THE IMPACT OF DIGITAL TRANSFORMATION ON ORGANIZATIONAL RESILIENCE: THE MEDIATING ROLE OF ORGANIZATIONAL INNOVATION IN IRAQI BUSINESS ORGANIZATIONS

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Abstract
This paper intends to assess the influence of DT on OR in business organizations within Iraq and also examine the role played by OI as a mediator in this effect. With the theoretical framework of the dynamic capability theory, the current research adopted a descriptive-analytical survey approach. Data necessary for the research was collected through a survey having 40 items which involved 312 managers comprising general managers and their deputies, department managers and unit/section managers of 32 organizations in three categories namely private banks, telecom operators and manufacturing/trading organizations. Tests for reliability, convergent validity, discriminant validity, common method variance, and independence of measures were conducted. The hypotheses were tested using simple regression, multiple regression, bootstrapped mediation analysis (PROCESS model 4; 5,000 samples), and sector-specific differences using one-way ANOVA and Duncan's multiple range test. The relationships between DT and OR ($\beta = 0.584$, $p < 0.001$) and between DT and OI ($\beta = 0.620$, $p < 0.001$), as well as between OI and OR ($\beta = 0.410$, $p < 0.001$), were positive and significant. The indirect influence of DT on OR through OI was positive and significant ($a \times b = 0.254$, 95% CI [0.181, 0.332]).Digital culture had the highest bivariate correlation with both OI and OR even though it had the lowest amount of practice. The banking industry and telecommunications were far more advanced in terms of their digital transformation and innovations when compared to the industrial and commercial sectors, while resilience levels between these two sectors differed less. All main findings were consistent in a conservative sensitivity analysis regarding nesting of managers in organizations. Practical Implications: Managers of Iraq should view DT as capability building exercise instead of technology acquisition program, paying more emphasis on digital culture and administration, and improving the anticipation phase of resilience. The paper is among the very few multi-sector empirical examinations of the mechanism DT → OI → OR within Iraq, an emerging fragile country prone to crisis that has been understudied in the literature on resilience.

1. Introduction

Business organizations function in an environment which is volatile, uncertain, complex and ambiguous. Issues such as pandemics, cyber threats, foreign exchange risks, and technological change have shown that resilience has shifted from a secondary concern to a primary organizational capability. This ability, termed Organizational Resilience, is described as the capacity of an organization to predict threats, adapt, and cope well with any event that may take place (Duchek, 2020). Interest in the concept have risen steadily within management studies, despite continued disagreements on how to define and measure the concept (Hillmann & Guenther, 2021; Chen et al., 2021).

On the other hand, digital transformation has emerged as one of the major factors affecting organizations. Digital transformation is a new way of generating value through its creation, distribution, and capture by leveraging information and communications technology, distinguishing

it from other waves of computerization (Vial, 2019; Verhoef et al., 2021). A growing body of international literature shows that companies that have reached digital maturity have a greater ability to detect environmental changes, operate amid disruption, and reconfigure themselves (Zhang et al., 2021; Awad & Martín-Rojas, 2024). However, the process by which digital transformation builds resilience remains poorly understood. Technology is not the solution to making an organization resilient; it must be transformed into innovative practices, processes, and services.

This is especially true in the Iraqi case, which has been experiencing security, political, budgetary, and health crises for two decades now, and has recently taken definite steps towards becoming a digital economy through Digital Payment Regulation No. 2 of the Central Bank of Iraq of 2024 (UNDP, 2024). The Iraqi studies that have been carried out in national academic journals demonstrate the increasing impact of digitalization in banking operations (Khudair, 2024), the performance of private banks both from a strategic perspective and financial perspective (Baries & Jabr, 2024; AL-Sabawy, 2023; A. A. Salih et al., 2024), the success of projects within telecommunications organizations (Ahmed & Mahdi, 2024), and government organization performance (Jassim & Algazali, 2024). Previous Iraqi research has examined capabilities in crises, such as the effect of digital leadership on crisis management efficiency (Hassan & Hamed, 2022) and the association between organizational ambidexterity and agility (W. Z. Salih et al., 2024). The closest work from Iraq found through the Iraqi Academic Scientific Journals (IASJ) website and Google Scholar focused on using electronic management to increase organizational flexibility in a selection of colleges at the University of Mosul (Khalil & Al-Sheikh, 2019). However, flexibility is conceptually more limited than resilience, as the latter involves not only recovery but also predicting the crisis and learning from it (Duchek, 2020). Furthermore, most studies have mainly analyzed performance-based outcomes, focused on one industry, and treated digital-to-outcome relationships as direct. To the authors' knowledge, no research in Iraq has investigated the role of organizational innovation as an intermediary between digital transformation and organizational resilience.

According to the dynamic capability theory (Teece et al., 1997; Warner & Wäger, 2019), this paper fills this research gap by proposing and validating a mediation model in which digital transformation (consisting of four dimensions: Digitalization of the infrastructure, skills, culture, and processes influences organizational resilience (anticipation, coping, and adaptation) via organizational innovation (administrative, process, and service innovation). The paper makes three significant contributions to the existing literature. The first contribution is that the literature on digital transformation-resilience is applied to a fragile developing country. The second contribution is recognizing organizational innovation as a partial mediator and estimating its share of total mediation. Lastly, the study decomposes the constructs into dimensions and conducts a sectoral analysis.

The remainder of this paper will be organized in the following manner. The second section will cover the research methodology, while the third section will be devoted to the theoretical framework and the hypotheses. The fourth section will cover the results of the analysis.

1.1. Research Problem

Observations and preliminary interviews conducted by the researchers with some managers in the sampled companies showed a clear contradiction. First, these companies have made significant investments in information technology, including core banking systems, mobile applications, electronic payments, and enterprise resource planning systems, especially after the rise of national e-payments. On the other hand, many still react to crises: they don’t track early-warning indicators, apply temporary fixes during disruptions, and never learn from experience. That implies that even the investment in digital has not necessarily made them resilient, and there is another layer involved in this process, that of being able to convert these digital assets into processes and services.

Thus, the research problem is formulated as the following major research question: To what extent does digital transformation influence the resilience of Iraqi business organizations, and does organizational innovation mediate this relationship? Several sub-questions follow from this. The first concerns how far digital transformation, organizational innovation, and organizational resilience have developed in the organizations under study. The study then asks whether digital transformation, including each of its components, significantly influences organizational resilience,

and whether digital transformation and all its dimensions significantly affect organizational innovation. It also examines whether organizational innovation and its dimensions significantly affect the role of digital transformation in enhancing organizational resilience and the mediating role of organizational innovation in the relationship between digital transformation and organizational resilience. Lastly, the study will examine whether there is a significant difference among the three variables across the three industries mentioned above.

1.2. Significance of the Study

Theoretical significance. This research combines three constructs, which have mainly been studied in pairs, and examines the relation between digital transformation and resilience using dynamic capabilities theory. Through investigating organizational innovation as a mediating variable, it shifts from investigating the importance of digital transformation to explaining how it makes a difference. In addition, it addresses the need for empirical work in non-Western, crisis-prone environments also aids in the limited number of Iraqi studies regarding the link between digitalization and crisis management. (Hassan & Hamed, 2022; Jassim & Algazali, 2024).

Practical significance. The chosen sectors (private banking, telecommunications, and industry/commerce) play a vital role in diversifying Iraq's economy and the success of its digital economy initiative. Recognizing the digital factors that contribute most to innovation and resilience helps decision-makers allocate resources and gives regulatory bodies such as the Central Bank of Iraq and the Communications and Media Commission guidance on developing digital readiness and continuity requirements.

1.3. Research Objectives

In light of this research problem, the study pursues seven objectives. First, it diagnoses the levels Regarding digital transformation, organizational innovation, and organizational resilience, including their respective dimensions, in the organizations being studied. Second, it measures the direct impact of digital transformation and its dimensions on the resilience of organizations. Third, it measures the impact of digital transformation and its dimensions on organizational innovation. Fourth, it evaluates the impact of organizational innovation and its dimensions on organizational resilience. Fifth, it determines the extent to which organizational innovation acts as a mediator between digital transformation and organizational resilience. Sixth, it reveals any statistical differences in the variables among the three industries – banking, telecommunication, and industry/ commerce. Thirdly, it offers evidence-based guidelines for fostering digital resilience among managers and policy makers.

1.4. Theoretical Framework and Hypothesis Development

1.4.1. Digital Transformation

Many definitions of digital transformation have been provided, ranging from technological to strategic. For example, Vial (2019), after reviewing 282 articles, defines digital transformation as a process in which a firm is enhanced by substantial changes to its attributes, driven by interactions among information, computing, communication, and connectivity technologies. Verhoef et al. (2021) identify three stages of digital transformation, namely, digitization, digitalization, and digital transformation, and note that the third one implies the change within the whole company that brings about a new business model. Therefore, digital transformation is not the adoption of technology but the strategic reconfiguration of the organization's resources, processes, and culture (Warner & Wäger, 2019).

Multidimensional definitions have been used by researchers studying Iraq. Digital transformation of the Iraqi public sector has been defined as the integration of technical and organizational demands by Jassim and Algazali (2024), while the effect of digital transformation in altering the structure and processes of private banks has been studied by Baries and Jabr (2024). Similarly, Ahmed and Mahdi (2024) have investigated digital transformation strategies in telecommunication firms. In line with this literature, the current study defines digital transformation in four dimensions: (1) digital infrastructure, (1) the infrastructure of hardware, software, networks, databases, and cybersecurity that enable operations; (2) digital competencies, which refer to the

abilities of the employees and managers to apply digital capabilities to their job functions and decision making; (3) digital culture, which means shared values that encourage experimentation, technological and data openness, along with senior management support; and (4) digitization of processes, the degree to which important processes and customer services are done digitally and in real-time.

1.4.2. Organizational Innovation

Organizational innovation can be described as creating or adopting something new within the adopting organization (Damanpour, 1991). The Oslo Manual further expands the definition of organizational innovation to define business innovation as "a new or improved product or production process which is significantly different from the products or processes of the business unit itself and which has been introduced on the market or into use" (OECD/Eurostat, 2018). As indicated in the meta-analysis by Damanpour (1991), factors and consequences of innovation differ by type; therefore, a multidimensional measurement is needed. In the 2018 version of the Oslo Manual, the number of innovation types changed from four to two: product innovation and business process innovation (OECD/Eurostat, 2018). Service innovation thus constitutes product innovation in the Oslo definition, while administrative innovation and process innovation constitute the two forms of business process innovation; the term "organizational innovation" is employed here in the broader context of the three innovations in contrast to its narrower Oslo 2005 definition of organizational innovation as a new method of organization.

Three dimensions are used in this study, which are equally applicable to both organizations that provide intensive services and those that are industry-oriented: (1) administrative innovation, which refers to the incorporation of new management processes, structure, and organization; (2) process innovation, which entails introducing new or improved methods aimed at reducing costs and improving the quality of the product or service provided by the firm; and (3) service innovation, which is concerned with the development of new or improved services, typically based on customers' feedback. In Iraq, Khalil and Hamid (2021) discovered that Kaizen practice is a significant antecedent of organizational innovation in the General Company for Electrical and Electronic Industries.

1.4.3. Organizational Resilience

The idea of resilience was first coined in ecology and engineering and has since been translated into psychology and management. From the perspective of organization studies, resilience can be defined in terms of outcome (bouncing back from a crisis), process, or as a capability (Hillmann & Guenther, 2021; Kantur & İşeri-Say, 2012). According to Lengnick-Hall et al. (2011), it is the capacity of an organization to respond to disruptive surprises by absorbing and developing appropriate responses. In line with a systematic review, Duchek (2020) suggests that the conceptual framework be based on capability and involve three consecutive phases: anticipation (observation of the environment and identifying critical events to respond effectively to any unforeseen situations), coping (acknowledging the problem and devising a solution), and adaptation (reviewing and learning from the crisis).

The theoretical perspective of Duchek (2020) was chosen to be applied in this research for three main reasons, including the fact that it considers resilience as a set of skills that can be controlled, it includes all stages of a crisis from the period before, during, and after it, and it is in line with the dynamic capability approach that has been used to analyze the importance of digital transformation. Iraqi researchers have also correlated crisis management capabilities with digital behaviors; Hassan & Hamed (2022) concluded that digital leadership improves crisis management capabilities through strategic vigilance.

1.4.4. Theoretical Foundation: Dynamic Capabilities

The resource-based view suggests that a firm achieves competitive advantage through resources which are valuable, rare, inimitable, and non-substitutable (Barney, 1991). The dynamic capability's view addresses the problem of static resources losing value in turbulent conditions by describing dynamic capabilities as a firm's ability to integrate, build, and reconfigure internal and external competencies to meet the challenges of a changing environment (Teece et al., 1997). Such competencies are frequently broken down into recognizing opportunities and threats, capitalizing on them, and reconfiguring the resource base (Teece, 2007).

Digital transformation, according to Warner and Wäger (2019), has its own dynamic capabilities that digital transformation processes require and develop. This approach serves as a theoretical basis for the presented model, as digital transformation provides technology and human resources, along with digital sensing capabilities (data, monitoring systems, and digital channels). Organizational innovation is the process of exploiting and reconfiguring these assets into new practices, processes, and services, while organizational resilience is the emergent result of an organization's ability to sense threats and reconfigure itself in response. In other words, this theory suggests that digital transformation impacts organizational resilience directly and indirectly via innovation.

1.4.5. Previous Studies and Research Gap

International studies: Zhang et al. (2021) find that digital transformation increases organizational resilience. The authors use PLS-SEM and fsQCA to analyze the relationships between digital transformation and resilience among Chinese enterprises. According to Awad and Martín-Rojas (2024), in an analysis of 259 SMEs in Andalusia, Spain, digital transformation positively correlates with organizational learning and innovation, which in turn correlate with organizational resilience. This is the closest antecedent to the current research framework, although the researchers used different regression models, did not analyze indirect relationships, and did not establish a direct relationship between digital transformation and resilience. Chen et al. (2021) pointed out the multidimensionality of resilience and the capabilities involved in its formation, and Kantur and İşeri-Say (2015) developed one of the first measurement scales of organizational resilience.

Iraqi studies. Research findings from Iraqi and neighboring publications offer useful but scattered insights. For example, the research carried out by Hassan and Hamed (2022) on the Journal of Economics and Administrative Sciences indicated that digital leadership influences the effectiveness of crisis management through strategic vigilance in 160 leaders working at the University of Baghdad. Similarly, Khalil & Hamid (2021) demonstrated the importance of continuous improvement in innovation at an Iraqi state-owned industrial firm. Baries & Jabr (2024), in the Iraqi Journal of Administrative Sciences, found that digital transformation technology significantly influenced the strategic performance of six private banks in Karbala. The findings presented by Ahmed and Mahdi (2024) and Khudair (2024), published in Al-Ghary Journal of Economic and Administrative Sciences, indicated that digital transformation strategy leads to project success in Iraqi telecoms firms and that digitization has enhanced the business performance of Iraqi banks, whereas Jassim and Algazali (2024) found a positive relationship between digital transformation and high performance in Iraqi government organizations. According to A. A. Salih et al. (2024), digital transformation increases the effect of entrepreneurial orientation on the performance of private banks in Baghdad. Additionally, according to AL-Sabawy (2023), there is a positive correlation between digital transformation and financial performance in the Iraqi banking industry. Finally, W. Z. Salih et al. (2024) in the Tikrit Journal of Administrative and Economic Sciences demonstrated that organizational ambidexterity improves organizational agility among Iraqi universities.

Research gap. From the literature review, there are four gaps that exist. For instance, in the case of Iraq, the focus of research related to digitalization has been more on the outcome, and the concept of resilience, which is very important in a crisis prone environment, has not been researched empirically. The only study on resilience was about flexibility of organizations (Khalil & Al-Sheikh, 2019). The second point is that the majority of the research studies examined direct effects, and the mechanism of how digital investments translate into organizational performance was not investigated. The third point is that although the closest international study (Awad & Martín-Rojas, 2024) to the current research is also an empirical one, it did not include an investigation of an indirect effect in the model. Fourthly, all the Iraqi studies used a limited sample from a single sector or firm. This study aims to cover these research gaps through employing mediation and using a large sample.

1.4.6. Hypothesis Development

Digital transformation and organizational resilience. Information technology helps improve the efficiency of all the three stages of resilience. Information integration systems, real-time data, and dashboard analytics help the organization develop better situational awareness capabilities and receive early warnings (anticipation); cloud computing, remote work applications and digital communication means help keep key processes running in case of any disruptions (coping); And digitalized information about past crises helps learning from crises and reconfiguration of resources

(adaptation) (Zhang et al., 2021; Awad & Martín-Rojas, 2024). In the case of Iraq, digitalized banks and telecommunications companies will still be able to offer their services to clients via mobile and digital means even under curfews and lockdowns as occurred during the COVID-19 pandemic. Therefore, H1 and sub-hypotheses H1a-H1d were suggested.

Digital transformation and organizational innovation. Digital infrastructure reduces the cost of experimentation, digital competence allows workers to identify new ways to use data and technology, digital culture encourages experimentation and accepts failure, and digitalization creates data that shows how things can be improved. Dynamic capabilities theory sees these digital tools and routines as the basic ingredients for exploiting and transforming activities (Warner & Wäger, 2019). Iraq-specific research on the effect of digital transformation strategies on project success in telecommunication companies (Ahmed & Mahdi, 2024) and on strategic performance in banks (Baries & Jabr, 2024) aligns with this. Therefore, H2 and H2a-H2d were postulated.

Organizational innovation and organizational resilience. A creative organization will always have an array of alternative routines, structures, and services it can leverage when the current one is disrupted. Innovations in administration generate flexible structures and decision-making processes, innovations in processes generate redundancy and efficiency, and innovations in services will enable the organization to switch to new customer requirements even amidst a crisis (Duchek, 2020; Lengnick-Hall et al., 2011). Consequently, H3 and H3a-c were formulated.

The mediating role of organizational innovation. In sum, these discussions imply that digital transformation enhances resilience through innovation. Digital assets alone do not build resilience; they become useful only when transformed into new organizational systems, procedures, and offerings that can be used in emergencies. Awad and Martín-Rojas (2024) offer an innovative perspective on how digital transformation can affect organizational resilience. Therefore, H4 was formulated: organizational innovation mediates the relationship between digital transformation and organizational resilience.

2. Method

2.1. Hypothetical Research Model

Based on the research problem, objectives, and theoretical framework, a conceptual framework has been developed (Figure 1). Digital transformation serves as the independent variable (X) and consists of four dimensions: digital infrastructure, digital skills, digital culture, and process digitalization. Organizational innovation is the mediator (M) and has three dimensions: administrative, process, and service innovation (Damanpour, 1991; OECD/Eurostat, 2018). Organizational resilience is the dependent variable (Y), with three capability phases: anticipation, coping and adaptation proposed by Duchek (2020Path a refers to the effect of X on M; path b refers to the effect of M on Y controlling for X; path c refers to the total effect of X on Y; and path c' refers to the effect of X on Y controlling for M.

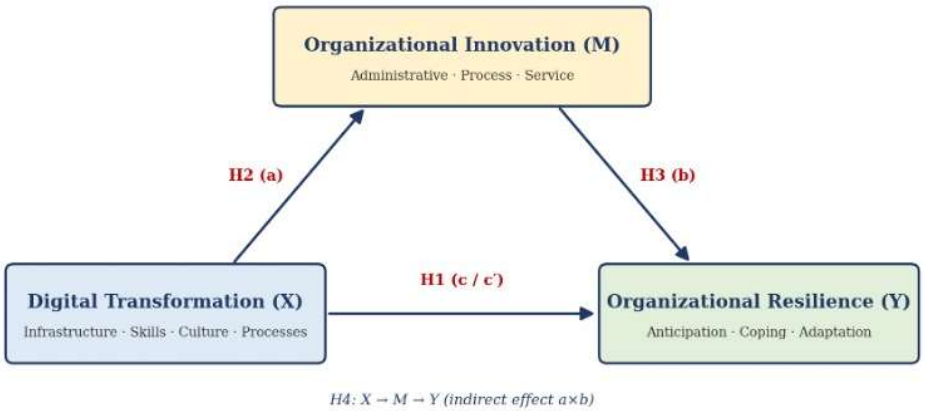


Figure 1. Hypothetical research model

2.2. Research Hypotheses

The following hypotheses, developed in Section 3.6, were formulated:

H1: The digital transformation creates a statistically significant effect on the resilience of organizations.

H1a–H1d: The digital infrastructure (H1a), digital skills (H1b), digital culture (H1c) and digital processes (H1d) have a statistically significant positive impact On organizational resilience.

H2: Digital transformation has a statistically significant positive impact on organizational innovation.

H2a-H2d: Digital infrastructure (H2a), digital competencies (H2b), digital culture (H2c), and process digitalization (H2d) all have statistically very important contributions to organizational innovation.

H3: Organizational innovation has a significant positive impact on organizational resilience.

H3a-H3c: Administrative innovation (H3a), process innovation (H3b), and service innovation (H3c) individually have considerable importance in increasing organizational resilience.

H4: Organizational innovation is a mediating variable in the relationship between digital transformation and organizational resilience.

2.3. Population and Sample

The study population comprises the management personnel of three different levels (general managers and their assistants, departmental managers, and section/unit heads) from a total of 32 organizations that conduct their business operations in Iraq: 14 private banks, 6 telecommunications firms (which include mobile and internet service providers), and 12 industries and commercial firms. These areas were selected for the fact that they vary in terms of the level of digitalization and susceptibility to crises, thereby providing a useful basis for cross-sector analysis. The managerial level was selected because only they have the necessary understanding of the company's operations to assess digital, innovation, and resilience strategies. The population size was 1,450 managers. [Note: add the sources of population data]

We determined the minimum required sample size based on the table suggested by Krejcie & Morgan (1970), which estimates 302-306 respondents for a population of 1,450 at a 95% A confidence level and 5% margin of error. Nonresponse was accounted for by distributing 350 questionnaires using proportionate stratified random sampling, with each sector as a stratum. In total, 312 valid questionnaires were retained (Table 1), exceeding the required number and providing more than 7.8 observations per item compared with the required ratio of five observations per item (Hair et al., 2019). As the table from Krejcie & Morgan (1970) was developed to estimate population proportion and not for regression analysis, Additionally, an a priori power analysis was performed using G*Power 3.1 (Faul et al., 2009): in order to detect a medium effect size ($f^2 = 0.15$) with two predictors, given alpha = 0.05 and power = 0.95, 107 participants are needed, hence the sample size is sufficiently large.

As shown in Table 2, the sample comprised more males (68.6%), which aligns with the under-representation of females in managerial roles in Iraqi business firms. This sample comprised only people with a bachelor's degree.43.6% had a postgraduate degree, and 81.4% had five years or more of experience. The biggest proportion of the sample comprised heads of sections and units (61.2%), while department managers constituted 31.1%, and general managers/deputies made up 7.7%. This distribution suggests that respondents had the requisite educational background and work experience to make an informed evaluation of the research variables.

Table 1. Sample distribution by sector

Sector	Organizations	Population (N)	Valid questionnaires (n)	Percentage
Private banks	14	595	128	41.0%
Telecommunications companies	6	446	96	30.8%
Industrial and commercial firms	12	409	88	28.2%
Total	32	1,450	312	100%

Table 2. Respondents' characteristics

Characteristic	Category	Frequency	%
Gender	Male	214	68.6
	Female	98	31.4
Education	Bachelor's	176	56.4
	Higher diploma	41	13.1
	Master's	69	22.1
	PhD	26	8.3
Job position	General manager / deputy	24	7.7
	Department manager	97	31.1
	Head of section / unit	191	61.2
Experience	Less than 5 years	58	18.6
	5–10 years	107	34.3
	11–15 years	84	26.9
	More than 15 years	63	20.2

2.4. Measurement Instrument

The primary data collection method was a structured questionnaire, supported by personal interviews and field observation. The questionnaire had four components, which were: (a) respondent demographics and work-related information; (b) digital transformation, 16 questions in four dimensions; (c) organizational innovation, 12 questions in three dimensions; and (d) organizational resilience, comprising 12 items under three dimensions. As no Arabic version was found to exist measuring the aforementioned constructs, items were constructed based on existing conceptual frameworks such as those by Vial (2019), Verhoef et al. (2021), and Warner & Wäger (2019) related to digital transformation; organizational innovation was adapted using Damanpour's (1991) model and the Oslo Manual (OECD/Eurostat, 2018). Organizational resilience was defined using the items proposed by Duchek (2020). Where possible, they were also taken from items used in earlier studies by Zhang et al. (2021), Awad & Martín-Rojas (2024), Kantur & İşeri-Say (2015), and Jassim & Algazali (2024). Participants rated the statements on a five-point scale of Likert, ranging from 1 (strongly disagree) to 5 (strongly agree).

Since the items and conceptual definitions were in English language, translation and re-translation were carried out from English to Arabic language and vice versa by two bilingual translators. (Brislin, 1970). The face and content validity test was done using nine experts from the discipline of Business Administration and Information Systems from the universities of Iraq. The items that were 80 percent agreed upon by all the respondents were used, while the other items were modified. The testing of the survey instrument was done using 30 managers who were not part of the major sample. The results are provided in Table 3 below.

Table 3. Summary of questionnaire distribution and instrument validation

Indicator	Value
Questionnaires distributed	350
Questionnaires returned	323
Excluded (incomplete / patterned)	11
Valid for analysis	312
Response rate (valid / distributed)	89.1%
Expert judges	9
Judges' agreement criterion	≥ 80%
Pilot sample (excluded from main sample)	30

From Table 3 above, of the 350 questionnaires distributed, 323 were returned; 11 were disregarded for being incomplete or showing straight-line responding patterns, leaving 312 usable questionnaires. The reason for a high response rate of 89.1% is the follow-up by the researcher of organizations involved.

2.5. Statistical Methods

The data analyses were conducted using IBM SPSS Statistics (version 26) and PROCESS macro (version 4.2) for SPSS (Hayes, 2022). The data analyses consisted of five steps:

2.5.1. Preliminary diagnostics

The test Harman's Test for Common Method Bias (Podsakoff et al., 2003); measures of skewness and kurtosis to test normality, in which both the values must lie within ±2 (George & Mallery, 2019), as well as the less stringent criteria of |3| and |10|, respectively, as per Kline (2016) in case of severe deviations from normal distribution; and coefficient of intraclass correlation ICC(1) and ICC(2) with the design effect to measure non-independence as a result of nesting of individuals within organizations (Bliese, 2000; LeBreton & Senter, 2008; Muthén & Satorra, 1995). A more conservative sensitivity analysis using design effect and effective sample size (Kish, 1965) was also conducted to examine if the findings hold in light of the nesting of individuals.

2.5.2. Measurement quality

Kaiser-Meyer-Olkin index (KMO) and test for sphericity by Bartlett's (Kaiser, 1974); exploratory factor analysis using construct variables and principal axis factoring method with oblique (Promax) rotation because there was assumed a correlation between dimensions of the construct (Fabrigar et al., 1999; Costello & Osborne, 2005); Measurement Model for Confirmatory Analysis using AMOS version [ ] to derive standardized loadings; Cronbach's alpha, Composite Reliability (CR) and Average Variance Extracted (AVE) (Fornell & Larcker, 1981; Hair et al., 2019); and discriminant validity based on Fornell-Larcker criterion and HTMT (Henseler et al., 2015).

2.5.3. Descriptive analysis

Average, standard deviation and relative importance (RI = average ÷ 5 × 100). Classification was based on class interval size of Very Low (1.00-1.80), Low (1.81-2.60), Moderate (2.61-3.40), High (3.41-4.20) and Very High (4.21-5.00): 0.80

2.5.4. Hypothesis testing

Pearson correlations; simple and multiple regression analysis for the effect, with the significance of the increase in the explained variance tested using the F-change test; and percentile bootstrapping, with 5,000 iterations (PROCESS Model 4) for the indirect effect, along with the Sobel test and variance accounted for (VAF) as the means of indicating the kind of mediation involved (Zhao et al., 2010; Hair et al., 2017). The hypothesis was confirmed if $p < 0.05$ or if the 95% bootstrap confidence interval did not include zero. Because each sub-hypothesis was tested using simple regression analysis, which does not account for dimension interdependence, dimension strength was compared descriptively. Since eleven sub-hypotheses were examined, a Holm (1979) sequential adjustment procedure was utilized; the bootstrap confidence interval for the indirect effect was validated against a Monte Carlo confidence interval (Preacher & Selig, 2012), and the mediated incremental effect was represented by Cohen's f^2 (Cohen, 1988).

2.5.5. Group differences

One-way analysis of variance (ANOVA), with a preliminary test of Levene's test for homogeneity of variance prior to post-hoc comparisons, followed by Duncan's multiple range test (Duncan, 1955) and, due to the lack of familywise error rate control by the latter test, Tukey–Kramer HSD test for unequal group size (Kramer, 1956); effect sizes in η^2.

3. Results and Discussion

Findings from preliminary diagnostics, analysis of measurement model, descriptive statistics, correlation analysis, hypothesis testing, and sectoral comparison are all presented in this part.

3.1. Common Method Bias and Normality

Since all variables were gathered using self-reporting from the same respondents in one single occasion, common method variance (CMV) was a possible issue. Some procedural solutions have been adopted while collecting data; namely, respondents' anonymity was assured, items on the three variables were separated in different sections, and items were stated clearly and polished in the expert review and pilot testing process (Podsakoff et al., 2003). Using statistical techniques, Harman's single-factor test was carried out by inputting all 40 items into an unrotated principal component analysis (Table 4).

Table 4. Harman's single-factor test (Total Variance Explained)

Component	Initial eigenvalue	% of variance	Cumulative %
1	12.72	31.80	31.80
2	2.46	6.15	37.95
3	1.93	4.83	42.78
4	1.41	3.53	46.31
5	1.18	2.95	49.26
6	1.12	2.80	52.06
7	1.06	2.65	54.71
8	1.02	2.55	57.26
Single factor extracted (unrotated)	12.72	31.80	31.80
Threshold		< 50%	

From Table 4Moreover, it can be observed that there were eight factors which had eigenvalues more than one while the unrotated first factor accounted only 31.80% of the variance which was far below the 50% standard. This clearly shows that there was no dominating factor causing covariance among the factors. It has been explained by Podsakoff et al. (2003) that Harman's test is a necessary condition only and as it doesn't show any problem, along with other criteria described above, this indicates that CMB is not an issue with validity of the study.

We used Kock's (2015) full collinearity diagnostic, an additional statistical tool, to examine the construct scores. Running a regression of each construct on the other two based on the correlations provided in Table 10 results in variance inflation factors of 1.82 for digital transformation, 1.93 for organizational innovation and 1.80 for organizational resilience, all of which are below the critical value of 3.3. This constitutes additional, but not decisive, evidence for the lack of distortion of the associations due to common method variance.

Because the 312 managers were nested within 32 organizations, their responses may be non-independent, as some were taken from the same organization. Intraclass correlations were calculated using one-way ANOVA with the organization as the grouping variable (Table 5).

Table 5. Intraclass correlation coefficients by organization (32 groups)

Variable	MSB	MSW	F (31, 280)	ICC (1)	ICC (2)	Design effect
Digital transformation	1.126	0.435	2.59***	0.14	0.61	2.22
Organizational innovation	1.188	0.510	2.33***	0.12	0.57	2.05
Organizational resilience	0.937	0.425	2.21***	0.11	0.55	1.96

The ICC (1) values varied from 0.11 to 0.14, suggesting that 11-14% of the variance for the three variables was explained by organizational group membership, and the F-statistics were significant. ICC (2) values (0.55-0.61) reveal moderate reliability of the organizational means (Bliese, 2000; LeBreton & Senter, 2008). As the constructs were defined and measured from the viewpoint of managersThe analysis was done at an individual level. The design effect, using the formula $1 + (\bar{k} - 1) \times \text{ICC}(1)$, where $\bar{k} = 312/32 = 9.75$, for digital transformation (2.22) and organizational innovation (2.05), marginally exceed the threshold value of 2 proposed by Muthén & Satorra (1995), thus indicating the possibility that the standard errors may be under-estimated. This could be regarded as a limitation, though even when all the standard errors were inflated taking into account the square root of the maximum value of the design effect (1.49), then the lowest t statistic presented below (6.11) will decrease to around 4.1, which still would be statistically significant (at $p < 0.001$); thus, our conclusions would not change (refer to the sensitivity analysis in Table 14a).

3.2. Measurement Model: Reliability and Validity

We initially assessed the appropriateness for factor analysis of the data and the dimensions of each construct using the Kaiser-Meyer-Olkin measure of sampling adequacy, Bartlett's test of sphericity, and exploratory factor analysis (principal axis factor analysis with Promax rotation) individually conducted on each construct (Table 6).

Table 6. KMO, Bartlett's test, and exploratory factor analysis by construct

Construct	Items	KMO	Bartlett's χ^2	df	Sig.	Factors (eigenvalue > 1)	Variance explained	Loadings range
Digital transformation	16	0.912	2,814.37	120	< 0.001	4	64.8%	0.54 – 0.83
Organizational innovation	12	0.894	1,962.45	66	< 0.001	3	61.9%	0.52 – 0.81
Organizational resilience	12	0.901	2,103.82	66	< 0.001	3	63.4%	0.53 – 0.82

Values of KMO (0.894-0.912) are within the range of "meritorious" (0.80-0.89) to "marvelous" (0.90 and higher) as defined by Kaiser (1974), while Bartlett's tests proved to be significant ($p<0.001$), hence guaranteeing the factorability of the correlation matrix. In case of EFA, four factors for digital transformation were revealed, as well as three factors for both organizational innovation and organizational resilience, which fully coincided with the theoretical dimensions. These factors accounted for 61.9-64.8% of variance, exceeding 60% threshold traditionally set in the social sciences, and all loadings were above 0.50 without cross-loading issues (Hair et al., 2019; Costello & Osborne, 2005).

Table 7. Reliability and convergent validity

Construct	Items	Loadings range	Cronbach's α	CR	AVE
Digital transformation	16	0.66 – 0.84	0.91	0.96	0.58
Organizational innovation	12	0.64 – 0.83	0.89	0.94	0.56
Organizational resilience	12	0.65 – 0.82	0.90	0.94	0.57

Table 7 shows that the standard loadings of the measurement model were between 0.64 and 0.84, which is greater than the 0.60 limit. The Cronbach's alpha (0.89-0.91) and composite reliability (0.94-0.96) were both significantly higher than 0.70.The high CR is mainly due to the number of items for the constructs (12-16), since CR increases automatically with the number of indicators; however, values higher than 0.95 may indicate item redundancy (Hair et al., 2017) that should be confirmed or excluded by looking at the inter-item correlation matrix. The AVE values (0.56-0.58) were above 0.50, confirming convergent validity because each construct accounts for over fifty percent of the variance in the items of (Fornell & Larcker, 1981; Hair et al., 2019).

Table 8. Discriminant validity

Construct	DT	OI	OR	HTMT
Digital transformation (DT)	0.76			DT–OI: 0.68
Organizational innovation (OI)	0.620	0.75		DT–OR: 0.64
Organizational resilience (OR)	0.584	0.615	0.75	OI–OR: 0.67

Discriminant validity was tested using two criteria (Table 8). In terms of the Fornell-Larcker Criteria; The Square Root of Average Variance Extracted of Each Construct (Diagonal Elements: 0.75-0.76) is higher than their Correlation with Other Constructs (0.584 - 0.620). Additionally, all the HTMT Ratios (0.64-0.68) are lower than the threshold limit of 0.85 (Henseler et al., 2015). It means that the Constructs Differ Empirically, Hence a Suitable Measurement Model for Testing Hypotheses.

3.3. Descriptive Statistics

Normality. All skewness (−0.71 to −0.28) and kurtosis (−0.46 to 0.83) values in Table 9 fall within ±2 (George & Mallery, 2019) and are well below |3| and |10|, which Kline (2016) associates with severe non-normality. This is evidence of the normal distribution of the data set. Negative skewness shows a slight preference among respondents toward the statements.

Digital transformation. The overall mean score of digital transformation was 3.62 (SD = 0.71; RI = 72.4%), denoting a high degree of maturity. Digital infrastructure emerged as the top scorer (M = 3.81; RI = 76.2%), followed by process digitalization (M = 3.74), digital skills (M = 3.54), and finally, digital culture (M = 3.39; RI = 67.8%), which barely meets the minimum requirement of being classified as high and hence is placed in the moderate category. This suggests that the organizations

surveyed are at an advanced stage in the "hard" elements of transformation rather than the "soft" ones.

Organizational innovation. Innovation within the organization reached a relatively high level (M = 3.48; SD = 0.76; RI = 69.6%). Process innovation had the highest score (M = 3.57), followed by service innovation (M = 3.46) and administrative innovation (M = 3.41), which was the lowest in the high-level range. Therefore, innovation is mainly implemented at the operational process level, and management innovation lags.

Organizational resilience. Organizational resilience was also found at a very high level (M = 3.55; SD = 0.69; RI = 71.0%). Coping was the first factor (M = 3.61), while adaptation was the second (M = 3.60); however, anticipation was the least developed (M = 3.44). Although all three factors are high and the differences are slight, the trend suggests that organizations cope better with crises after they occur than they detect and prepare for them in advance, which makes sense given the constant occurrence of unexpected crises.

Table 9. Descriptive statistics, skewness, and kurtosis of variables and dimensions

Variable / Dimension	Mean	SD	RI	Level	Rank	Skew.	Kurt.
Digital infrastructure	3.81	0.78	76.2%	High	1	−0.71	0.83
Digital skills	3.54	0.82	70.8%	High	3	−0.44	0.12
Digital culture	3.39	0.88	67.8%	Moderate	4	−0.28	−0.46
Digitalization of processes	3.74	0.80	74.8%	High	2	−0.63	0.57
Digital transformation	3.62	0.71	72.4%	High		−0.52	0.41
Administrative innovation	3.41	0.85	68.2%	High	3	−0.31	−0.22
Process innovation	3.57	0.81	71.4%	High	1	−0.58	0.48
Service innovation	3.46	0.84	69.2%	High	2	−0.39	0.05
Organizational innovation	3.48	0.76	69.6%	High		−0.47	0.29
Anticipation	3.44	0.83	68.8%	High	3	−0.34	−0.18
Coping	3.61	0.77	72.2%	High	1	−0.66	0.71
Adaptation	3.60	0.79	72.0%	High	2	−0.49	0.26
Organizational resilience	3.55	0.69	71.0%	High		−0.55	0.37

3.4. Correlation Analysis

Table 10. Pearson correlation matrix

Variable	Mean	SD	1	2	3
1. Digital transformation	3.62	0.71	1		
2. Organizational innovation	3.48	0.76	0.620**	1	
3. Organizational resilience	3.55	0.69	0.584**	0.615**	1

As is shown in Table 10, there there are positive and statistically significant correlations ($p<0.01$) among all three variables. The highest correlation was that between digital transformation and innovation (r=0.620), folllowed by organizational innovation and organizational resilience (r=0.615), and digital transformation and organizational resilience (r=0.584). These correlations indicate the presence of a relationship between variables, and because none is above 0.85 and the variance inflation factor of the two predictors in Model 3 is only 1.62 (that is, $1 \div (1 - 0.620^2)$), there is no threat of multicollinearity (Kline, 2016; Hair et al., 2019). The mediator is correlated with both the independent and dependent variables.

3.5. Hypothesis Testing

The hypotheses were tested using three regression equations for paths a, c, and c'/b in the mediation model (Table 11). The sub-hypotheses were tested using simple regression equations for each dimension against the respective variable (Table 12). The standardized coefficients are presented below.

Table 11. Regression results for direct and total effects

Path	β	SE	t	p	R^2	F
Model 1: DT → OI (a)	0.620	0.045	13.91	< 0.001	0.384	193.5
Model 2: DT → OR (total effect, c)	0.584	0.046	12.67	< 0.001	0.341	160.5
Model 3: DT → OR (direct effect, c′)	0.330	0.054	6.11	< 0.001	0.445	123.7
Model 3: OI → OR (b)	0.410	0.054	7.59	< 0.001		

Testing H1In the second model presented in Table 11, digital transformation has been found to have significantly and positively affects organizational resilience (β = 0.584, t = 12.67, p < 0.001). The above model also shows significance (F = 160.5, p < 0.001), where the digital transformation explains 34.1% of the variance in organizational resilience (R^2 = 0.341). Therefore, H1 is supported.

Testing H2. According to Model 1, digital transformation positively affects innovation within organizations (β = 0.620, t = 13.91, p < 0.001), accounting for 38.4% of its variance (R^2 = 0.384; F = 193.5). Hypothesis 2 is thus confirmed.

Testing H3. Model 3, after accounting for digital transformation, showed a strong positive correlation between organizational innovation and organizational resilience (β = 0.410, t = 7.59, p < 0.001). By adding organizational innovation, the variance accounted for in resilience rose from 34.1% to 44.5% (ΔR^2 = 0.104; F-change (1, 309) = 57.9, p < 0.001; f^2 = 0.19, implying a moderate effect size, based on Cohen, 1988). The model remained significant (F = 123.7, p < 0.001). As such, H3 was confirmed. Nonetheless, the impact of digital transformation decreased from 0.584 (c) to 0.330 (c').Table 12. Simple regression results for the sub-hypotheses

Table 12. Simple regression results for the sub-hypotheses

Hypothesis	Path	β	SE	t	R^2	F (1, 310)	Decision
H1a	Digital infrastructure → OR	0.47	0.050	9.38	0.221	87.9	Supported
H1b	Digital skills → OR	0.52	0.049	10.72	0.270	114.9	Supported
H1c	Digital culture → OR	0.55	0.047	11.60	0.303	134.4	Supported
H1d	Digitalization of processes → OR	0.49	0.050	9.90	0.240	97.9	Supported
H2a	Digital infrastructure → OI	0.50	0.049	10.17	0.250	103.3	Supported
H2b	Digital skills → OI	0.55	0.047	11.60	0.303	134.4	Supported
H2c	Digital culture → OI	0.58	0.046	12.54	0.336	157.1	Supported
H2d	Digitalization of processes → OI	0.53	0.048	11.00	0.281	121.1	Supported
H3a	Administrative innovation → OR	0.55	0.047	11.60	0.303	134.4	Supported
H3b	Process innovation → OR	0.51	0.049	10.44	0.260	109.0	Supported
H3c	Service innovation → OR	0.53	0.048	11.00	0.281	121.1	Supported

Sub-hypotheses H1a–H1d. The impact of all four dimensions of digital transformation is positively strong for organizational resilience (see Table 12). The relationship between digital culture and resilience is the is the most important (β = 0.55; R^2 = 0.303), while digital skills (β = 0.52; R^2 = 0.270), process digitalization (β = 0.49; R^2 = 0.240), and digital infrastructure (β = 0.47; R^2 = 0.221) follow in that order.

Sub-hypotheses H2a–H2d. All four Dimensions have a profound impact on organizational innovation in the following order of preference: digital culture (β = 0.58; R^2 = 0.336), digital competencies (β = 0.55; R^2 = 0.303), process digitalization (β = 0.53; R^2 = 0.281), and digital infrastructure (β = 0.50; R^2 = 0.250). H2a-H2d are confirmed.

Sub-hypotheses H3a-H3c. Each type of innovation in the organization has a very significant effect on organizational resilience. Administrative innovation has the strongest effect on organizational resilience (β=0.55; R^2=0.303), followed by service innovation (β=0.53; R^2=0.281), and finally process innovation (β=0.51; R^2=0.260). H3a-H3c are supported. Since we have created eleven sub-hypotheses, Holm (1979) correction method has been used for all sub-hypotheses; as the lowest t-value is 9.38 (p<0.001, way below the Holm's strictest value of 0.0045), all sub-hypotheses are supported.

This raises an interesting issue when comparing the obtained values with descriptive statistics, as the lowest level of practice across dimensions is most strongly associated with digital culture and administrative innovation, whereas the highest level of practice is least strongly associated with digital infrastructure and process innovation. The finding requires cautious interpretation since the regression coefficients are purely bivariate and do not consider the overlaps between the dimensions, and the difference between the dimensions is relatively low (0.47–0.58). Yet the finding indicates more room to develop resilience by focusing on the human and management dimensions.

3.6. Testing H4 (mediation)

The hypotheses H4 were empirically analyzed by means of PROCESS Macro (Model 4) with 5,000 bootstraps and 95% Confidence Interval. Based on the Zhao et al. (2010) study, mediation occurs when an indirect effect (a x b) is significantly present despite the significance of the total effect, and its kind can be determined through the significance of the direct effect (c'). Findings are shown in Table 13 and Figure 2.

Table 13. Bootstrapped mediation analysis (5,000 resamples)

Effect	Estimate	SE / Boot SE	95% LLCI	95% ULCI	Result
Total effect (c)	0.584	0.046	0.494	0.674	Significant
Direct effect (c′)	0.330	0.054	0.224	0.436	Significant
Indirect effect (a × b)	0.254	0.038	0.181	0.332	Significant
Sobel test	z = 6.66				p < 0.001
VAF (indirect / total)	43.5%				Partial mediation

The indirect influence of digital transformation on organizational resilience through organizational innovation proves to be highly positive (a×b = 0.254; Boot SE = 0.038), considering that 95% bootstrap confidence interval [0.181, 0.332] does not include zero value. Nonetheless, the use of Sobel test should be treated as purely comparative because it requires normality assumption. (Hayes, 2022), and it also confirms the hypothesis stated above (z = 6.66, p < 0.001). As both the direct (c′ = 0.330, 95% CI [0.224, 0.436]) and the indirect effects are also significant, and both have the same sign, it indicates complementary mediation (Zhao et al., 2010( ), and this form of mediation is generally termed as partial mediation. According to the VAF measure, 43.5% of the total effect is mediated by organizational innovation, which means that partial mediation takes place (Hair et al., 2017). To serve as a check on the above results, we can compute the Monte Carlo confidence interval using the a and b parameters and their standard errors (200,000 simulations), which equals [0.182, 0.332]. This is almost identical to the confidence interval obtained through bootstrapping and hence supports H4. Since our data are cross-sectional, the findings suggest that there is consistency in terms of the pattern of association expected in the mediation model.

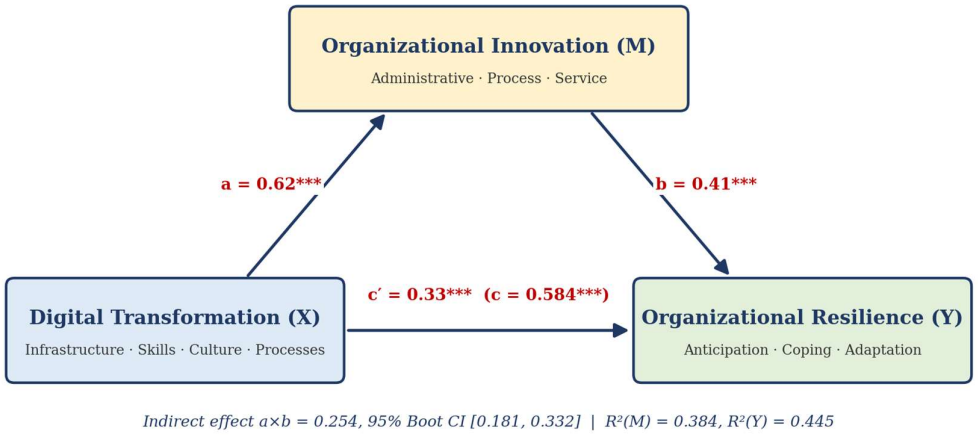


Figure 2. Estimated mediation model (standardized coefficients; *** p < 0.001)

Table 14. Summary of hypothesis testing

Hypothesis	Path	Key statistic	Decision
H1	DT → OR	β = 0.584, p < 0.001	Supported
H2	DT → OI	β = 0.620, p < 0.001	Supported
H3	OI → OR	β = 0.410, p < 0.001	Supported
H1a–H1d	DT dimensions → OR	β = 0.47 – 0.55, all p < 0.001	Supported
H2a–H2d	DT dimensions → OI	β = 0.50 – 0.58, all p < 0.001	Supported
H3a–H3c	OI dimensions → OR	β = 0.51 – 0.55, all p < 0.001	Supported
H4	DT → OI → OR	a×b = 0.254, CI [0.181, 0.332]	Supported (partial mediation)

From Table 14, it is evident that all the major hypotheses and minor hypotheses were supported, and organizational innovation was found to partially mediate effect of digital transformation on organizational resilience.

Resistance to non-independence. As a consequence of possible underestimation of the ordinary standard errors (4.1), a conservative sensitivity analysis was conducted: the standard errors were inflated by multiplying each of divide them by the square root of the largest design effect ($\sqrt{2.22} \approx 1.49$), degrees of freedom were calculated considering the effective sample size ($n_{eff} = 312 \div 2.22 \approx 141$; Kish, 1965), and the indirect effect was re-analyzed using a Monte Carlo interval (Preacher & Selig, 2012). Table 14a shows that the significance of all paths and the indirect effect does not change. This means the hypothesis-testing conclusion remains valid despite managers being nested within organizations. The approximation is conservative since it assumes the largest design effect for all paths.

Table 14a. Sensitivity analysis with design-effect-adjusted standard errors (n_eff ≈ 141)

Path	Estimate	Adjusted SE	95% LL	95% UL	Result
a (DT → OI)	0.620	0.067	0.487	0.753	Significant
b (OI → OR)	0.410	0.080	0.251	0.569	Significant
c (total effect)	0.584	0.069	0.448	0.720	Significant
c′ (direct effect)	0.330	0.080	0.171	0.489	Significant
a × b (Monte Carlo)	0.254	–	0.148	0.373	Significant

3.7. Differences Across Sectors: One-Way ANOVA and Post-Hoc Tests

To address the sixth research question, A one-way analysis of variance was employed for comparing the three sectors, whereas Levene's test was performed for homogeneity of variance, and Duncan's multiple range test was applied for determining homogeneous subsets (Tables 15 and 16).Table 15. One-way ANOVA and Duncan's multiple range test by sector.

Table 15. One-way ANOVA and Duncan's multiple range test by sector

Variable	Banks (n = 128)	Telecom (n = 96)	Industrial & commercial (n = 88)	Levene F (p)	ANOVA F (2, 309)	Sig.
Digital transformation	3.78 a	3.71 a	3.29 b	1.55 (0.214)	14.72	< 0.001
Organizational innovation	3.55 a	3.63 a	3.21 b	1.80 (0.167)	8.34	< 0.001
Organizational resilience	3.66 a	3.58 a	3.36 b	1.20 (0.302)	5.19	0.006

As regards Levene's test, all variables were found to have homogeneity of variance ($p > 0.05$). ANOVA showed significant differences in digital transformation ($F = 14.72$, $p < 0.001$), organizational innovation ($F = 8.34$, $p < 0.001$), and organizational resilience ($F = 5.19$, $p = 0.006$). The outcome of Duncan's test showed that banks and telecommunications had significantly higher means than the industrial and commercial companies in all three variables (same homogeneous subset a), while banks and telecommunications had no significant difference between them. However, banks had the highest levels of digital transformation and resilience (3.78 and 3.66, respectively), while telecommunications had the highest level of innovation (3.63).

Since Duncan's test does not correct for familywise error rate, the post hoc comparison for each of the dependent variables was carried out using the Tukey-Kramer test of unequal sample sizes (Kramer, 1956) based on group means and within-groups mean squares of tables 15 and 16 (critical $q = 3.33$; $df = 309$). As far as digital transformation is concerned, the average difference for banks (0.49, $p < 0.001$) and telecommunications companies (0.42, $p < 0.001$) was larger than the average difference for industrial and commercial companies and for organizational innovation the same trend prevailed (0.34, $p = 0.003$; 0.42($P < 0.001$). In case of organizational resilience, however, the only significant average difference was between banks and industrial/commercial companies (0.30, $p = 0.005$), while no significant difference was noted for the average difference between telecommunications companies and industrial/commercial companies (0.22, $p = 0.075$). No average difference was found to be significant between banks and telecommunications companies (all $p > 0.65$).

Table 16. ANOVA summary

Variable	Source	Sum of squares	df	Mean square	F
Digital transformation	Between groups	13.64	2	6.82	14.72
	Within groups	143.14	309	0.463	
	Total	156.78	311		
Organizational innovation	Between groups	9.20	2	4.60	8.34
	Within groups	170.43	309	0.552	
	Total	179.63	311		
Organizational resilience	Between groups	4.81	2	2.41	5.19
	Within groups	143.26	309	0.464	
	Total	148.07	311		

From Table 16, the effect sizes of the proportion of variance associated with sector affiliation (η^2 = SS between ÷ SS total) amount to 0.087 0.051 for digital transformation, 0.032 for organizational innovation, and 0.037 for organizational resilience. While these variables' sectoral affiliation is statistically significant, their effect sizes are moderate for digital transformation, almost moderate for organizational innovation, and small for organizational resilience based on Cohen's (1988) benchmarks of 0.01, 0.06, and 0.14 respectively, suggesting that the majority of the variance is among managers from the same sectors rather than across different sectors. Moreover, the gap in resilience across sectors is smaller than that in digital transformation, and one possible reason is that industrial and commercial organizations partially depend on non-digital resilience factors.

These comparisons across sectors must also be viewed with care in light of the F-tests that assume independence among the 312 managers when, in reality, they are nested into just 32 organizations (14 banks, 6 telecommunication firms and 12 industrial and commercial firms). Based on the ICC(1)s presented in Table 5, the individual-level analysis will definitely yield estimates of the sector differences that are much more precise than they really are and, therefore, need confirmation at the organizational level (df = 2, 29).

Using the same correction for the design effect as done in Table 14a (F ÷ DEFF, where the denominator degrees of freedom are calculated using the effective sample size) shows that there remain statistically significant differences between sectors with respect to digital transformation (F = 6.63, p = 0.002) and organizational innovation (F = 4.07, p = 0.019), but not organizational resilience (F = 2.65, p = 0.074). This approach is conservative because some variance at the organizational level captured by ICC (1) is attributable to sector; therefore, differences between sectors in resilience should be treated as tentative.

This research aimed to examine how digital transformation strengthens the resilience of Iraqi organizations through organizational structure. The findings supported the hypotheses and led to several conclusions.

First, digital transformation is a critical variable for organizational resilience, accounting for a third of its variance. This finding is in line with international research findings (Zhang et al., 2021) Moreover, it is supported by positive associations between digitalization and resilience (Awad & Martín-Rojas, 2024), and by studies conducted in Iraq on the effects of digitalization on banks and telecoms (Baries & Jabr, 2024; Ahmed & Mahdi, 2024; Khudair, 2024). The innovation of the present research is in demonstrating the importance of digitalization not only as a source of better performance during normal operations but also as a means of maintaining stability and resilience. In line with dynamic capabilities theory, digitalization resources improve sensing capability (data and monitoring systems) and provide technical redundancy through electronic and remote work tools needed when physical operations become impossible.

Second, organizational innovation partially mediated the connection, transmitting 43.5 percent of the total impact. This finding empirically confirms the dynamic capabilities perspective used in the research: digital assets make organizations resilient primarily by being transformed into innovation processes and services (Teece et al., 1997; Warner & Wäger, 2019). This paper confirms Awad and Martín-Rojas (2024), who find a connection between digital transformation and innovation and between innovation and resilience for Spanish SMEs; however, it does so by statistically proving the indirect influence through bootstrapping in a developing, crisis-prone economy. This is also consistent with Iraqi evidence that improvement-oriented practices can promote innovation (Khalil

& Hamid, 2021). The fact that mediation is partial, not total, suggests that other factors may link digitalization to resilience, including organizational learning, digital leadership, and strategic vigilance, the last two of which have proven effective in managing crises within Iraqi organizations (Hassan & Hamed, 2022).

Thirdly, the findings from the dimensional analysis indicated a tendency that could be referred to as the "capability paradox," according to which the two least developed dimensions - digital culture and administrative innovation - demonstrated the greatest associations, while the two most developed ones – digital infrastructure and process innovation – demonstrated the weakest. Even though these differences seem minor and are based on bivariate analysis only, one possible explanation would be the law of diminishing returns, which states that when a certain level of development is already reached, further development requires less and less investment unless it is combined with a culture of experimentation and decision-making based on data and innovations in management. The latter explanation is fully consistent with the assumption of transformation being mainly organizational rather than technological (Vial, 2019; Verhoef et al., 2021).

Fourth, anticipation was the least developed among the three resilience phases; however, all three were highly developed. One possible reason is that two decades of persistent crises in Iraq's security, finance, and healthcare sectors taught local managers to be creative and adapt in times of need, but not to build an environment-scanning system. It is here that digital transformation may contribute uniquely, as data analytics and real-time monitoring tools are inherently anticipatory mechanisms. This aligns with Hassan and Hamed's (2022) focus on strategic vigilance as a way to translate digital competence into crisis management.

Thirdly, banks and telecommunication firms performed better compared to the industrial and commercial firms concerning digitalization and innovation, and the banks also outperformed the latter in terms of resilience, although the distinctions among different sectors with regard to resilience were minimal and susceptible to being adjusted for nesting. The above variations can be explained by greater pressures from the regulating agencies to use digitalization tools in the banking industry (e.g. Digital Payment Regulation No. 2 of 2024 of the Central Bank of Iraq, UNDP, 2024), digitalization character of telecommunications services and greater financial ability of the sectors in question. However, it is clear that the first two sectors are lagging behind and are thus potential candidates for the implementation of digital policy tools, although it needs further investigation.

4. Conclusions

These companies exhibit high levels of digital transformation, innovation, and resilience. Nevertheless, there is an irregularity in the process of their digital transformation: Technology and digital processes have developed quite far, but digital culture is at an intermediate stage. The digital transformation has a significant relationship with organizational resilience because organizations having a high level of digital transformation have the ability to cope with the crisis effectively, but cross-sectional design fails to determine causalityDigital transformation also helps in the innovation of the organization, which makes the organization resilient. It proves the point that innovation is a significant mechanism through which organizations derive the value of digital investments during tough times.Digital transformation indirectly affects organizational resilience through organizational innovation, which is responsible for 43.5% of the effect of digital transformation on organizational resilience, while the rest occurs directly or indirectly through other means. While digital culture and administrative innovation showed to be the strongest correlated factors with resilience, they were also the weakest developed. From among all three stages of resilience, anticipation had the lowest average score, suggesting that these firms tend to be more reactive rather than proactive in their approach to resilience. Lastly, banks and telecommunication firms had substantially higher levels of digitalization and innovation compared to industrial and commercial firms. The differences between firms from different sectors regarding resilience were not very big and significant for the banking sector only. First, companies must focus on digital culture; the leaders of the company should act as role models for their subordinates, create an environment free from punishment for mistakes, and assess the digital conduct of the employees during the performance appraisal and reward processes. Second, organizations need to treat people the same way as systems; any technological acquisition must be complemented with funding for the appropriate training program in technology and data analysis.Third, administrative innovation should be institutionalized through periodic reviews of structures, processes, and incentives, the creation of cross-functional teams, and the maintaining of

the flexible work schedule that worked well during the COVID-19 outbreak. Fourth, organizations should move from reactive to proactive resilience by establishing environmental scanning and early-warning units supported by dashboards and analytics, developing and regularly testing business continuity and crisis management plans, and systematically reviewing past crises for lessons learned. Fifth, digital and innovation strategies should be linked, so that digital initiatives are judged not only by their technical success but also by the innovative practices, processes, and services they generate. Finally, at the policy level, The Ministry of Industry and Mining, the Ministry of Commerce, and the business chambers can provide assistance through programs like discounted digital counseling, cloud computing, and training. The Central Bank of Iraq and the Communications and Media Commission could also incorporate resilience metrics into their regulatory frameworks.

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