academic contexts, there emerges, within the specific context of the Algerian university, a distinct perception. This perception reflects the extent to which faculty members are increasingly aware of the powerful influence these capabilities exert on the university's ability to realize the goals of the Fourth-Generation model.

This growing awareness appears to be shaped in part by previous institutional experiences in Algerian universities, where delays in recognizing the importance of technical, human, and logistical dimensions were noticeable. These delays often occurred in parallel with a focus on expanding physical infrastructure, buildings, academic facilities, and large-scale structural development, intended primarily to absorb the growing number of students within the framework of Algeria's social policy of educational democratization and the commitment to free higher education. However, despite the visible growth in infrastructure, these developments were not always matched by an equivalent investment in operational or strategic capabilities.

The recognition of the integrated and multidimensional impact of capabilities may be closely linked to the rapid acceleration of challenges brought on by the distinctive nature of Fourth-Generation demands. These challenges are increasingly dynamic, and their complexity is amplified by the expanding influence of artificial intelligence in redefining the profile of the modern university. This transformation reinforces the idea that developing strategic, effective, and high-impact frameworks for the dissemination of academic knowledge, the advancement of scientific research, and the enhancement of research value through impactful publishing and practical application, particularly within the ecosystem of startup projects, has led many faculty members to reconsider earlier assumptions. The belief that buildings and infrastructure alone are sufficient for achieving the aspirations of a 21st-century university is now being replaced

with a deeper conviction that innovation, resources, and strategic capability development are essential drivers of academic success.

Although the magnitude of the effect observed between capabilities and requirements in this study was notably high and significant (0.55), this does not necessarily reflect a complete consensus among faculty members regarding the interpretation or perception of capabilities in this context. Some members of the academic community maintain that the current reality in certain university institutions, especially those still constrained by bureaucratic administrative approaches and lacking a forward-looking strategic vision for effectively leveraging available capabilities, continues to foster skepticism.

These perspectives reflect a broader concern that the issue may not lie solely in the quantity or presence of capabilities, but rather in the nature of public policy governing higher education in Algeria. From this point of view, even if greater capabilities were to be allocated in the future, their impact would remain limited unless accompanied by a transformation in how such resources are mobilized, valued, and invested in alignment with clear, pragmatic, and results-oriented strategies.

In light of this broader discussion, the outlines of the influence exerted by the sub-dimensions that make up the variable of available capabilities on the requirements for the success of the Algerian Fourth-Generation University become increasingly clear. The results of the study indicate that human capabilities stand out as some of the most impactful factors within the Fourth-Generation University framework. The scientific and innovative competencies of faculty members and researchers, their ability to develop personal skills, and their adaptability in adopting modern educational and pedagogical methods, constitute a foundational pillar for activating institutional transformation toward a modern, forward-looking university model.

Investing in the training and professional development of these human resources, while encouraging them to engage in meaningful research and innovation, enhances the university's capacity to implement Fourth-Generation policies in key areas such as pedagogical quality, digital transformation, and the reinforcement of links between the university and its economic and social surroundings.

Within the context of Fourth-Generation requirements, financial investment is directly linked to the acquisition of advanced software systems, high-performance digital platforms, and state-of-the-art laboratory equipment. It also enables universities to expand their access to diverse sources of investment and establish strategic partnerships with private sector actors and international institutions. Against the backdrop of global transformations in higher education, particularly those involving artificial intelligence, big data, and cloud computing, financial investment has become a pivotal enabling factor in empowering universities to modernize and innovate.

Accordingly, research and scientific capabilities become the decisive engine for converting these financial resources into meaningful knowledge and innovation outputs. The strategic investment of available funds boosts the development of scientific projects aligned with contemporary societal and economic priorities. This trend mirrors recent developments in Algerian universities, which have increasingly prioritized scientific research. These institutions

have established research centers and startup incubators that transform innovative ideas into practical, market-oriented products and services, aiming to elevate the Algerian university's role and impact at both the national and international levels.

Most universities have begun to focus heavily on the adoption and dissemination of research results, active participation in joint international projects, and integration into global scientific cooperation networks. These efforts are aimed at enhancing their scientific visibility and improving their academic ranking. Ultimately, they pave the way for transforming human and financial investments into tangible scientific and knowledge-based outcomes, results that resonate both within society and within the wider global academic ecosystem.

While research and scientific capabilities empower the university to generate innovation and new knowledge, technological and organizational capabilities serve as the supportive framework that enables this knowledge to be transformed into applied and measurable outcomes. These capabilities are essential for ensuring the integration of human, financial, and research resources within the university ecosystem. Furthermore, effective organizational management, efficiency in decision-making, and structural flexibility in the face of innovation enhance the ability of faculty members and researchers to fully leverage available technological tools.

International experiences have shown that leading Fourth-Generation universities fundamentally rely on the integration of cutting-edge technology with agile and adaptive organizational structures in order to remain responsive to fast-paced global transformations. It is this perspective that appears to inform the thinking of Algerian university faculty members, who increasingly view technological and organizational capabilities as strategic levers. These elements are seen as critical for enabling the university to translate its human, financial, and research capital into innovative educational and research outcomes, ones that are fully aligned with the demands of global transformation and essential for meeting the core requirements of the Fourth-Generation University model.

As has been observed, "the most distinctive factor of these universities is the factor of proactiveness, as higher education institutions exert a fundamental influence on the transformations of the economy and local society due to the needs of the knowledge society. The logical approach of Fourth-Generation universities is broader in scope compared to Third-Generation universities, particularly with regard to their potential impact on the economy and local society. Fourth-Generation universities constitute an active socio-economic environment that focuses on serious innovation, which is a defining characteristic of these universities" (Wagdi, Abouzeid, & Fathy, 2021, p. 5766).

With regard to the results indicating the existence of an indirect effect of the available capabilities in the Algerian university on the six dimensions associated with the requirements for the success of the Fourth-Generation University, specifically through the mediating variable representing the overall requirements, this finding suggests that the relationship between the two variables is both interactive and dynamic. It extends beyond a simple linear influence to reflect a more complex structural relationship. This relationship is shaped, on the one hand, by the university's institutional and strategic framework, and on the other, by the nature of the resources and capabilities available to support the transition toward a Fourth-Generation University.

P-ISSN:2496-4476E-ISSN:2273-157
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Financial and logistical, human, technological, organizational, and scientific research capabilities, despite their individual significance, do not automatically translate into achievement across each requirement dimension. Rather, their effect is mediated by the adoption of a comprehensive and integrated framework of requirements, which serves as a guiding reference for the optimal use and distribution of these resources across various operational and strategic domains.

In the context of the current Algerian university landscape, capabilities, whether financial, logistical, human, organizational, or otherwise, pose a genuine challenge. The Ministry of Higher Education and Scientific Research is taking this challenge seriously within the broader framework of its efforts to support the transition toward Fourth-Generation Universities. However, when these capabilities are treated in isolation at both the legislative and practical levels, without being integrated into a coherent and synergistic structure, the result is a fragmentation of priorities. This disconnection makes it difficult to present these capabilities as unified and strategically supportive elements with a clear structural role.

Consequently, in the absence of a unified strategic vision that clearly defines institutional priorities and aligns available resources with actual needs, whether in terms of the quality and specialization of training, or the advancement of scientific research and infrastructure development, these capabilities are unlikely to exert a direct and effective influence on each specific dimension of the Fourth-Generation requirements. The success of the Ministry's initiatives concerning digital transformation and partnership-building with societal and economic actors has therefore become increasingly dependent on the presence of an institutional framework capable of coordinating the use of resources and converting individual capabilities into concrete, collective outcomes that enhance the full spectrum of Fourth-Generation University requirements.

It is also important to highlight that openness to the social and economic environment emerged as one of the most significant dimensions of the requirements that are indirectly influenced by the available capabilities. The effectiveness of this dimension hinges on the university's capacity to channel human and financial resources toward applied initiatives, such as partnerships with economic institutions, innovation incubators, and research centers. Such efforts help amplify the societal impact of university capabilities and foster an educational and research ecosystem that is tightly aligned with the realities and needs of the local labor market.

This reinforces the notion that the university's practical and measurable outputs do not emerge directly from its available capabilities, but rather from its ability to organize and structure those capabilities within an integrated strategic framework, a framework that connects resources with institutional objectives and desired societal outcomes. This is particularly relevant in the Algerian context, where there is still an absence of a deeply embedded and effective culture of economic innovation, as the legacy of a centrally planned economy continues to shape many aspects of the country's economic mindset.

Through even a brief comparison between Algerian universities and leading global institutions that have successfully adopted Fourth-Generation reforms, it becomes clear that scientific and knowledge productivity increases significantly when resources are mobilized within a comprehensive strategic model. Such a model unifies financial investments, human

competencies, and scientific research with a shared vision, actively stimulates innovation, and maximizes both local and international academic impact.

Accordingly, this interpretation of the mediating variable in the integrated model reinforces the overall strength and structural cohesion of the model itself. It affirms the soundness of the relationship between available capabilities and the requirements for the success of the Fourth-Generation University, as demonstrated within the analytical framework of this study.

8. Conclusion:

The relationship between requirements and capabilities at the university level represents a central axis for understanding the success of any academic institution in the context of the Fourth-Generation era. Requirements express the university's vision for its strategic future, while the various capabilities, human, financial, research-based, technological, and organizational, constitute the actual resources that empower the university to realize and implement this vision effectively. Through this integration, the importance of mobilizing capabilities within an institutional, rational, and comprehensive strategic framework becomes unmistakably clear.

The findings of this study confirm that the success of the Fourth-Generation University hinges on the dynamic interaction between capabilities and overarching requirements, within a creative and forward-looking vision. This vision moves beyond traditional organizational and administrative frameworks, toward intelligent, adaptive structures that take into account the interplay of multiple variables in rapidly evolving spatial and temporal contexts, especially those driven by technological advancements and artificial intelligence. Without question, these variables have become central to the national challenges currently confronting higher education institutions. These institutions are now called upon to keep pace with global transformations and to position themselves as platforms for the realization of smart society projects and innovation-driven startup ecosystems, where knowledge and innovation serve as foundational pillars for sustainable development pathways.

9. Proposals and Recommendations:

At the conclusion of this study, the following proposals and recommendations have been identified:

- Restructuring university infrastructure to align with the specific requirements of the digital university model.

- Supporting and expanding internet networks, and ensuring their smooth, continuous, and reliable availability across all institutional levels.

- Placing strong emphasis on human resources, and investing in them as a strategic priority through regular and continuous professional training programs.

- Conducting periodic evaluations of the Fourth-Generation University project to identify emerging requirements that should be integrated into the Algerian university's digital transformation strategy.

- Activating participatory governance to ensure that staffing and deployment decisions are based on merit and competence rather than seniority.

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- Guaranteeing that high-quality, value-added scientific research is effectively translated into practical, real-world projects that benefit society.

- Establishing dedicated committees at each university to ensure the effective implementation of the Fourth-Generation University model, under the supervision of experts in both information technology and pedagogy.

- Encouraging co-financing mechanisms through strategic partnerships with the economic sector, participation in international projects, and collaboration with renowned research institutions.

- Training faculty members and students through the establishment of hands-on technical workshops managed by highly qualified technicians, particularly in research areas related to artificial intelligence.

- Creating opportunities for university research laboratories to sign partnership agreements with socio-economic actors, while ensuring the optimal use and reinvestment of the financial returns generated by such partnerships.

- Promoting professional bachelor's and master's degree programs that can accommodate the largest possible number of students in alignment with labor market needs.

- Adopting a strategic planning approach that defines a forward-looking vision not only for the Fourth-Generation University, but also for the Fifth- and Sixth-Generation Universities already emerging worldwide.

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