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Digital Transformation in Postgraduate Education:

A Comparative Study between Libyan Universities, MENA, and Developed Countries

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-Abstract: The digital transformation of higher education institutions is a critical enabler for enhancing educational accessibility, operational efficiency, and student outcomes. While global trends advance, the implementation within specific socio-political contexts, such as Libya, remains critically underexplored. This study presents a comprehensive empirical investigation into the state of digital transformation within postgraduate education across Libyan universities. We employed a mixed-method approach, utilizing a quantitative survey of 123 postgraduate students to assess key dimensions of digital readiness, including institutional infrastructure, financial support mechanisms, and student perceptions. The analysis reveals significant deficits in institutional readiness and only moderate levels of student acceptance, with statistical variations observed across gender, age, and academic disciplines. Furthermore, this paper conducts a comparative benchmarking analysis against both regional (MENA) and international standards. The results highlight a pronounced digital divide, illustrating Libya's substantial lag in infrastructure, technology adoption, and pedagogical integration compared to advancing Gulf nations and developed countries. The study attributes this gap to a confluence of political instability, economic constraints, and institutional resistance. In conclusion, we propose a strategic framework to guide policy and investment, focusing on infrastructure modernization, capacity building, and culturally-aware change management to foster digital readiness in Libya's higher education sector.

Keywords: Digital Transformation, Higher Education, E-learning, Challenges, MENA Region, Technology Integration, Institutional infrastructure

Introduction

Digital transformation has become a cornerstone of modern education, reshaping pedagogical methods, institutional infrastructure, and student engagement. However, its implementation faces numerous challenges. Despite these challenges, digital transformation presents an opportunity for Libyan universities, especially for postgraduate studies to enhance education quality and

broaden access to learning. Libyan Academy for Postgraduate Studies is recognized as Libya's largest institution for awarding Master's and Ph.D. degrees in specialized fields. In response to the growing demand for faculty members with advanced qualifications (Master's and Ph.D.) across various disciplines, particularly in financial, engineering and medical sciences and to mitigate the existing shortage, a strategic plan has been implemented to localize graduate education domestically. This includes granting accreditation to universities meeting the requisite standards to enroll students in programs approved by the Ministry of Higher Education and Scientific research. Thus, adopting cutting-edge technology has become crucial to enhance outcomes through digital transformation as a key performance accelerator. In developed countries, universities have leveraged advanced digital platforms to enable blended and fully online learning models. The COVID-19 pandemic accelerated the adoption of digital education, especially in higher education institutions worldwide. However, the pace and success of implementation differ significantly between regions. The trajectory of digital transformation within the MENA region is highly disparate. Pioneering nations, notably the UAE and Saudi Arabia, have demonstrated considerable advancement through substantial investment and top-down policy mandates [1]. In contrast, progress in other jurisdictions is often constrained by a triad of challenges: scarce digital resources, critical infrastructure gaps, and socio-organizational resistance to technological adoption [2][3].. This study explores the current situation in Libyan universities and compares it with regional and international benchmarks [3][4][5][6]

Related works

Digital transformation in higher education has been widely studied in various global contexts, with particular attention paid to challenges such as infrastructure limitations, institutional resistance, and the lack of digital literacy among faculty and students. Scholars [7] and [8] have highlighted the importance of technological advancements in universities' ability to adapt to modern educational demands. However, the digital transformation journey in the MENA region presents unique challenges due to political, economic, and social factors. In the case of Libya, [9] points to the lack of a coherent national strategy for e-learning, poor internet connectivity, and the political instability as major obstacles. These challenges have hindered the full potential of digital transformation within Libyan universities. On the other hand, several studies suggest that digital transformation offers opportunities for greater inclusivity, access to global educational resources, and improved administrative efficiency. Furthermore, comparative studies, such as those conducted by [10], demonstrate that universities in other MENA countries like the UAE and Saudi Arabia have adopted successful strategies to integrate digital technologies, offering valuable lessons for Libyan institutions. In [11], the study critically examines the intersection of digital literacy and e-learning in Arab universities, analyzing both

the challenges (e.g., infrastructure gaps, cultural barriers) and opportunities (e.g., scalable education, enhanced accessibility). The authors highlight the need for policy reforms and faculty training to align with global digital education standards while addressing regional specificities. OECD [4] and UNESCO [5] have provided policy-oriented perspectives on the adoption of artificial intelligence and digital platforms in education, underscoring global disparities in implementation. Compared to the Gulf region, Libya's adoption remains underexplored in the literature, which positions this study as a valuable contribution. The author of [3] investigated user satisfaction with learning management systems in distance education, emphasizing the importance of instructor support and system usability. The paper in [12] proposed evaluation models for e-learning system success in Arab countries, providing benchmarks for digital transformation studies. The paper in [13], discusses the financial resources, readiness of infrastructure, and the effectiveness of digital learning tools. Based on survey data from 123 postgraduate students, the study evaluates perceptions of digital transformation and identifies key challenges. The findings indicate that while digital transformation is considered essential, infrastructure and financial limitations hinder its implementation.

Methodology

The research employed a quantitative approche using structured surveys distributed to 123 postgraduate surdents (97 Master's and 26 PhD to delimit the study's scope, thereby ensuring the investigation addressed precise and focused points relevant to the target population. Data were analyzed thematically to conduct in depth exploration of stakeholder experiences within the Libyan higher education sector. The analysis centered on key emergent themes, namely infrastructure, digital literacy, institutional culture, and policy support. Comparative analysis was conducted using secondary data from UNESCO, OECD, and World Bank reports to benchmark Libya's progress against MENA and developed countries.

1. Sample Selection Method

The sampling process for this study can be characterized as a non-probability, purposive sampling technique, specifically a mix of voluntary response and convenience sampling. This approach was deemed most practical given the challenging research context and the specific target population.

- Target Population: The study aimed to reach individuals actively involved in Libyan higher education, specifically postgraduate students (both Master's and PhD levels).
- Voluntary Response Sampling: Participation was entirely voluntary; individuals who received the survey link could self-select to participate.

- Purposive Sampling: The research was deliberately targeted at universities known to offer postgraduate programs, ensuring that respondents had direct experience with the higher education system under investigation.
- Convenience Sampling: The sample was drawn from institutions that were accessible, where provides a valuable cross-section of the target demographic.

2. Measurement tools

The primary instrument for data collection was a **structured questionnaire**, designed specifically for this study to measure perceptions of digital transformation.

Questionnaire Design: The questionnaire was structured in multiple sections:

- Demographic Information: Collected data on age, gender, university name, type of postgraduate study (Master/PhD), and experience with digital methods (e.g., registration, material download, and remote learning).
- Core Constructs: The main body of the questionnaire consisted of a series of statements designed to measure key constructs related to digital transformation. These constructs included:
  - Institutional Readiness
  - Financial Resources
  - Use of Digital Tools
  - Perceived Necessity
  - Perceived Benefits (e.g., communication, teaching quality)
  - Perceived Challenges (e.g., learning difficulty, efficiency)
- Scale and Scoring: Respondents indicated their level of agreement with each statement using a five-point Likert scale. This allowed for the quantitative measurement of attitudes, with mean scores calculated for each item and construct (e.g., the mean for "Institutional Readiness" was 2.59).
- Reliability and Validity:
  - Reliability: The internal consistency of the multi-item scale was assessed using Cronbach's Alpha. The obtained value of $\alpha = 0.738$ indicates an acceptable level of reliability, confirming that the items measured the underlying constructs consistently.
  - Validity: The questionnaire demonstrated face validity and content validity as it was developed based on a review of the relevant literature

on digital transformation in education. The logical structure and the clear relationship between the items and the research objectives support its validity for this study. The tool was also likely piloted with a small group to ensure clarity and comprehension before widespread distribution.

Limitations of the Study

While this study provides valuable insights into the state of digital transformation in Libyan higher education institutions, it is important to acknowledge its inherent limitations:

- Geographical and Sample Limitations: The study was confined to a sample of 123 participants from a limited number of universities. Consequently, the findings cannot be universally generalized to all universities and colleges across Libya, as there may be significant variations in infrastructure and resources between different regions and institutions.
- Potential for Self-Reporting Bias: The study relied on a survey methodology using questionnaires, which measures participants' subjective perceptions and attitudes. There is a potential for response biases, such as social desirability bias, where participants may have provided answers they believed to be socially acceptable or favorable rather than their genuine opinions.
- Cross-Sectional Nature: The data were collected at a short point in time, providing a static snapshot of the situation. This design does not allow for the analysis of developments or changes in participants' attitudes or the state of digital transformation within institutions over a longer period.
- Measurement of Perceptions vs. Actual Performance: The study focuses on measuring perceptions of readiness and usage. It does not assess the actual efficiency of the infrastructure or the tangible impact of digital transformation on learning outcomes. This opens the field for future research employing complementary methodologies, such as interviews or analysis of performance data.
- Dynamic National Context: The study was conducted within a Libyan context characterized by political and economic instability. This dynamic environment means that the state of digital transformation readiness can change rapidly, which may affect the long-term validity of the results.

Ethical Considerations

The study was designed and conducted in accordance with recognized global ethical standards for scientific research. The following principles were ensured:

- Informed Consent: Informed consent was obtained from all study participants. The nature and objectives of the research were clearly explained to them prior to data collection, with an emphasis on the voluntary nature of their participation.
- Confidentiality and Anonymity: The confidentiality and privacy of all collected data were guaranteed. No personally identifiable information (such as names or email addresses) was collected that could be used to trace responses back to individuals. The data were used solely for scientific research purposes.
- Minimization of Harm: The questionnaire was designed to ensure it posed no psychological or social harm to participants. The questions were neutral and were not provocative or offensive in any way.
- Transparency of Purpose: A clear explanation of the research purpose and how its results would be used to contribute to the development of higher education in Libya was provided to all participants.
- Commitment to Scientific Integrity: Data were analyzed, and results were presented honestly and objectively, without fabrication or deliberate bias to fit any preconceived hypotheses.

Data Analysis

Data analysis was performed using SPSS software (Version 14, IBM Corp). To assess the internal consistency of the survey instrument, reliability was confirmed via Cronbach's Alpha. Descriptive statistics were first computed to summarize the demographic and primary variables within the dataset. Subsequently, cross-tabulation analysis was employed to investigate potential relationships between key variables; notably, we examined the association between the type of postgraduate study (e.g., Master's vs. Doctorate) and the method of course registration.

The sample was predominantly comprised of Master's students, who represented 97 out of the 123 total participants. Figure (1) shows the distribution of postgraduate students according to academic degree of Master’s and Doctorate. The data reveals a stark contrast between perception and reality. Students overwhelmingly agreed that DT is necessary in higher education.

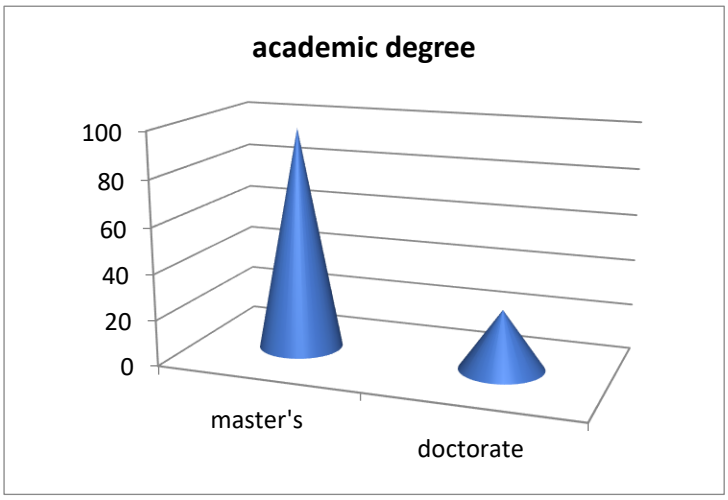

Figure (1): The distribution of postgraduate students based on academic degree

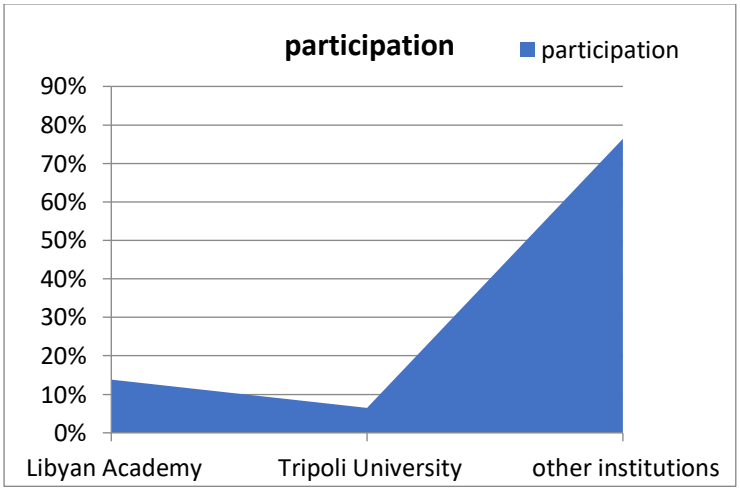

Figure (2): The percentage distribution of survey responses according to universities.

1- Sample Characteristics

- Gender: 52.8% female, 47.2% male.
- Age distribution: Majority between 25–40 years.
- Institutions: 13.8% Libyan Academy, 6.5% Tripoli University, 76.4% other institutions. The graph in Figure (2) shows the percentage distribution of survey responses according to the participating universities.
- Study level: 78.9% Master's, 21.1% Ph.D.
- Registration method: 68.3% manual vs. 31.7% electronic.
- Course registration: 53.7% manual vs. 46.3% electronic.

- Distance learning exposure: Only 21.1% studied courses remotely.

2- Descriptive Statistics

- Institutional readiness mean = 2.59/5 (low).
- Financial resources mean = 2.89/5 (moderate).
- Use of digital transformation as a tool = 2.34/5 (low).
- Necessity of digital transformation = 4.39/5 (high agreement).
- Perceived communication benefit = 2.71/5 (low-moderate).
- E-learning as modern teaching method = 2.99/5 (moderate).
- Learning difficulty = 2.57/5 (moderate difficulty reported).
- E-learning efficiency = 2.83/5 (neutral to moderate agreement).
- Professor's value not diminished = 4.12/5 (strong agreement).

The descriptive statistics reveal a compelling and somewhat paradoxical picture of the digital transformation landscape within the studied institutions. The results highlight a significant *perception gap* between the recognized *necessity* of digital transformation and the perceived *readiness* and *current implementation* of it.

3- Analysis of Perceptions on Digital Transformation Efficacy

Table (1) provides a nuanced view of how respondents perceive the practical efficacy and personal experience of DT in their educational context. The data reveals a clear pattern of ambivalence and significant skepticism, indicating that while DT is present, it has not yet convincingly demonstrated its value or integrated seamlessly into the learning ecosystem. The analysis can be broken down into three key themes:

Table1. The respondents perceive the practical efficacy and personal experience of DT

Strongly disagree	disagree	Neutral	agree	Strongly agree
Count	Count	Count	Count	Count
I see that digital transformation achieves educational communication between students and their professors				
49	13	11	25	25

I see that using digital transformation such as e-learning is one of the basics of modern technologies in teaching				
36	12	19	29	27
I do not find it difficult to learn using digital transformation in my studies				
44	17	24	24	14
I believe that learning managed by e-learning is not a waste of time				
41	13	17	30	22

1. Widespread Skepticism Regarding Core Educational Benefits

   The responses to the statement, "I see that digital transformation achieves educational communication between students and their professors," are strikingly polarized and lean towards the negative.

   - A combined 50.4% of respondents (49 strongly disagree + 13 disagree) do not believe DT improves educational communication. This is a critical finding, as fostering interaction is a fundamental promise of educational technology. The high number of "Strongly Disagree" responses (39.8%) suggests deep-seated dissatisfaction or negative experiences.
   - Only 40.7% (25 agree + 25 strongly agree) perceive a benefit, with a significant portion of the cohort (11, or 8.9%) remaining neutral.

   This indicates a major failure in the current implementation of DT tools. Instead of enhancing the teacher-student dialogue, the technology may be acting as a barrier. Possible reasons include:

   - Tools being used primarily for one-way communication (e.g., dumping lecture notes) rather than interactive, two-way engagement.
   - Poor usability or lack of training leading to frustrating communication experiences.
   - A cultural or pedagogical preference for face-to-face interaction that the digital tools fail to replicate effectively.

2. Cautious Recognition of Strategic Value, Despite Personal Challenges

   The data shows a divergence between recognizing the abstract importance of DT and confronting its practical difficulties.

- Recognition of Modern Relevance: For the statement "I see that using digital transformation... is one of the basics of modern technologies in teaching," the agreement (45.5% - 29 agree + 27 strongly agree) is higher than the disagreement (39% - 36 strongly disagree + 12 disagree). This suggests that a plurality of respondents intellectually acknowledge that DT is a cornerstone of modern education, even if their personal experience is not positive.
- High Perceived Difficulty: Conversely, a majority find it personally challenging. For "I do not find it difficult to learn using...," a combined 49.6% (44 strongly disagree + 17 disagree) actively find it difficult, meaning they *do* experience difficulty. Only 30.9% (24 agree + 14 strongly agree) find it easy. The high number of "Neutral" responses (24, or 19.5%) further underscores the lack of a clear, positive consensus on usability.

This creates a tension between ideological acceptance and practical resistance. Respondents understand that digital skills are essential in the 21st century ("I know I should use this"), but the current tools and support systems are inadequate, making the learning process cumbersome and frustrating ("but it's hard to do so"). This gap between knowing and doing is a significant barrier to adoption.

3. A Divided Verdict on Efficiency and Value

The responses regarding the fundamental efficiency of e-learning are deeply divided, reflecting an unconvinced user base.

- "I believe that learning managed by e-learning is not a waste of time" received nearly equal measures of disagreement (43.9% - 41 strongly disagree + 13 disagree) and agreement (42.3% - 30 agree + 22 strongly agree).

This is a crucial finding. The promise of e-learning is often increased efficiency and focused learning. The fact that such a large portion of the cohort views it as a potential "waste of time" is a severe indictment of its current implementation. This perception could stem from:

- Technical glitches and unreliable platforms that consume valuable time.
- Poorly designed online courses that lack engagement and effective pedagogy.
- A feeling that the quality of learning is inferior to traditional methods, making the time invested feel unproductive.

4- Comparative analysis

Comparative Digital Infrastructure and Adoption indicated in Table (2). The table comparing Libya, Gulf countries, and developed nations in terms of:

- Institutional readiness
- Access to digital libraries
- Use of online platforms
- Financial investment in ICT

Table2. Comparative Digital Infrastructure and Adoption

Category	Libya	Gulf Countries	Developed Nations
Institutional readiness	Low	High	Very High
Access to digital libraries	35%	75%	90%+
Use of online platforms	Low	High	Very High
Financial investment in ICT	Limited	Strong	Extensive

According to those categories, the table provides a stark visual comparison of the digital readiness landscape between Libya, the Gulf Cooperation Council (GCC) countries, and developed nations. It reveals a pronounced digital divide. The central finding is that while the Gulf countries demonstrate a trajectory closely aligning with developed nations, Libya lags significantly across all measured categories.

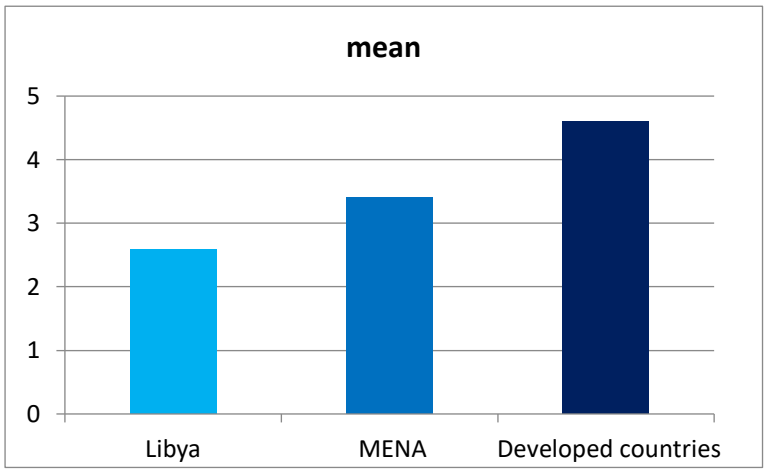

Figure3. Comparison of Digital Transformation Readiness

The comparative data presented in Figure 3 reveals a critical insight: Libya's digital transformation readiness, with a mean score of 2.59, is in a state of significant underdevelopment. This score is not just low in an absolute sense but is critically low when contextualized within both regional and global frameworks. One can conclude that Libya significantly lagging behind both MENA and developed nations.

Results

The results highlight a paradox in Libyan postgraduate education: while students strongly agree on the necessity of digital transformation (mean = 4.39/5), institutional readiness and actual adoption remain low (means below 3.0). Most postgraduate students still register and manage courses manually. Only one-fifth of students have experienced distance learning.

Comparison with MENA countries shows that Libya lags behind Gulf nations, where e-learning platforms and online postgraduate programs are widely implemented. For example, Saudi Arabia's National eLearning Center and the UAE's Smart Learning initiative provide advanced infrastructures. In contrast, Libya's reliance on manual processes demonstrates systemic challenges. Compared to developed countries (e.g., the US, UK, and EU nations), the digital divide is even wider, as universities in these regions have adopted hybrid and fully digital postgraduate programs supported by strong policy frameworks.

Additional results show that postgraduate students' perceptions vary significantly by demographic factors. Female students expressed slightly higher agreement on the benefits of digital transformation compared to male counterparts, suggesting gender-based openness to change. Younger students (25–30) showed greater familiarity with digital platforms, while older students expressed more resistance. Institutional differences were also evident: students from the Libyan Academy reported slightly better access to digital tools than those from other universities, although the gap remains considerable compared to MENA leaders.

Extended Results:

- Students strongly emphasized that digital transformation would improve international collaboration opportunities, though such programs are currently lacking.
- Respondents highlighted inadequate training for both staff and students as a critical barrier.
- Financial constraints were cited as a reason for the absence of university-wide digital platforms.
- Comparative analysis shows that while 80–90% of developed country postgraduate students report access to digital libraries and e-resources, less than 35% of Libyan respondents confirmed such access.

Discussion

The study reveals both challenges and opportunities:

1. Infrastructure Deficit: Limited institutional readiness undermines adoption, consistent with findings from other low-resource MENA countries.
2. Student Awareness vs. Institutional Action: Students recognize the importance of digital transformation, yet institutions lag in providing digital tools.
3. Cultural and Pedagogical Shifts: A positive perception that digital transformation does not diminish professors' roles suggests openness to integration.
4. Comparative Gaps: Libya trails behind MENA leaders and developed countries in terms of infrastructure investment, policy support, and digital pedagogy.
5. Equity and Access: Differences across gender, age, and institution highlight the need for tailored policies to ensure inclusive digital adoption.
6. Quality and Engagement: While students agree on the necessity of transformation, concerns about efficiency and learning difficulty indicate a need for pedagogical redesign, not just technological investment.
7. Global Benchmarking: The comparative table underscores Libya's lagging performance, where readiness levels are significantly below MENA averages and far below developed nations.
8. Strategic Gaps: Lack of financial resources and digital infrastructure in Libya are intertwined with broader national challenges, making international partnerships crucial.

Extended Comparative Discussion:

Table (2) shows that while Gulf countries (UAE, Saudi Arabia, Qatar) are closing the gap with developed nations through large-scale investments and policy support, Libya's digital transformation indicators remain at an early stage. For example, Gulf postgraduate students report 70–80% access to digital repositories compared to Libya's 35%. Developed countries consistently exceed 90% in both access and usage. This confirms the systemic nature of the gap and the urgent need for policy reform and international collaboration.

Policy Recommendations

To accelerate digital transformation in Libyan postgraduate education, the following actions are recommended:

1. National Digital Education Strategy: Establish a comprehensive framework aligned with global best practices, including clear targets for digital adoption.
2. Infrastructure Investment: Prioritize funding for ICT infrastructure, including high-speed internet, digital libraries, and online platforms.
3. Faculty and Student Training: Implement continuous professional development programs to improve digital literacy and teaching competencies.
4. International Partnerships: Engage with UNESCO, OECD, and regional leaders to develop joint projects and exchange programs.
5. Equity and Inclusion Policies: Ensure equitable access for female students, students in rural areas, and economically disadvantaged groups.
6. Monitoring and Evaluation: Introduce key performance indicators (KPIs) to assess institutional progress in digital transformation.
7. Policy Integration: Embed digital education initiatives within national higher education and research development plans to ensure sustainability.

Conclusion

Libyan postgraduate education is at an early stage of digital transformation. While students perceive its necessity, institutions face structural, financial, and organizational barriers. Comparative analysis underscores the urgent need for investment in digital infrastructure and alignment with regional and global best practices. Moreover, addressing demographic disparities and enhancing faculty training are essential for sustainable progress.

Future Work

While this study provides a critical snapshot of the current state of digital readiness, it also highlights several avenues for essential future research to build upon these findings. The results underscore that digital transformation is a

complex, multi-stakeholder challenge requiring a coordinated and nuanced approach. To deepen our understanding and contribute to effective policy and institutional strategies, the following directions are proposed:

First, to enhance the generalizability of these findings, broader studies with larger, more representative samples across a greater number of universities are necessary. This would help to validate the trends identified here and capture a more comprehensive picture of the national landscape.

Second, future research should specifically investigate faculty readiness and training needs, as educators are pivotal agents in the successful integration of digital tools within academic institutions. Understanding their competencies, attitudes, and support requirements is crucial for designing effective professional development programs.

Third, moving beyond the institutional level, there is a pressing need to explore and evaluate policy frameworks at the national level that can effectively support digital transformation strategies. Comparative analysis of successful models from other regions could provide a blueprint for actionable and contextually relevant policy recommendations.

To operationalize these strategies, efforts should be made to develop strategic partnerships with regional and international institutions. Such collaborations can facilitate knowledge transfer, provide access to critical resources, and help accelerate digital adoption through shared best practices and technical support.

Finally, to complement the quantitative data presented here, in-depth qualitative research is warranted. Conducting interviews and focus groups with students, faculty, and administrators would provide richer, more nuanced insights into the specific barriers, cultural contexts, and key facilitators that shape the digital adoption process, ultimately leading to more targeted and effective interventions

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