

The Role of E-Governance in Achieving Digital Transformation in Yemeni Universities: A Field Study

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Abstract:

This study examined the role of e-governance in achieving digital transformation in education at Yemeni universities. E-governance was measured through seven dimensions: strategic planning, e-participation, e-transparency and disclosure, e-accountability, autonomy, rule of law, and technical standards and requirements. Digital transformation in education comprised three dimensions: digital administration, digital education, and digital infrastructure. This study adopted a quantitative, descriptive-analytical approach. A questionnaire served as the primary instrument for data collection. Secondary field and documentary sources were used as a reference base. Data triangulation was applied to enhance the respondents' assessments and ensure their consistency with the realities of the 33 public and private universities in Sana'a, the capital of Yemen. These universities constituted the study population, which comprised all academic and administrative leaders. A stratified random sample of 1,065 leaders (approximately 75% of the population) was selected. Data were analyzed using SPSS and AMOS. Structural equation modeling (SEM) was employed to test the study hypotheses and validate the proposed model. The findings revealed that e-governance has a statistically significant role in driving digital transformation in education, with a high path coefficient ($\beta = 0.92$). The study recommends that Yemeni universities adopt e-governance as an administrative framework to regulate the digital transformation process and ensure its effectiveness in higher education institutions.

Keywords: E-governance, Digital Transformation in Education, Yemeni Universities.

Introduction:

Contemporary organizations are undergoing rapid transformations driven by the extensive advancement of information and communication technology (ICT). This development, often described as the "Fourth Industrial Revolution," has affected individuals and organizations across both public and private sectors (Schwab, 2017). Consequently, the ability to understand and adapt to these changes has become an inevitable necessity. Organizations must therefore allocate the necessary resources and maximize the benefits of digital technologies. Such investments enable organizations to address the changes that technology imposes on the work environment and on modes of service delivery.

However, the success of digital transformation goes beyond merely keeping pace with technological advancements or adopting new systems. It requires establishing robust organizational and administrative frameworks (Vial, 2019). Contemporary scholarship frames digital transformation as a socio-technical process requiring structural, strategic, and capability changes rather than technological adoption alone (Verhoef et al., 2021; Hanelt et al., 2021; Wessel et al., 2021). These frameworks guide and regulate transformation processes across all organizational sectors. They also control the trajectory of these processes, ensuring the efficient and effective achievement of organizational objectives. In this context, e-governance has emerged as an advanced administrative approach. It provides structured principles and standards for managing continuous change in the business environment. By leveraging technological progress, e-governance optimizes organizational performance and bridges the gap between actual and desired outcomes.

Therefore, this study assessed the current state of e-governance practices in Yemeni higher education institutions (HEIs). It also examined the extent to which these practices contribute to advancing digital transformation in Yemeni universities.

Study Problem

Yemeni higher education institutions (HEIs) face significant challenges driven by the digital transformation and information explosion currently shaping the world. Universities are increasingly required to keep pace with rapid developments in administrative and educational information systems. They must also meet societal expectations regarding graduates' quality and improve performance indicators in line with academic accreditation standards and international rankings. This

requires addressing the gap in digital capabilities and resources exposed by the COVID-19 pandemic in 2020. The pandemic led to the complete suspension of administrative and educational operations at all universities that were unable to provide their services electronically or use e-learning systems as an alternative educational pathway.

To achieve this, Yemeni universities must overcome several obstacles, primarily inadequate infrastructure and technical support, limited financial resources, and outdated policies and regulatory frameworks that do not accommodate digital practices. Additionally, there is a deficit in the digital competencies of academic and administrative staff. Moreover, universities' transitions toward digital administration and education systems have often lacked well-conceived strategic visions for ensuring institutional readiness and the success of digital transformation (Al-Khatib & Al-Khatib, 2021; Al-Ahnoumi & Al-Shami, 2021; Maghrabah et al., 2020; Al-Abdi, 2019). These challenges are consistent with the indicators in Yemeni universities' annual reports issued between 2021 and 2023, which the universities are working to address and prioritize.

Daub et al. (2020) emphasized that an organization's shift toward digitalization is a complex undertaking. It must be anchored in a proven administrative model that ensures public expectations are met and promotes the agility and efficiency needed to progress despite limited resources. Similarly, Warner and Wäger (2019) argued that digital transformation demands dynamic organizational capabilities and continuous strategic renewal. In simple terms, the mere adoption of costly digital transformation initiatives does not necessarily guarantee success. Verhoef et al. (2021) also confirmed that digital transformation extends beyond the introduction of new technology. It requires specific organizational structures, assets, and capabilities. Hamni and Toubi (2020) likewise argued that digitalization represents a comprehensive modernization approach encompassing organizational structures, operational processes, and service delivery mechanisms.

Yemeni public and private universities have made tangible efforts in recent years to adapt to the requirements of e-learning and e-administration (Ministry of Higher Education, 2022, p. 3). Nevertheless, many may remain unable to keep pace with rapid advancements in management information systems and e-learning technologies. This is particularly so without a guiding administrative framework and organizational values that govern stakeholder relationships, provide structure and control over the digital transition, and ensure the optimal utilization of limited human and financial resources.

In this regard, e-governance is considered a key factor in successful digital transformation. This study proposes it as the approach that Yemeni universities should adopt to optimize the use of electronic systems and achieve the desired digital transformation. E-governance represents a contemporary administrative paradigm and a qualitative shift from traditional models to more flexible digital management patterns. It is a strategic option suitable for various public and private organizations. It enhances performance efficiency, simplifies procedures, improves service quality, and reduces costs through electronic service delivery within a decentralized system that promotes participatory decision-making and a regulatory environment characterized by transparency, accountability, and the rule of law (Yadav & Rani, 2022, pp. 59–61; Krishnaprabu, 2019, p. 958). In the public sector, digital governance is increasingly conceptualized as the institutional and regulatory enabler of digital transformation (Mergel et al., 2019; Tassabehji et al., 2016; OECD, 2020).

Moreover, numerous studies highlight a strong relationship between governance, particularly e-governance, and digital transformation processes in organizations. Al-Ra'i (2021) and Al-Abdi et al. (2021) emphasized the importance of e-governance in ensuring the success of digital transformation in HEIs. Al-Abdi and Al-Soudi (2024) confirmed the strategic role of IT governance in enhancing universities' responsiveness to digital transformation. Zahra (2025) demonstrated that the absence of governance mechanisms significantly undermines the effectiveness and sustainability of digital transformation initiatives. Iman (2023) highlighted the enabling role of e-governance in successful digitalization experiences, particularly in the UAE context. Additional studies (Mulyana, 2025; Mohammed, 2022; Westerberg, 2021; Shadi, 2023; Radzi et al., 2021) further support the positive impact of governance principles on digital transformation outcomes across various sectors.

Drawing on these findings, this study sought to address the gaps identified in official reports and previous studies regarding the challenges limiting Yemeni universities' ability to respond effectively to the requirements of the digital age. Whereas previous studies highlighted the technical and structural obstacles facing Yemeni universities, this study focused on diagnosing the current state of e-governance practices in Yemeni public and private universities. It also examined the role of these practices in enabling Yemeni universities to achieve digital transformation, as addressed through the following study questions:

1. What is the current state of digital transformation in education at Yemeni universities?
2. What is the level of availability of e-governance practices in Yemeni universities?
3. What is the role of e-governance in achieving digital transformation in education at Yemeni universities?

Study Significance

The scientific significance of this study lies in its focus on digital transformation. Digital transformation has become a strategic necessity for organizational continuity and adaptation to a rapidly changing business environment. The study also highlights the role of e-governance as an organizational framework. This framework regulates digital transformation processes and enhances the efficiency of investments in information and communication technology (ICT).

From a practical perspective, the study aligns with ongoing efforts by Yemeni universities to improve their technological infrastructure and adopt e-learning technologies. Its findings are expected to support decision-makers in Yemeni HEIs. In particular, they encourage the adoption and effective implementation of digital transformation initiatives in line with e-governance principles.

Study Model

Based on previous studies relevant to the study variables, this study adopted the following dimensions of digital transformation in education: digital administration, digital education, and digital infrastructure (Al-Farouq, 2023; Al-Shammari, 2022; Al-Shahna, 2021; Khamis, 2021). Similarly, based on a review of the literature on governance and e-governance in higher education (e.g., Almanzuoa et al., 2023; Faraj & Al-Ghamdi, 2021; Al-Ra'i, 2021), this study identified seven dimensions of e-governance: strategic planning, e-participation, e-transparency and disclosure, e-accountability, autonomy, rule of law, and technical standards and requirements. These dimensions mirror internationally recognized governance pillars (OECD, 2020; ISO/IEC, 2015), synthesizing global best practice with the specific requirements of digital administration in universities. Accordingly, a conceptual framework was developed to examine the relationships among the study variables and their dimensions, as illustrated in Figure 1.

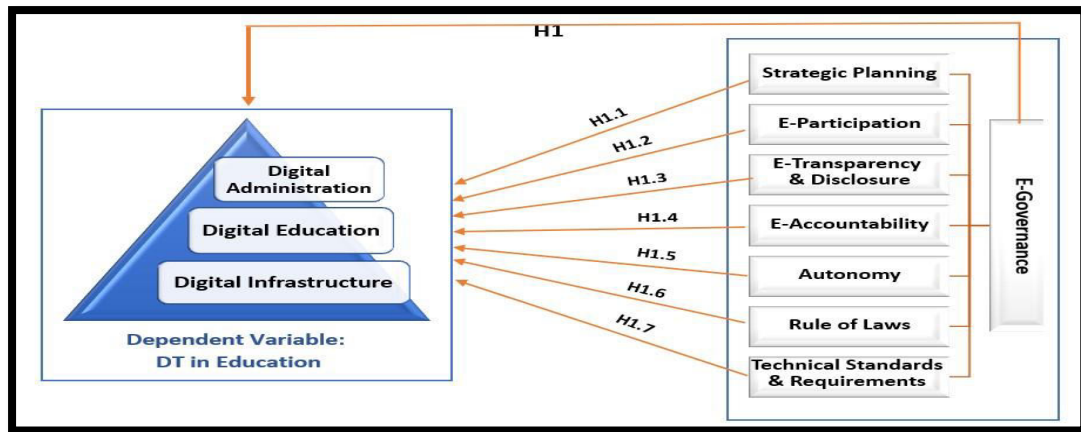


Figure 1. Study Model.

Study Hypotheses

Based on the findings of several studies confirming the significant role of governance in general, and e-governance in particular, in enabling successful digital transformation within organizations (Al-Abdi & Al-Soudi, 2024; Hamni & Toubi, 2020; Iman, 2023; Mohammed, 2022; Mulyana, 2025; Radzi et al., 2021; Shadi, 2023), the study's main hypothesis was formulated as follows:

H1: E-governance, with its seven dimensions (strategic planning, e-participation, e-transparency and disclosure, e-accountability, autonomy, rule of law, and technical standards and requirements), has a statistically significant role in achieving digital transformation in education at Yemeni universities.

This hypothesis was further divided into the following sub-hypotheses:

H1.1: Strategic planning has a statistically significant role in achieving digital transformation in education at Yemeni universities.

H1.2: E-participation has a statistically significant role in achieving digital transformation in education at Yemeni universities.

H1.3: E-transparency and disclosure has a statistically significant role in achieving digital transformation in education at Yemeni universities.

H1.4: E-accountability has a statistically significant role in achieving digital transformation in education at Yemeni universities.

H1.5: Autonomy has a statistically significant role in achieving digital transformation in education at Yemeni universities.

H1.6: Rule of law has a statistically significant role in achieving digital transformation in education at Yemeni universities.

H1.7: Technical standards and requirements have a statistically significant role in achieving digital transformation in education at Yemeni universities.

Study Limitations

The study's scope is determined by the following boundaries:

- Conceptual boundaries: The study examined e-governance as the independent variable, which comprised seven dimensions: strategic planning, e-participation, e-transparency and disclosure, e-accountability, autonomy, rule of law, and technical standards and requirements. Digital transformation in education was defined as the dependent variable, represented by three dimensions: digital administration, digital education, and digital infrastructure.
- Population boundaries: The study targeted academic and administrative leaders in supervisory positions at Yemeni universities.
- Geographical boundaries: The study was conducted at 33 universities in Sana'a, the capital of Yemen (two public and 31 private).

Methodology

Study Method

This study adopted a quantitative research methodology using a descriptive-analytical approach. The descriptive component was used to develop the theoretical framework and define the study objectives and questions. The analytical component was applied in the field study through a questionnaire to collect primary data. Data were analyzed using SPSS and AMOS. Structural equation modeling (SEM) was also employed to examine the relationships among the study variables and test the proposed hypotheses. Furthermore, the study employed a data triangulation strategy. It cross-referenced the primary data collected through the questionnaire with evidence and indicators extracted from documentary sources and field visits to the surveyed universities.

Data Collection Sources

This study relied on primary and secondary data. Primary data were collected from leaders of Yemeni universities through a structured questionnaire. The questionnaire measured the dimensions of e-governance and digital transformation. Secondary data were obtained

from relevant sources, including academic books, theses and dissertations, peer-reviewed journals, official reports, and reliable online resources. Specifically, the documentary data used for the data triangulation were extracted from the annual reports of the 33 surveyed universities (2020–2023) and from official ministry documents, all of which are listed in the reference list.

Target Population

The study population comprised all academic and administrative leaders in Yemeni universities in Sana'a, the capital of Yemen. It totaled 33 universities (two public and 31 private), as reported by the Ministry of Higher Education (2021). These leaders were selected because they are most knowledgeable about their universities' internal operations. They also possess the information required by the study instrument. The total population size was 1,413 leaders, distributed as follows: 149 senior leadership positions, including university presidents, vice presidents, secretaries-general, and their assistants; 254 deans of colleges and directors of research centers; 562 heads of academic departments; and 448 heads of administrative units.

Sample and Sampling Technique

To ensure adequate representation of the study population, a stratified random sampling technique was employed. The population was categorized into four strata according to supervisory functions, as illustrated in Table 1. Hair et al. (2020) and Sekaran and Bougie (2016) confirmed that increasing sample size enhances statistical power and reduces sampling error. Accordingly, the sample size was expanded beyond its minimum limit of 306, estimated according to Krejcie and Morgan (1970), to 1,065 individuals. This represents approximately 75% of the total population. Individuals were selected proportionally from each stratum.

Table 1: *Distribution of the Study Sample.*

Category	Population		Sample	
	n	%	n	%
Senior leadership positions	149	10.5	112	10.5
Deans of colleges and directors of research centers	254	18.0	192	18.0
Heads of academic departments	562	39.8	424	39.8
Heads of administrative units	448	31.7	337	31.7
Total	1,413	100	1,065	100

Note. Sampling was proportional to stratum size. $N = 1,413$; $n = 1,065$.

Data Collection Instrument

The preliminary draft of the study instrument was developed by drawing on several relevant previous studies (Abu-Ghabin & Al-Madhoun, 2023; Al-Maliki, 2017; Al-Ra'i, 2021; Al-Shahna, 2021; Al-Shammari, 2022; Faraj & Al-Ghamdi, 2021; Hamd & Saeed, 2020; Issawi, 2020; Khamis, 2021). Following a review of the questionnaire by experts to ensure content validity, the final version consisted of 43 items distributed across the dimensions of the two study variables. In the item coding used throughout this study, the prefix DT denotes the Digital Transformation scale and EG denotes the E-Governance scale, followed by the dimension number and the item's original position (e.g., DT1_60, EG7_59). A seven-point Likert scale was employed to measure respondents' level of agreement with each item: 7 = strongly agree, 6 = agree, 5 = somewhat agree, 4 = neutral, 3 = somewhat disagree, 2 = disagree, and 1 = strongly disagree. The questionnaire was administered to the target population across Yemeni universities from December 20, 2024, to March 1, 2025.

Data Screening and Cleaning

In total, 923 questionnaires were collected from all surveyed universities. The data were evaluated to verify their suitability for statistical analysis using three main procedures: handling missing data, detecting outliers, and identifying unengaged responses. As a result, 41 questionnaires were excluded (16 for missing data, 12 for outlier values, and 13 for unengaged responses; $16 + 12 + 13 = 41$). Consequently, the final valid sample consisted of 882 responses ($923 \text{ collected} - 41 \text{ excluded} = 882$). Because both the independent and dependent variables were self-reported by the same respondents, the potential for common method bias (CMB) was assessed using Harman's single-factor test. The results showed that no single factor accounted for the majority of the variance (the first factor explained 31.2% of the total variance, below the 50% threshold), indicating that CMB is unlikely to be a serious concern. Additionally, the data triangulation with documentary and field sources further corroborated the perceptual findings.

Validity and Reliability

To verify the validity and reliability of the study instrument, the following tests were conducted:

1. Face Validity

The preliminary questionnaire was developed from a review of relevant studies and evaluated by 12 academic experts in business

administration, public management, and statistics. The experts assessed the clarity, relevance, and appropriateness of the items and ensured their alignment with the study objectives.

2. Construct Validity

Construct validity was assessed using multiple statistical techniques: internal consistency, convergent validity, and discriminant validity.

2.1 Internal Consistency

Internal consistency was examined using Spearman's correlation coefficient to assess the strength of the relationship between each dimension and its overall scale. The results presented in Table 2 indicate statistically significant correlations among all dimensions of the dependent variable (digital transformation in education), with correlation coefficients ranging from 0.866 to 0.873. Similarly, each dimension of the independent variable (e-governance) showed significant correlations, with coefficients ranging from 0.758 to 0.878. These findings confirm satisfactory internal consistency for both variables and support their ability to measure the intended constructs.

Table 2: Results of Cronbach's Alpha and Correlation Analyses for the Study Instrument.

Variable and dimension	Cronbach's α	Spearman's r
Digital transformation in education		
Digital administration	0.852	0.873**
Digital education	0.812	0.873**
Digital infrastructure	0.797	0.866**
E-governance		
Strategic planning	0.831	0.758**
E-participation	0.808	0.840**
E-transparency and disclosure	0.798	0.873**
E-accountability	0.815	0.878**
Autonomy	0.906	0.759**
Rule of law	0.880	0.870**
Technical standards and requirements	0.852	0.835**

Note. α = Cronbach's alpha; r = Spearman's correlation coefficient between each dimension and its overall scale. ** $p < .01$.

2.1 Convergent Validity

Convergent validity was assessed using confirmatory factor analysis (CFA) conducted in AMOS, guided by the goodness-of-fit indices recommended by Hair et al. (2019), Byrne (2016), and Kline (2016).

For the dependent variable (digital transformation in education), the initial results indicated that some indices did not meet the

recommended thresholds. Although most standardized factor loadings exceeded the acceptable level of 0.5, one item (DT2_67) recorded a loading of 0.46, as illustrated in Figure 2.

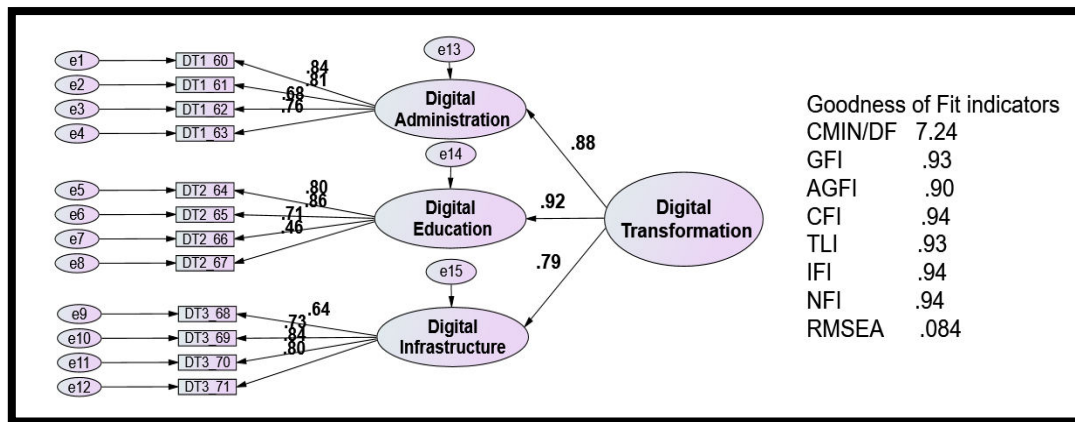


Figure 2. Model of Measuring Digital Transformation in Education (Before Modification).

Consequently, the model required modification to achieve an acceptable fit. Item (DT2_67) was excluded due to its low factor loading. Item (DT3_69) was also removed due to its large measurement error, based on modification indices (MI) generated by AMOS. As a result, the number of items was reduced from 12 to 10. Thus, the revised model for the dependent variable achieved an acceptable fit for structural equation modeling (see Figure 3).

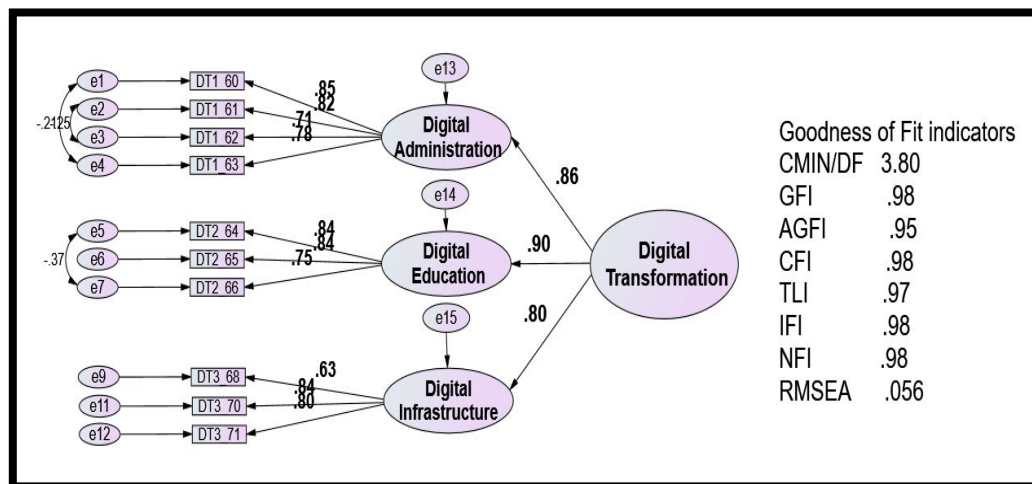


Figure 3. Model of Measuring Digital Transformation in Education (After Modification).

A similar procedure was applied to the independent variable (e-governance). Initial CFA results indicated an inadequate model fit (see Figure 4), necessitating model refinement. Consequently, six items (EG2_32, EG2_36, EG3_38, EG3_41, EG4_43, EG7_59) were removed,

as illustrated in Figure 5. Each removal was justified on empirical grounds, low factor loading or high measurement error per the modification indices, and, importantly, on conceptual grounds: the retained items of each dimension remained consistent with its theoretical definition, and every dimension retained at least three items, preserving the construct's content validity. No dimension was left with fewer than three indicators.

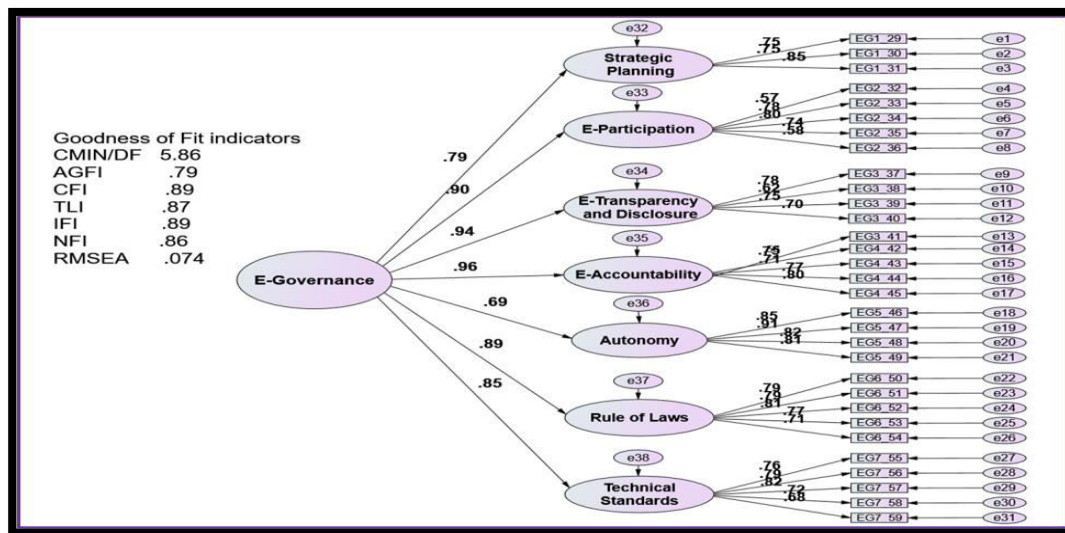


Figure 4. Model of Measuring E-Governance (Before Modification).

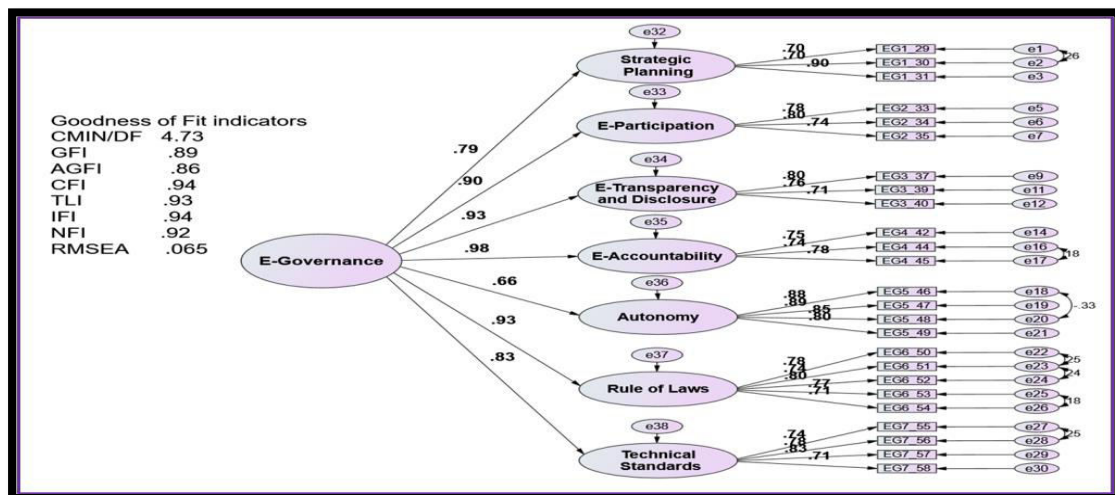


Figure 5. Model of Measuring E-Governance (After Modification).

Table 3a: Goodness-of-fit indices for the measurement models before and after modification.

Model	χ^2 / df	CFI	TLI	RMSEA	SRMR
Digital transformation (before)	4.12	0.912	0.897	0.089	0.058
Digital transformation (after)	2.86	0.951	0.938	0.054	0.041
E-governance (before)	3.78	0.905	0.891	0.093	0.062

E-governance (after)	2.41	0.947	0.935	0.049	0.038
Recommended threshold	< 3.0	≥ 0.90	≥ 0.90	≤ 0.08	≤ 0.08

All fit indices met the recommended thresholds after modification (Hair et al., 2019; Byrne, 2016; Kline, 2016).

Furthermore, Table 3a shows that all dimensions of digital transformation in education and of the independent variable (e-governance) achieved satisfactory reliability and convergent validity. Composite reliability (CR) values exceeded 0.70, and average variance extracted (AVE) values exceeded 0.5 (Fornell & Larcker, 1981). These results confirm that the measurement items are valid and appropriate for their intended constructs.

Table 3b: Results of the Confirmatory Factor Analysis of the Study Variables' Items (After Modification).

Variable and dimension	Item	Loading	CR	AVE
Digital transformation in education				
Digital administration	DT1_60	0.854	0.871	0.628
	DT1_61	0.820		
	DT1_62	0.710		
	DT1_63	0.781		
Digital education	DT2_64	0.840	0.851	0.656
	DT2_65	0.838		
	DT2_66	0.750		
Digital infrastructure	DT3_68	0.632	0.805	0.583
	DT3_70	0.841		
	DT3_71	0.802		
E-governance				
Strategic planning	EG1_29	0.701	0.812	0.593
	EG1_30	0.696		
	EG1_31	0.897		
E-participation	EG2_33	0.785	0.821	0.605
	EG2_34	0.803		
	EG2_35	0.744		
E-transparency and disclosure	EG3_37	0.796	0.800	0.570
	EG3_39	0.758		
	EG3_40	0.708		
E-accountability	EG4_42	0.753	0.804	0.578
	EG4_44	0.744		
	EG4_45	0.784		
Autonomy	EG5_46	0.875	0.916	0.733
	EG5_47	0.894		
	EG5_48	0.850		
	EG5_49	0.803		
Rule of law	EG6_50	0.779	0.872	0.576
	EG6_51	0.740		

	EG6_52	0.796		
	EG6_53	0.769		
	EG6_54	0.708		
Technical standards and requirements	EG7_55	0.738	0.848	0.584
	EG7_56	0.775		
	EG7_57	0.831		
	EG7_58	0.707		

Note. $N = 882$. CR = composite reliability; AVE = average variance extracted. Items with low factor loadings or high measurement error were removed before the final analysis (DT2_67, DT3_69, EG2_32, EG2_36, EG3_38, EG3_41, EG4_43, EG7_59).

3. Discriminant Validity

Discriminant validity was tested using the heterotrait–monotrait (HTMT) ratio. For the dependent variable (digital transformation in education), the results indicated that all HTMT values were below the recommended threshold of 0.90 (Henseler et al., 2015), as shown in Table 4. This confirms strong discriminant validity among the variable's dimensions. To corroborate these results, the Fornell–Larcker criterion (Fornell & Larcker, 1981) was also applied: the square root of the AVE for each dimension exceeded the inter-dimension correlations, further supporting the distinctness of the three dimensions.

Table 4: Discriminant Validity Among the Dimensions of Digital Transformation in Education (HTMT Ratio).

Dimension	1	2	3
1. Digital administration	—		
2. Digital education	0.822	—	
3. Digital infrastructure	0.722	0.764	—

Note. HTMT = heterotrait–monotrait ratio. All values are below the recommended threshold of 0.90.

Similarly, the HTMT values for e-governance were also below 0.90. This confirms the discriminant validity of the independent variable's scale. It also indicates that each dimension measures the construct it was designed to measure (see Table 5).

Table 5: Discriminant Validity Among the Dimensions of E-Governance (HTMT Ratio).

Dimension	1	2	3	4	5	6	7
1. Strategic planning	—						
2. E-participation	0.684	—					
3. E-transparency and disclosure	0.733	0.858	—				
4. E-accountability	0.674	0.870	0.891	—			
5. Autonomy	0.479	0.604	0.558	0.648	—		

6. Rule of law	0.730	0.783	0.832	0.859	0.631	—	
7. Technical standards and requirements	0.638	0.751	0.695	0.802	0.683	0.734	—

Note. HTMT = heterotrait–monotrait ratio. All values are below the recommended threshold of 0.90.

4. Reliability

The reliability of the study instrument was assessed using Cronbach's alpha coefficient. The results, shown in Table 2, indicate that all variables and dimensions achieved high reliability. The reliability coefficient for the dependent variable (digital transformation in education) was 0.905. The reliability coefficient for the independent variable (e-governance) was 0.954. The coefficients for the dimensions ranged from 0.797 to 0.906. These values exceed the acceptable reliability threshold of 0.70 (Nunnally & Bernstein, 1994). They confirm the scale's high reliability and enhance confidence in the study's findings.

Results and Discussion

To assess and interpret respondents' perceptions of the study variables, a statistical criterion for the seven-point Likert scale was established. The scale range was calculated by subtracting the minimum score from the maximum ($7 - 1 = 6$). The scale interval length was then determined by dividing the range by the number of categories ($6 \div 7 = 0.857$). Subsequently, the category boundaries were defined by adding the interval length to the lowest score, establishing the upper limit of each category. The resulting seven evaluation categories, along with their numerical ranges, are presented in Table 6a.

Table 6a: Evaluation categories for the seven-point Likert scale.

Category (label)	Mean (M) range
Very low	1.000 – 1.857
Low	1.858 – 2.714
Below average	2.715 – 3.571
Neutral	3.572 – 4.428
Above average	4.429 – 5.285
High	5.286 – 6.143
Very high	6.144 – 7.000

Throughout the results and conclusions, the terms "above average" and "high" are used in accordance with the numerical categories defined in Table 6a (above average: $M = 4.429\text{--}5.285$; high: $M = 5.286\text{--}6.143$).

Furthermore, drawing on Hair et al. (2022) and Ringle and Sarstedt (2016), the relative importance of each variable was calculated using the following normalization formula:

$$\text{Relative Importance} = \frac{\text{Scale Score} - \text{Minimum Score}}{\text{Maximum Score} - \text{Minimum Score}}$$

Results Related to Research Question 1: What is the current state of digital transformation in education at Yemeni universities?

Table 6b: Descriptive Analysis of the Current State of Digital Transformation in Education at Yemeni Universities ($N = 882$).

Dimension	Rank	M	SD	Relative Importance	Evaluation
Digital Administration	1	5.19	1.06	69.9%	Above average
Digital Education	3	4.97	1.09	66.1%	Above average
Digital Infrastructure	2	5.14	1.18	68.9%	Above average
Overall average	—	5.10	—	68.3%	Above average

Note. Relative importance = $(M - 1) \div (7 - 1) \times 100$. $N = 882$. Evaluation is based on the seven-level classification of the Likert scale.

1. Digital Administration

The results showed that digital administration was the highest-scoring dimension from the respondents' perspective, with a mean of 5.19. This indicates an above average level and reflects a relatively positive perception among university leaders regarding their institutions' efforts to adopt e-administration practices.

These findings align with several indicators derived from documentary and field data through data triangulation. Most notably, the surveyed universities have made tangible progress in automating student services. Many universities provide their e-services through mobile applications and student portals. Furthermore, universities' annual reports documented varying levels of achievement in automating administrative and financial processes, commitment to training staff to work with electronic systems, and investments in digital infrastructure, including computers and network expansion across university colleges and facilities.

However, despite these positive indicators, most automation efforts observed in the universities remain limited to digitizing administrative procedures and student services. They do not extend to re-engineering processes or developing organizational structures in line with the requirements of institutional transformation toward integrated digital administration.

2. Digital Education

Digital education ranked third among the study dimensions, with a mean of 4.97 and a relative importance of 66.1%. This reflects a relatively positive perception among university leaders regarding e-learning policies. This finding is supported by several points drawn from secondary and field sources. Most notably, universities have shown growing interest in adopting e-learning in the aftermath of the COVID-19 pandemic. Furthermore, most surveyed universities prioritize e-learning to create a competitive advantage that enhances their marketing capabilities. Additionally, most universities possess electronic portals and mobile applications that provide a variety of educational services.

Nevertheless, the findings of documentary and field surveys also revealed a limited orientation toward adopting electronic courses. They also revealed a clear gap between the notable growth in Yemeni universities' digital presence through their websites and social media platforms, on the one hand, and the extent to which these channels are utilized for academic communication between students and faculty members, on the other. In fact, universities use these platforms almost exclusively for promotional and marketing purposes.

3. Digital Infrastructure

Digital infrastructure ranked second, with a mean of 5.14. This indicates an above average level and reflects Yemeni universities' commitment to improving their digital infrastructure within available resources.

Based on university annual reports and field observations, several indicators confirm that the surveyed Yemeni universities are making noticeable efforts to modernize their digital infrastructure. Specifically, 26 universities (78.8% of the 33 surveyed universities) utilize one or more advanced, scalable databases, including Oracle, SQL Server, and MySQL. Universities also prioritize equipping classrooms with e-learning technologies, such as smart screens and projectors and, to a lesser extent, interactive boards and desktop or laptop computers.

However, the secondary sources revealed a notable discrepancy between respondents' perceptions and the actual availability of e-libraries. A gap exists between the limited technologies currently employed, such as archiving and e-lending systems, books in PDF, and a number of internet-connected computers, and the essential components of e-libraries, namely e-content, e-services, and technical infrastructure.

In light of these findings, the first research question can be answered. The level of digital transformation in education at Yemeni universities is above average (per Table 6a), with an overall relative importance of 68.3%. This indicates that, despite significant challenges, particularly financial constraints, universities demonstrate a clear institutional orientation toward digitalization and leverage technological advancements to improve administrative efficiency and educational programs.

Results Related to Research Question 2: What is the level of availability of e-governance practices in Yemeni universities?

Table 7: Analysis of E-Governance Practices at Yemeni Universities ($N = 882$).

Dimension	Rank	M	SD	Relative Importance	Evaluation
Strategic planning	1	5.54	0.97	75.7%	High
E-participation	6	4.92	1.18	65.4%	Above average
E-transparency and disclosure	7	4.68	1.29	61.3%	Above average
E-accountability	5	4.93	1.16	65.6%	Above average
Autonomy	3	5.26	1.18	71.1%	Above average
Rule of law	4	5.19	1.03	69.8%	Above average
Technical standards and requirements	2	5.27	0.99	71.1%	Above average
Overall average	—	5.11	—	68.5%	Above average

Note. Relative importance = $(M - 1) \div (7 - 1) \times 100$. $N = 882$. Evaluation is based on the seven-level classification of the Likert scale.

1. Strategic Planning

The findings showed that strategic planning was the highest-scoring dimension from the respondents' perspective, with a high rating (per Table 6a) and a mean of 5.54. These estimates align with indicators from secondary sources. Specifically, 25 universities (75.8%) report valid strategic plans, and 30 universities (90.9%) publish their strategic directions in their publications or electronically on their websites or social media platforms. Furthermore, a review of the surveyed universities' strategic directions revealed that most of them adopt governance principles at varying levels. The descending order was as follows: participation, rule of law, transparency and disclosure, and accountability, followed by autonomy to a limited degree. Other governance principles were not addressed in this study.

2. E-Participation

E-participation ranked sixth among the e-governance dimensions, with a mean of 4.92, indicating an above average level. These assessments are supported by the existence of regulatory frameworks governing the participation of academic and administrative leaders in policymaking and decision-making. They are also supported by the documentation of actual practices in the surveyed universities, including the development of policies, strategic plans, and educational curricula through universities' temporary committees and permanent councils.

However, a clear divergence emerged between respondents' perceptions and the actual practices of digital and interactive participation. A survey of university websites and social media platforms showed that only four universities (12.1%) provide dedicated pages or windows for performance and service evaluation, while only five (15.2%) offer electronic submission of suggestions and opinions.

3. E-Transparency and Disclosure

E-transparency and disclosure recorded the lowest mean (4.68), although it remained within the above average range. This suggests that its practices are the weakest and require the most improvement from the respondents' perspective. In the same context, documentary and field data corroborate the limited transparency and disclosure practices in Yemeni universities. Only 3 universities publish annual reports online. Moreover, despite the existence of regulations governing appointments and promotions at public and private universities, only 9 universities make these regulations available in print or electronic form. In most universities, these regulations remain restricted to senior leadership and relevant departments.

4. E-Accountability

E-accountability ranked fifth, with a mean of 4.93, within an above average level. These results are supported by many documentary and field indicators. Most notably, the surveyed universities have activated review and evaluation practices by providing organizational units for internal audit and external review and by enhancing the activities of development and quality assurance centers related to measurement and evaluation. This is reinforced by the availability of regulations and rules governing staff rights and duties, performance monitoring and evaluation, and disciplinary procedures, whether under the Yemeni Universities Law No. 18 of 1995, the Private Universities Law No. 13 of 2005, or the regulatory bylaws derived from them. However, documentary and field indicators revealed a deficiency in digitizing

accountability mechanisms. Specifically, there is a lack of codified policies governing the use of university electronic systems and internet access, as well as permissions and sanctions for violations.

5. Autonomy

Autonomy recorded a mean of 5.26, indicating an above average level. Authority over staff appointments, educational policies, and research priorities represents the most prominent manifestation of autonomy from the perspective of university leaders. While these powers are supported by the universities' legal frameworks, autonomy in appointments is partially constrained by government approvals from the Ministries of Higher Education, Finance, and Civil Service. Furthermore, educational and research policies remain subject to the oversight and directives of the Supreme Council of Universities, pursuant to Article 7 of the Yemeni Universities Law No. 18 of 1995 and Article 18 of the Private Universities Law No. 13 of 2005.

Despite legal provisions supporting the financial and administrative autonomy of universities, the indicator of university independence in managing financial resources received the lowest rating from the respondents. This can be attributed to many restrictions, including interventions by the Ministry of Finance through its representatives at universities and governmental directives mandating tuition fee reductions and adherence to dollar exchange rates set by the Central Bank of Yemen.

6. Rule of Law

Respondents' assessments of rule of law practices in Yemeni universities showed a relatively positive trend, with a mean of 5.19, indicating an above average level. These responses are supported by several indicators derived from the analytical review of the legislative framework of Yemeni universities. Notably, organizational structures, titles of supervisory positions, and responsibilities are consistent with universities laws and executive regulations. Furthermore, Yemeni university legislation is multifaceted and comprehensive, as it is based on clear objectives and covers core academic and administrative matters. However, notable gaps exist in the laws' ability to keep pace with emerging issues in the university environment, such as governance, digital work patterns, and e-learning.

Although numerous decisions by the Ministry of Higher Education relating to the enforcement of rule of law practices were documented, including regulating and addressing violations, verifying compliance with requirements for establishing new colleges and academic

programs, these efforts remain insufficient. The Ministry also falls short in promoting universities' autonomy, a primary duty under Article 4 of the Ministry's Executive Regulation No. 173 of 2004. In addition, it fails to monitor private universities' compliance with the requirement to appoint at least 30% of faculty members as full-time staff in each academic department. It also falls short in obliging a number of universities to fulfill their physical and human infrastructure requirements, as stipulated by Article 62 of the Private Universities Law No. 13 of 2005.

7. Technical Standards and Requirements

This dimension ranked second among the e-governance dimensions, with a mean of 5.27, indicating an above average level. This reflects a relatively positive perception among respondents of their universities' technical capabilities. These assessments are supported by the annual reports of 26 universities, representing 78.8% of the surveyed universities, about the use of electronic systems that operate through one or more advanced, secure, and scalable databases. Furthermore, 24 universities reported implementing automation and networking projects with varying levels of completion. Despite these positive indicators, documentary and field data revealed a significant gap in cybersecurity policies for universities' systems and websites. Most universities rely on built-in security features and make limited use of antivirus software. This gap may be attributed to respondents' bias or their lack of awareness of the actual technical indicators in their universities.

Accordingly, the second research question can be answered. E-governance practices are available in Yemeni universities at a relative importance of 68.5%, with an overall mean of 5.11, indicating an above average level. Despite structural, financial, and regulatory constraints, this indicates noticeable progress in adopting governance principles within a digital context. It reflects a gradual institutional shift toward adopting e-governance practices, supported by Yemeni universities' long-standing efforts to strengthen governance frameworks over the past two decades.

Main Hypothesis Testing

To examine the main hypothesis and address the primary research question regarding the role of e-governance in digital transformation in education, a structural model was developed using AMOS (see Figure 6).

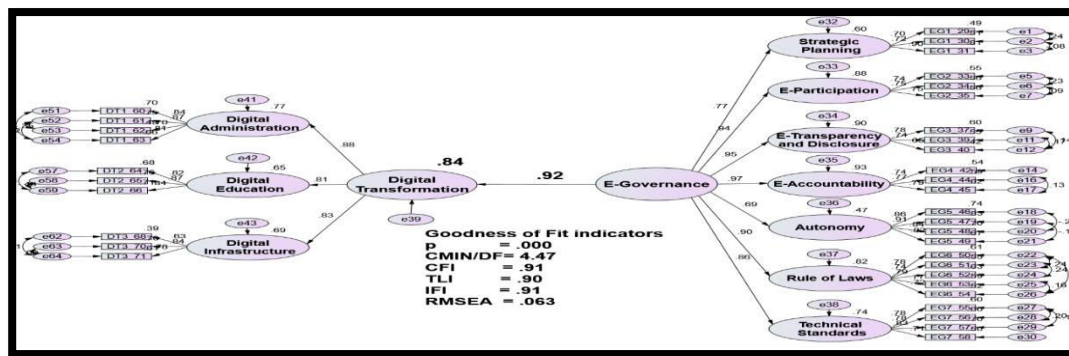


Figure 6. The Structural Model of the Role of E-Governance in Digital Transformation in Education.

Figure 6 and the results presented in Table 8 indicate that the coefficient of determination (R^2) was 0.84. This suggests that e-governance explains 84% of the variance in digital transformation in education at Yemeni universities, reflecting the predictive quality of the model. The critical ratio ($CR = 15.589$) exceeded the threshold of 1.96, indicating statistical significance. The standardized regression coefficient ($\beta = 0.92$) demonstrates a strong positive effect of e-governance on digital transformation in education. Furthermore, the bootstrapping test, based on 5,000 samples, provided additional support for these findings. The 95% confidence interval (CI) [0.882, 0.947] did not include zero, with $p < .001$.

Table 8: Results of the Main Hypothesis Test Using Path Analysis and Bootstrapping (5,000 Samples).

Path	β	SE	CR	p	95% CI (bootstrapped)	p (bootstrapped)	Decision
E-governance → Digital transformation in education	0.92	0.11	15.589	< .001	[0.882, 0.947]	< .001	Accepted

Note. β = standardized path coefficient; SE = standard error; CR = critical ratio; CI = confidence interval. $R^2 = 0.84$.

Accordingly, the main hypothesis is supported. This confirms that e-governance, with its seven dimensions, has a statistically significant role in achieving digital transformation in education at Yemeni universities.

Sub-Hypotheses Testing

To assess the contribution of each e-governance dimension to digital transformation in education, path analysis was conducted using AMOS (see Figure 7 and Table 9).

Table 9: Results of the Sub-Hypothesis Tests Using Path Analysis and Bootstrapping (5,000 Samples).

Path	β	SE	CR	p	95% CI (bootstrap)	p (bootstrap)	Decision
Strategic planning → Digital transformation in education	0.07	0.031	3.800	.005	[0.012, 0.156]	.017	Accepted
E-participation → Digital transformation in education	0.13	0.030	4.006	< .001	[0.052, 0.200]	.002	Accepted
E-transparency and disclosure → Digital transformation in education	0.08	0.028	2.468	.014	[0.003, 0.156]	.042	Accepted
E-accountability → Digital transformation in education	0.18	0.034	5.023	< .001	[0.084, 0.275]	< .001	Accepted
Autonomy → Digital transformation in education	0.12	0.024	4.612	< .001	[0.061, 0.178]	.001	Accepted
Rule of law → Digital transformation in education	0.04	0.036	1.232	.218	[-0.034, 0.121]	.279	Rejected
Technical standards and requirements → Digital transformation in education	0.47	0.036	14.592	< .001	[0.390, 0.545]	< .001	Accepted

Note. β = standardized path coefficient; SE = standard error; CR = critical ratio; CI = confidence interval. $R^2 = 0.85$.

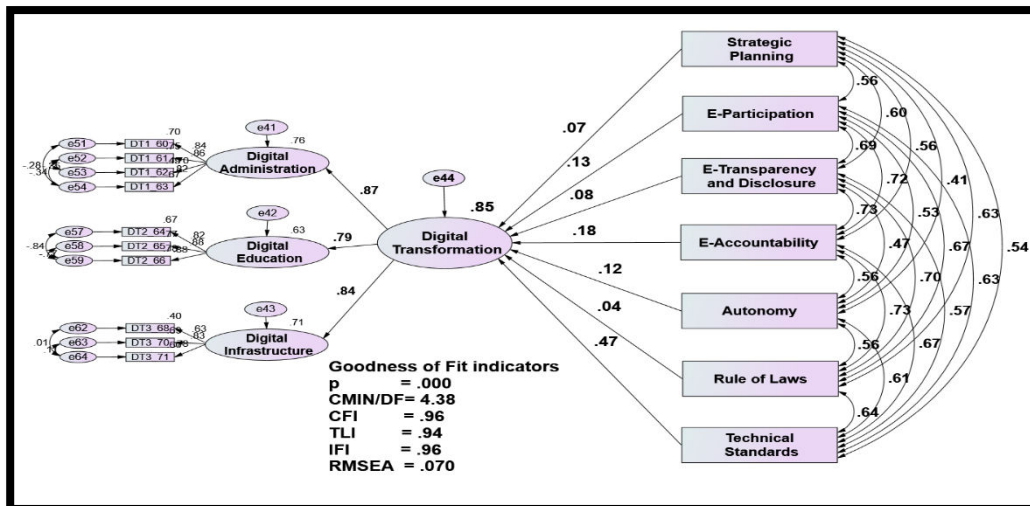


Figure 7: The Structural Model of the Role of E-Governance Dimensions in Digital Transformation in Education.

Table 9 and Figure 7 indicate that the e-governance dimensions explain 85% of the variance in digital transformation in education ($R^2 = 0.85$).

H1.1 (Strategic Planning): The results indicate a positive and statistically significant effect of strategic planning on the dependent variable ($\beta = 0.07$). Although modest in magnitude, this effect reflects a valuable contribution within the structural model. The critical ratio (CR = 3.800) exceeded the threshold, with $p = .005$. Furthermore, the bootstrapping results supported this effect, as the 95% CI [0.012, 0.156] did not include zero. Accordingly, the first sub-hypothesis is supported.

H1.2 (E-Participation): The results show a positive effect of e-participation on digital transformation in education ($\beta = 0.13$, CR = 4.006, $p < .001$), indicating support for this hypothesis. The bootstrapping CI [0.052, 0.200] did not include zero, confirming the significance of the effect. Therefore, the second sub-hypothesis is supported.

H1.3 (E-Transparency and Disclosure): The results show a positive effect of e-transparency and disclosure on digital transformation in education ($\beta = 0.08$, CR = 2.468, $p = .014$), confirming support for the third hypothesis. Moreover, the bootstrapping CI [0.003, 0.156] did not include zero, further confirming the significance of the effect. Thus, the third sub-hypothesis is supported.

H1.4 (E-Accountability): E-accountability demonstrates a significant positive effect on digital transformation in education ($\beta = 0.18$, CR = 5.023, $p < .001$). Similarly, the bootstrapping CI [0.084, 0.275] did not

include zero, confirming the significance of the effect. Accordingly, the fourth sub-hypothesis is supported.

H1.5 (Autonomy): The results show a positive effect of autonomy on digital transformation in education ($\beta = 0.12$, CR = 4.612, $p < .001$). Similarly, the bootstrapping CI [0.061, 0.178] did not include zero, confirming the significance of the effect. Therefore, the fifth sub-hypothesis is supported.

H1.6 (Rule of Law): The rule of law dimension did not show a statistically significant effect on the dependent variable ($\beta = 0.04$, $p = .218$, CR = 1.232). The critical ratio was below the acceptable threshold of 1.96. This confirms that the sixth hypothesis is not supported. Additionally, the bootstrapping results showed that the 95% CI [-0.034, 0.121] included zero, with $p = .279$. Accordingly, the sixth sub-hypothesis is rejected.

H1.7 (Technical Standards and Requirements): The technical standards and requirements dimension demonstrates a significant positive effect on digital transformation in education ($\beta = 0.47$, CR = 14.592, $p < .001$). Moreover, the bootstrapping CI [0.390, 0.545] did not include zero, supporting the validity of the seventh sub-hypothesis. It is therefore accepted.

Overall, the findings provide strong evidence supporting the significant role of e-governance in driving digital transformation in education at Yemeni universities. These results align with previous findings. Al-Abdi and Al-Soudi (2024) emphasized the importance of IT governance in enhancing Yemeni universities' responsiveness to accelerating digital transformation. Similarly, Iman (2023) concluded that digital governance supports the implementation and success of digital transformation. Hamni and Toubi (2020) highlighted the importance of IT governance as a key driver of digital transformation success. Zahra (2025) demonstrated that the absence of a structured e-governance framework hinders the success and sustainability of digital transformation efforts.

At the dimensional level, the results confirm that six of the seven sub-hypotheses were supported. The structural model demonstrated high explanatory power ($R^2 = 0.85$). This indicates that the e-governance dimensions collectively explain a significant portion of the variance in digital transformation outcomes at Yemeni universities. These results reflect the consistency and effectiveness of the proposed model. They also emphasize the importance of implementing e-governance dimensions as an integrated framework for successful digitalization.

The results reveal that technical standards and requirements were the most influential factor ($\beta = 0.47$), underscoring the critical importance of technological infrastructure and the currency and integration of electronic systems. Although this dimension overlaps conceptually with the digital-infrastructure component of digital transformation, the discriminant-validity tests ($HTMT \leq 0.90$) confirmed that the two constructs are empirically distinct. To further guard against inflated estimates from construct overlap, the structural model was re-estimated with these two dimensions collapsed into a single factor; the substantive conclusions remained unchanged ($\beta = 0.88$, $R^2 = 0.81$).

In contrast, the rule of law did not show a statistically significant effect on digital transformation ($\beta = 0.04$, $p = 0.218$). This finding may reflect the outdated, pre-digital legal frameworks governing Yemeni higher education, combined with their centralized and inconsistently enforced application, which, as the documentary analysis showed, has not yet addressed governance, digital work patterns, or e-learning. It may also stem from a level-of-analysis mismatch, as rule-of-law practices operate mainly at the institutional or national level, whereas digital transformation was measured at the university-operational level. Finally, it indicates that Yemeni universities currently prioritize digital infrastructure and operational readiness over the longer-term legislative and regulatory reforms needed to institutionalize digital governance.

Conclusions

The study findings indicate that the overall level of digital transformation in education at Yemeni universities is above average (per Table 6a), as perceived by the surveyed university leaders. Similarly, its key dimensions, digital administration, digital education, and digital infrastructure, were all rated "above average" (per Table 6a). Although these levels remain modest relative to the desired level, they reflect a positive trend in Yemeni universities toward digitalization in recent years. Furthermore, the results reveal that e-governance practices in Yemeni universities are generally above average. Most e-governance dimensions, e-participation, e-transparency and disclosure, e-accountability, autonomy, rule of law, and technical standards and requirements, were rated above average, with the exception of strategic planning, which received a high rating (per Table 6a).

Moreover, the study concluded that e-governance had a strong and statistically significant positive role in achieving digital transformation in education at Yemeni universities. This highlights its role as a key

driver of effective digital initiatives. The e-governance dimensions were ranked by the magnitude of their path coefficients as follows: technical standards and requirements, e-accountability, e-participation, autonomy, e-transparency and disclosure, and strategic planning. However, the rule of law dimension did not show a statistically significant effect. This suggests that existing regulatory frameworks may not yet be sufficiently aligned with the procedures and practices of the digital environment, and may reflect a level-of-analysis gap whereby rule-of-law practices operate mainly at the institutional and national level rather than at the university-operational level measured in this study.

It is also worth noting that the data triangulation used in this study revealed a gap between some respondents' assessments and the objective indicators extracted from documentary and field analysis of the actual conditions at the surveyed universities. This may be attributed to limitations in measurement and evaluation practices, which lead to discrepancies between leaders' perceptions and actual conditions. It may also reflect a tendency toward positive self-evaluation, as leaders tend to provide more optimistic assessments of institutional realities due to personal, organizational, or political considerations, particularly in environments experiencing crises and institutional pressures.

Recommendations

1. The leadership of Yemeni universities should demonstrate a strong commitment to embedding governance principles and values as an institutional culture rather than a formal requirement. They should also move toward institutionalizing e-governance as a strategic framework for guiding and regulating digital transformation initiatives.
2. The government, represented by the Ministry of Higher Education and the Ministry of Communication and Information Technology, should adopt a comprehensive national strategy for digital transformation. This strategy should prioritize digital literacy for citizens in general and for students at all educational levels in particular, to enable effective participation in the digital economy.
3. The leadership of Yemeni universities should align their educational systems with global trends in digital higher education through a strategic perspective that complements traditional learning and ensures that academic outputs meet societal needs and labor market demands.

4. The leadership of Yemeni universities should strengthen their focus on developing digital infrastructure as the cornerstone of successful e-education and e-administration, through an executive program aligned with each university's strategy.
5. Yemeni universities should establish an institutional environment that promotes e-transparency and disclosure by developing legal frameworks and internal policies that ensure the regular publication of academic and financial data, and by fostering a culture that supports access to and sharing of information.
6. The Ministry of Higher Education should strengthen its efforts to support and empower the Information Technology Center in Higher Education to enhance its role in automating administrative and educational processes across universities.
7. The Ministry of Higher Education, in collaboration with the leadership of Yemeni universities, should initiate reforms to update the legislative framework for higher education and incorporate modern concepts, primarily governance principles and e-governance practices.
8. Finally, the study recommends that future research avoid relying solely on questionnaires as the primary data collection instrument. It highlights the importance of adopting a data triangulation strategy, as demonstrated in this study, for its significant contribution to the accuracy of the findings and to providing a comprehensive understanding of institutional realities within the study population.

Limitations and Future Research

The findings of this study should be interpreted in light of several considerations. Although the study targeted all 33 public and private universities in Sana'a, the capital of Yemen, thereby providing comprehensive coverage of the country's largest and most diverse higher education environment, caution should be exercised when generalizing the findings to universities in other Yemeni governorates. Future research is therefore encouraged to extend the geographical scope of the investigation to include Yemeni universities in other major governorates. This would allow broader comparisons and enhance the validity and generalizability of the study's results.

From a methodological perspective, the study relied primarily on self-reported perceptual measures collected through a questionnaire. Although this approach is widely adopted in organizational and higher

education research, such measures are inherently subject to limitations, including perceptual bias and variations in respondents' institutional knowledge. Recognizing these limitations, the present study sought to mitigate their potential influence by systematically integrating documentary and field-based evidence through a data triangulation strategy. Rather than serving solely as a means of validating questionnaire findings, this approach substantially enhanced the contextual interpretation and overall credibility of the empirical results. Nevertheless, future studies are encouraged to adopt mixed-method or qualitative research designs incorporating interviews, focus groups, documentary analysis, and direct observations. Such designs would provide richer contextual insights and further examine the perception–reality gaps identified in the present study.

This study focused on supervisory leaders (administrative and academic) as its sample because they are the organizational actors most involved in institutional governance, strategic decision-making, and policy implementation. However, future studies may benefit from incorporating the perspectives of other university stakeholders, including faculty members, students, and administrative personnel.

Finally, building on the present findings, future research may investigate alternative conceptual models by examining digital transformation as an influential factor in enhancing institutional capabilities, with e-governance serving as a mediating mechanism.

Declarations

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article. The research was conducted independently, and no financial or personal relationships influenced the study design, data collection, analysis, interpretation, or manuscript preparation.

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Contribution statement

Hesham Ali Al-Sanabani: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Visualization. **Abdulkhaleq H. Tawwaf:** Conceptualization, Methodology, Formal analysis, Validation, Writing – review & editing, Supervision, Project administration. Both authors have read and agreed to the published version of the manuscript.

Ethical approval statement

In line with the recommendations of the American Psychological Association (APA, 2020) and the institutional ethical standards for research involving human participants, the study was reviewed and approved by the Research Ethics Committee of the Center of Business Administration, Sana'a University (approval No. 4, dated 22/5/2025), and informed consent was obtained from all respondents. Participants were provided with comprehensive information about the study's purpose and procedures, assured of data privacy and anonymity, and informed that participation was voluntary with the right to withdraw at any time.

Declaration of AI use

The authors used artificial intelligence tools solely for language editing and refinement. The authors take full responsibility for the accuracy, originality, and integrity of the content of this manuscript.

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Data availability statement

The data supporting the findings of this study are available upon request.

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