JOURNAL OF MANAGEMENT AND BUSINESS SOLUTIONS

Presenting a Model to Explain the Factors Affecting Customers' Loyalty Intention Toward the Online Services of Product-Providing Retail Stores

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ABSTRACT

This study was conducted with the aim of identifying and explaining the key factors influencing customer loyalty toward the services of online product-providing retail stores. The statistical population of the study consisted of 245 active customers of online stores, and based on their actual experience of using these services, the required data were collected through a standardized questionnaire developed in accordance with the study's conceptual model. In the proposed model, variables such as user expectations, system usability, visual attractiveness, user experience, and the level of innovation in service delivery were considered as independent variables, while customer loyalty intention was treated as the dependent variable. The findings derived from data analysis indicated that all research hypotheses were supported, and each of the examined components exerted a significant and positive effect on customer loyalty. These results suggest that customer loyalty in the context of electronic commerce is a multidimensional phenomenon and cannot be attributed to a single factor; rather, it emerges from the interaction of a set of technical, perceptual, and experiential characteristics. Among the independent variables, the usability of online services, with an effect coefficient of 0.76, played the most prominent role in predicting customer loyalty, highlighting the critical importance of simple, comprehensible, and user-oriented design in online environments. Moreover, the results revealed that factors such as the ease of using the website or application, clarity in the organization and presentation of information, the design of visual and logical menus, the speed and quality of responsiveness to users' needs and problems, as well as the presence of strong and reliable security protocols, play a substantial role in shaping users' sense of trust and satisfaction.

Keywords: Loyalty, usage intention, customers, online services, online product-providing retail stores

Introduction

The rapid expansion of digital technologies has fundamentally transformed the structure of service delivery and customer–organization interactions across industries, particularly within online and electronic service environments. The proliferation of e-commerce platforms, mobile banking applications, digital insurance services, and technology-enabled customer relationship systems has reshaped how customers evaluate service quality, perceive value, and develop long-term relational outcomes such as satisfaction, trust, and loyalty. In this context, customer loyalty has emerged as a critical strategic asset for organizations seeking sustainable competitive advantage, profitability, and

Article history:
Received 02 April 2025
Revised 19 May 2025
Accepted 22 May 2025
Published online 01 June 2025

How to cite this article:
Arghavaninobar, M. H. (2025). Presenting a Model to Explain the Factors Affecting Customers' Loyalty Intention Toward the Online Services of Product-Providing Retail Stores. *Journal of Management and Business Solutions, 3*(3), 1-15. https://doi.org/10.61838/jmbs.134

long-term survival in increasingly saturated and competitive digital markets (1, 2). Unlike traditional service settings, online environments introduce unique technological, experiential, and perceptual dimensions that intensify customer expectations and heighten sensitivity to service performance, system reliability, usability, and innovation.

Customer loyalty in digital service contexts is no longer solely driven by transactional satisfaction but rather by a complex interplay of service quality dimensions, technological characteristics, perceived value, and experiential outcomes. Empirical evidence suggests that loyal customers exhibit stronger repurchase intentions, higher resistance to switching, positive electronic word-of-mouth, and greater lifetime value for organizations (3, 4). Consequently, understanding the determinants of loyalty intention has become a central concern for scholars and practitioners in management, marketing, and information systems research. This concern is particularly pronounced in online service ecosystems, where switching costs are relatively low and customer alternatives are abundant.

Service quality remains one of the most extensively studied antecedents of customer loyalty. Classical and contemporary studies consistently demonstrate that perceived service quality positively influences customer satisfaction, trust, and loyalty across diverse sectors, including banking, insurance, and electronic commerce (1, 5, 6). However, digital service environments introduce additional layers of complexity, as service quality is mediated by system functionality, interface design, responsiveness, security, and personalization. As such, researchers have increasingly adopted multidimensional frameworks that integrate both technical and experiential attributes to explain loyalty formation in online contexts.

The growing reliance on mobile and online platforms has intensified scholarly interest in understanding how users perceive service quality and how these perceptions translate into continued usage and loyalty intentions. Studies focusing on mobile banking and mobile payment services emphasize the importance of system quality, information quality, ease of use, and perceived security in shaping trust and continuance intention (7-9). These findings underscore the fact that digital service quality extends beyond traditional interpersonal interactions and is deeply embedded in technological infrastructure and user experience design.

Customer expectations represent a foundational psychological construct in service evaluation and loyalty formation. Expectations shape how customers interpret service encounters and determine the degree to which perceived performance leads to satisfaction or dissatisfaction. In digital service environments, expectations are influenced by prior experiences, technological familiarity, perceived innovativeness, and external information sources such as online reviews and electronic word-of-mouth (4, 10). When services meet or exceed expectations, customers are more likely to develop positive attitudes, trust the service provider, and demonstrate loyalty intentions. Conversely, unmet expectations can rapidly erode trust and trigger switching behavior, particularly in competitive online markets.

Usability and user-friendliness have been repeatedly identified as pivotal determinants of customer satisfaction and loyalty in online services. The extent to which systems are intuitive, easy to navigate, and aligned with user needs directly influences perceived service quality and emotional responses toward the service provider (5, 11). Empirical studies confirm that user-friendly interfaces reduce cognitive effort, enhance perceived control, and increase perceived value, thereby strengthening continuance and loyalty intentions (12, 13). In online retail and financial services, even minor usability flaws can result in significant customer dissatisfaction and abandonment.

Visual attractiveness and interface aesthetics also play a critical role in shaping customer perceptions in digital environments. Aesthetically pleasing designs can enhance perceived professionalism, credibility, and trustworthiness of online platforms, thereby reinforcing customer confidence in the service provider (10, 14).

Research in e-commerce contexts demonstrates that visual appeal positively influences emotional engagement, perceived quality, and loyalty intention, particularly when combined with functional usability and reliable performance. These findings highlight the importance of integrating both utilitarian and hedonic design elements in online service platforms.

Customer experience has emerged as a holistic construct that encompasses cognitive, emotional, sensory, and behavioral responses to service interactions. In online services, customer experience is shaped by system performance, responsiveness, personalization, and consistency across service touchpoints (15, 16). Positive experiences foster emotional attachment, trust, and long-term relational bonds, which are essential for sustaining customer loyalty in digital environments. Studies indicate that experiential quality mediates the relationship between service quality and loyalty, emphasizing the need for experience-centric service design (2, 13).

Innovation in service delivery represents another critical driver of customer loyalty, particularly in technology-intensive industries. Continuous innovation signals organizational competence, adaptability, and commitment to customer needs. In online and mobile services, innovation may manifest through advanced features, personalized recommendations, integration of emerging technologies, and enhanced security mechanisms (17, 18). Empirical research suggests that perceived service innovation positively influences customer satisfaction, trust, and loyalty by enhancing perceived value and reducing uncertainty (14, 19).

The integration of advanced technologies such as big data analytics, blockchain, artificial intelligence, and Internet of Things has further reshaped service delivery and customer relationship management. These technologies enable organizations to improve service accuracy, responsiveness, and personalization, thereby strengthening customer engagement and loyalty (17, 18). In sectors such as insurance and financial services, technology-driven innovation has been linked to improved sustainability, operational efficiency, and customer trust (20). As digital ecosystems continue to evolve, the ability to leverage technological innovation effectively becomes a decisive factor in retaining customers.

Trust and perceived risk are particularly salient in online services, where physical interaction is absent and concerns related to privacy, security, and data misuse are prevalent. Prior research demonstrates that trust mediates the relationship between service quality and loyalty intention, while perceived risk negatively affects continuance behavior (21, 22). High-quality service delivery, transparent communication, and robust security protocols can mitigate perceived risk and foster trust, thereby enhancing loyalty intentions. These dynamics are especially relevant in online retail and financial services, where customer data sensitivity is high.

Cross-cultural and regional studies further reveal that the determinants of loyalty may vary depending on contextual factors such as technological infrastructure, consumer maturity, and regulatory environments. Studies conducted in emerging markets emphasize the importance of service reliability, usability, and trust in shaping customer loyalty, while developed markets highlight experiential quality and innovation as key drivers (11, 23, 24). These variations underscore the necessity of context-specific empirical investigations to inform managerial decision-making.

Despite the extensive body of literature on service quality and customer loyalty, several gaps remain. First, many studies focus on single dimensions of service quality without adequately capturing the multidimensional nature of online service experiences. Second, empirical evidence remains fragmented across sectors, limiting the generalizability of findings. Third, there is a need for integrative models that simultaneously examine expectations, usability, attractiveness, experience, and service innovation as predictors of loyalty intention within a unified

analytical framework (3, 13). Addressing these gaps is essential for advancing theoretical understanding and providing actionable insights for practitioners.

Moreover, the growing interdependence between digital service quality and customer relationship management necessitates a comprehensive examination of how service attributes translate into loyalty outcomes. Research indicates that effective customer relationship management practices enhance perceived service quality and strengthen loyalty, particularly in small and medium-sized enterprises operating in digital markets (15, 19). Integrating CRM perspectives with service quality frameworks can therefore enrich loyalty research and managerial practice.

In light of these considerations, the present study contributes to the literature by empirically examining a comprehensive model of factors influencing customer loyalty intention in online service environments, drawing upon established theoretical frameworks and recent empirical findings across digital service domains (1, 2, 14). By simultaneously analyzing customer expectations, usability, attractiveness, experience, and service innovation, the study provides a holistic understanding of loyalty formation in online product-providing services.

Accordingly, the aim of this study is to identify and explain the key factors influencing customer loyalty intention toward online services by examining the effects of expectations, usability, attractiveness, customer experience, and service innovation within an integrated structural model.

Methods and Materials

In this study, the target statistical population consisted of citizens of Tehran. To examine this population, a sample was selected for analysis. Simple random sampling was employed to select the sample. In simple random sampling, each individual in the statistical population has an equal probability of being selected as a member of the sample, and there is no prior determination in the selection process. This means that all individuals in the population have an equal chance of selection. Using this method, 245 citizens of Tehran were randomly selected and considered as the research sample. This sample was subsequently examined and analyzed to investigate the factors affecting service quality and loyalty intention in online services.

In this study, the individuals selected as the sample had varying levels of education, ranging from a high school diploma to a doctoral degree, and their ages ranged between 18 and 50 years. The selection of participants was based solely on simple random sampling, and educational level was not used as a criterion for sample selection. Accordingly, the selected sample included individuals with diverse educational backgrounds, from those holding only a diploma to those with a doctoral degree. From this perspective, the study evaluates the impact of factors affecting service quality and loyalty intention in online services across different educational levels.

Table 1 presents the demographic information in numerical form.

Table 1. Demographic Information

Variable	Indicator	Percentage
Gender	Male	60%
	Female	40%
Age	18–28 years	30%
	28–38 years	40%
	38–48 years	20%
	48 years and above (up to 50)	10%
Educational level	Diploma	20%
	Bachelor’s degree	50%
	Master’s degree	20%

	Doctoral degree	10%
Experience using online product-providing retail services	No experience	3.33%
	Less than 1 year	30%
	1–5 years	40%
	More than 5 years	26.67%

The research methodology adopted in this study is descriptive or qualitative in nature. In this approach, participants responded to a questionnaire, and the data were collected using this instrument. In this article, which focuses on factors affecting service quality and loyalty intention in online services, the researchers used a questionnaire to gather data. The questionnaire included items related to participants' opinions, experiences, and loyalty intentions; participants completed the questionnaire, and the required information regarding factors influencing service quality and loyalty intention was collected accordingly. The data obtained from the questionnaire can be analyzed using statistical and comparative methods. Such analyses may include descriptive and inferential statistical analyses of variables, examination of relationships among variables, and statistical inferences. This research approach enables the derivation of reliable findings and conclusions regarding the relationship between influencing factors, service quality, and loyalty intention in online services through the analysis of participant data.

The questionnaire was designed to examine factors affecting service quality and loyalty intention in online services. The aim of this research is to gain a better understanding of the attitudes and needs of online service customers so that organizations can improve their services and enhance customer satisfaction. It should be noted that participants' responses to the questionnaire were analyzed confidentially and anonymously and were used solely for research purposes. The questionnaire consisted of 15 items developed to test the proposed hypotheses regarding factors influencing customer loyalty in online product-providing retail stores. The relevant details are presented in Table 2.

Table 2. Questionnaire Items

Dimensions	Cronbach's alpha (reliability)
Expectations	0.789
Usability	0.702
Attractiveness	0.711
Experience	0.733
Service innovation	0.832
Customer loyalty intention	0.841
Total questionnaire	0.830

The results reported in Table 2 indicate that the questionnaire designed to examine the factors affecting customer loyalty intention toward the services of online product-providing retail stores demonstrates adequate validity and reliability for this study, as all indices show values above 0.70 for each dimension.

Findings and Results

Based on the analyses conducted in the previous sections, which examined each dimension and assessed the fit of the questionnaire within those sections, this part focuses on evaluating the overall construct of the study. According to the outputs obtained, the non-standardized construct was first identified. Subsequently, by eliminating redundant data, the standardized construct was specified, and the analysis was performed based on this standardized model.

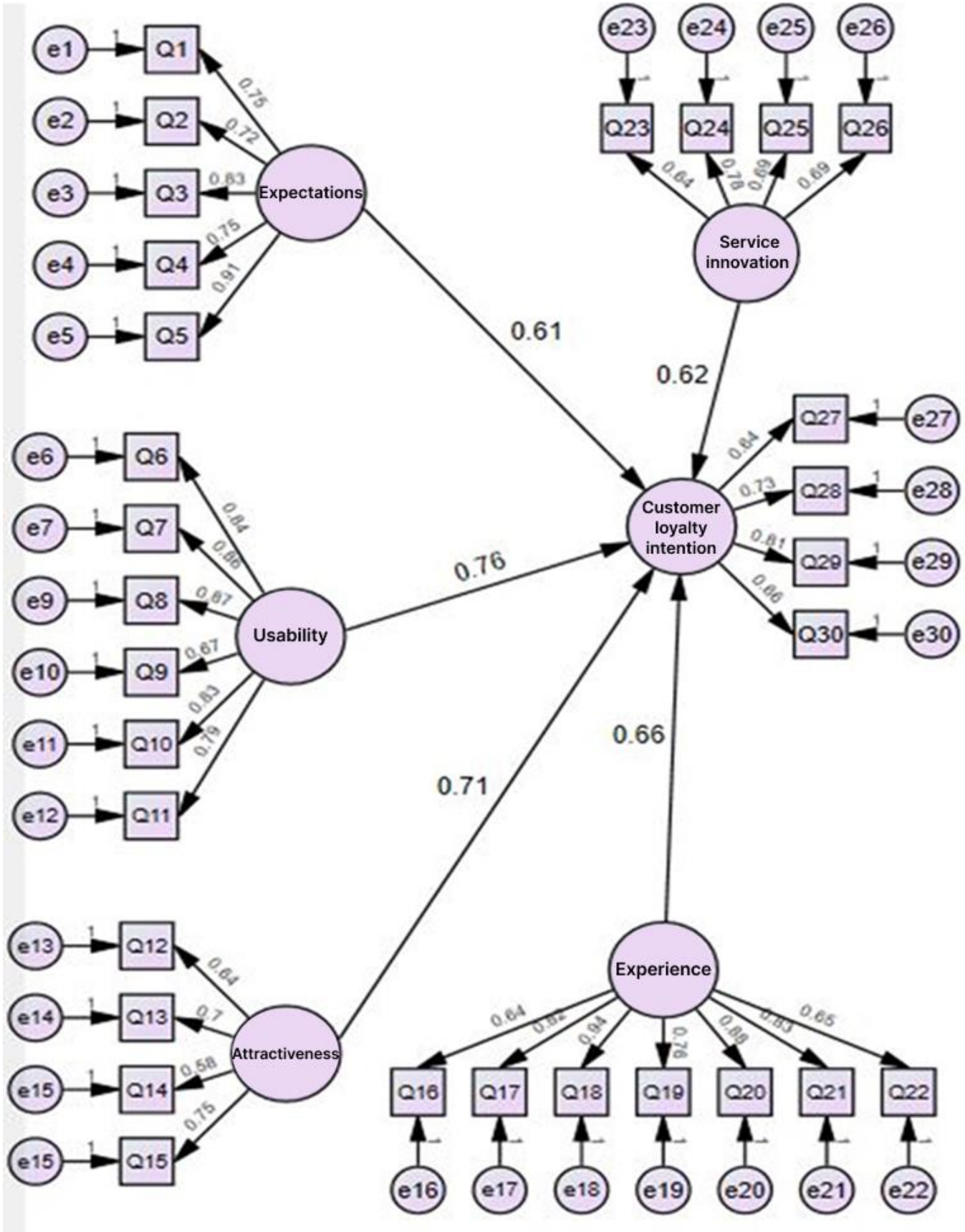

Figure 1. Structural Equation Model (Construct in the Standardized State)

To examine the model fit, the results are presented in the following tables.

Table 3. Overall Goodness-of-Fit Indices for the Structural Equation Model (Standardized Construct)

Parameter name	Value	Acceptable threshold
Chi-square to degrees of freedom ratio (χ^2/df)	2.223	Less than 3
Root Mean Square Error of Approximation (RMSEA)	0.000	Less than 0.05
Comparative Fit Index (CFI)	0.947	Greater than 0.90
Goodness-of-Fit Index (GFI)	0.912	Greater than 0.80
Adjusted Goodness-of-Fit Index (AGFI)	0.859	Greater than 0.80

According to the results presented in Table 3, the chi-square statistic tests the hypothesis that the proposed model is consistent with the covariance pattern among the observed variables. The obtained value of 2.223 satisfies the acceptable threshold of less than 3, indicating an appropriate model fit based on this criterion. The RMSEA, which represents the root mean square error of approximation, is considered acceptable for good models when it is 0.05 or lower; in this study, the RMSEA value is 0.000, indicating an excellent fit in this regard. The CFI value, which should be greater than 0.90 to indicate acceptable model fit, is equal to 0.947 in this study, further confirming adequate model fit. The GFI and AGFI indices assess the relative amount of variances and covariances jointly explained by the model, with AGFI representing the adjusted form of GFI for degrees of freedom. The obtained values of 0.912 and 0.859, respectively, meet the acceptable thresholds, indicating satisfactory goodness of fit.

The hypotheses of the present study are as follows:

1. Expectations have a positive and significant effect on customer loyalty intention in using the services of online product-providing retail stores.
2. Usability has a positive and significant effect on customer loyalty intention in using the services of online product-providing retail stores.
3. Attractiveness has a positive and significant effect on customer loyalty intention in using the services of online product-providing retail stores.
4. Experience has a positive and significant effect on customer loyalty intention in using the services of online product-providing retail stores.
5. Service innovation has a positive and significant effect on customer loyalty intention in using the services of online product-providing retail stores.

In this section, the results of hypothesis testing based on path analysis are presented in Table 4.

Table 4. Hypothesis Testing Results

Hypothesis	Path coefficient (explained variance R^2)	Student's t-statistic	Significance level	Test result
1. Expectations → Customer loyalty intention	0.61 (0.86)	2.458	0.02	Supported
2. Usability → Customer loyalty intention	0.76 (0.89)	2.576	0.02	Supported
3. Attractiveness → Customer loyalty intention	0.71 (0.83)	2.457	0.008	Supported
4. Experience → Customer loyalty intention	0.66 (0.87)	1.989	0.01	Supported
5. Service innovation → Customer loyalty intention	0.62 (0.85)	3.354	0.01	Supported

Discussion and Conclusion

The findings provide a coherent institutional–causal explanation for why digitalization in humanitarian supply chains progresses unevenly across contexts and why technology-centric interventions often underperform when governance and managerial foundations are weak. The DEMATEL results indicate that policymaking and

governance regulations (D2) hold the highest positive net causal role (R–C) and therefore function as the primary driver of the institutional system. This outcome implies that digitalization in humanitarian logistics is first and foremost a governance problem: without updated, enforceable, and operationally interpretable rules for data stewardship, inter-agency mandates, accountability, and cross-sector collaboration, the adoption of digital technologies remains episodic, fragmented, and difficult to scale. This interpretation aligns with scholarship emphasizing that humanitarian digital initiatives must be embedded in institutional and regulatory architectures to remain legitimate and sustainable (25), and with ethical analyses arguing that AI-enabled humanitarian action requires clear obligation structures, accountability mechanisms, and governance safeguards that translate normative commitments into operational constraints (26). In practical terms, the prominence of D2 underscores that legal clarity and policy coherence shape the feasibility of data sharing, platform interoperability, and digital coordination during crises, which is consistent with evidence that privacy and regulatory frameworks can significantly constrain crisis analytics and humanitarian data practices when not reconciled with operational needs (27). The centrality of governance is also consistent with the localization perspective showing that digital humanitarian protection outcomes depend on decision rights, legitimacy, and institutional alignment with local realities rather than on technology availability alone (28).

A second major result is the causal and mediating role of leadership and change management (D4). Although D4's net causal effect is smaller than D2, its positive R–C value indicates that leadership operates as a transmission mechanism through which macro-level policies become implementable routines, resourced programs, and coordinated inter-organizational practices. This is consistent with research showing that digital transformation outcomes depend on managerial capacities to mobilize partners, sustain collaboration, and convert information alignment into operational agility in humanitarian supply chains (29). The leadership finding also resonates with broader digital supply chain transformation studies demonstrating that transformation value depends on capabilities that enable organizations to absorb, integrate, and deploy knowledge across relationships and operational processes (30). From this perspective, governance (D2) creates the "rules of the game," but leadership (D4) determines whether those rules become executable change portfolios and whether the organization and its partners can navigate resistance, ambiguity, and resource constraints. This mediating logic is consistent with action research evidence that guiding digital transformation in multi-actor supply chains requires deliberate leadership to orchestrate collaborative knowledge creation and to institutionalize new practices (31). It also aligns with performance management arguments suggesting that digitalization gains traction when leaders build measurement architectures and accountability routines that connect technology use to operational outcomes (32).

In contrast, the study identifies inter-organizational coordination and management (D1), data management and information transparency (D3), infrastructure and cybersecurity (D5), and culture-building and future orientation (D6) as predominantly influence-receiving dimensions (negative R–C values). This pattern is theoretically meaningful because it indicates that these dimensions improve primarily as downstream effects of policy and leadership interventions rather than as independent starting points. For example, coordination capacity (D1) depends on clarified mandates, standardized protocols, and formal mechanisms for aligning agencies—conditions typically created through governance reforms (D2) and sustained through leadership (D4). This inference is supported by evidence that information alignment and coordination in humanitarian supply chains are strengthened when institutional arrangements enable collaboration and shared standards, and when technologies such as blockchain are embedded into agreed governance structures rather than deployed as isolated tools (33). Similarly,

findings on the need for standardized methods of data collection and sharing, along with improved agency coordination, indicate that coordination deficits are not merely operational failures but are rooted in institutional fragmentation and the absence of shared process models (34). The role of standardized humanitarian process models further supports the conclusion that coordination (D1) strengthens when governance and inter-agency agreements codify shared operating procedures and responsibilities across crisis phases (35).

The results also show that data management and information transparency (D3) has among the highest total prominence (R+C), despite being influence-receiving. This implies that D3 is highly connected within the system and is central to overall performance, even if it is not the primary causal driver. This is consistent with the view that data-driven digital transformation can enable antifragility and resilience, but only when data quality, accessibility, and governance arrangements are institutionalized across actors (36). It also aligns with evidence that real-time data capture is foundational to effective disaster response logistics and that the operational value of data is realized through institutional commitments to standardization, verification, and integration across agencies (37). The prominence of D3 also coheres with the increasing integration of machine learning and decision-support systems in post-disaster humanitarian supply chains, where advanced analytics require reliable data architectures, traceability, and accountable data pipelines (38). Furthermore, the convergence of AI and big data for humanitarian supply chain resilience emphasizes that the resilience value of analytics depends on institutional trust and data governance capacity, echoing why D3 becomes pivotal yet structurally dependent (39). The study's finding that D3 is influence-receiving also aligns with governance-driven data-protection arguments, which suggest that without clear legal protections and operational policies for data stewardship, transparency and sharing mechanisms remain weak regardless of technology investments (40).

The downstream positioning of infrastructure and cybersecurity (D5) and the post-threshold network result that D5 lacks salient outgoing relationships after thresholding provide a nuanced managerial implication. While infrastructure and cybersecurity are widely recognized as critical enablers, in the present causal structure they appear primarily as "response variables" that are strengthened once governance priorities, funding allocations, technical standards, and leadership mandates are established. This does not imply that infrastructure is unimportant; rather, it indicates that infrastructure readiness is often an outcome of strategic choices and policy frameworks that determine investment, standardization, and acceptable risk thresholds. This interpretation is consistent with evidence that digitalization can improve humanitarian logistical efficiency in real-world settings but is strongly conditioned by infrastructure stability and institutional support for operational continuity (41). It also aligns with reviews of Industry 4.0 technologies in humanitarian supply chains that highlight infrastructural and capability constraints as systemic bottlenecks but implicitly situate their resolution within broader institutional programs and cross-organizational planning (42). Technology-specific innovations such as 3D printing illustrate the same structural logic: technical feasibility and performance gains are contingent on governance arrangements for quality assurance, certification, and coordinated deployment, which are typically policy- and leadership-driven rather than purely operational choices (43).

The influence-receiving role of culture-building and future orientation (D6) also aligns with established evidence that organizational culture and trust dynamics complement analytics and collaboration in humanitarian supply chain performance. Prior work demonstrates that big data analytics capabilities interact with organizational culture to support swift trust and collaborative performance in humanitarian networks (44). The present findings suggest that culture-building initiatives become more effective when governance and leadership establish consistent narratives,

incentives, and learning systems that make digital practices normal, legitimate, and supported. This is consistent with barrier analyses identifying cultural resistance, capability gaps, and weak information norms as key impediments to adopting digital technologies in humanitarian supply chains (45). The study's causal ordering implies that culture change is less likely to be sustained when policy signals are ambiguous or when leadership does not institutionalize training, accountability, and cross-agency learning routines.

A further contribution of the study is its prioritization logic for addressing adoption barriers that are known to be interdependent. Research using ISM-DEMATEL to analyze barriers to IoT adoption in humanitarian logistics emphasizes that barriers form structured hierarchies, where upstream conditions—often institutional—shape downstream readiness and diffusion dynamics (46). The current study extends this insight by demonstrating an institutional causal backbone in which policymaking/regulation (D2) and leadership/change management (D4) operate as core drivers that shape data governance (D3), coordination (D1), infrastructure and cybersecurity (D5), and culture-building (D6). This causal backbone helps reconcile why technically promising solutions such as blockchain can produce uneven outcomes: while blockchain can enhance trust, traceability, and collaboration, successful deployment depends on alignment among actors and on governance structures that specify participation rules, compliance expectations, and data stewardship responsibilities (47). Evidence from humanitarian blockchain pilots similarly indicates that implementation success depends on stakeholder alignment, policy support, and the institutional context of adoption—conditions that map closely onto D2 and D4 in the present model (48). Complementary studies that model blockchain adoption determinants in humanitarian supply chains through group-DEMATEL further reinforce that the adoption environment is structured by interacting factors rather than single-variable "drivers," supporting the value of causal modeling for sequencing interventions (49).

The results also speak to the expanding role of AI in humanitarian supply chain management and the institutional prerequisites for responsible scaling. Studies identifying key drivers for AI incorporation emphasize the need for governance readiness, capability maturity, and clarity in decision-making accountability when AI is introduced into humanitarian operations (50). The present findings position governance (D2) and leadership (D4) as the causal levers that can establish those prerequisites, while data governance (D3) becomes a highly prominent dependent dimension that mediates practical AI deployment quality. This interpretation aligns with ethical and legal scholarship cautioning that AI's benefits in humanitarian action are inseparable from risk management, accountability, and rights protection structures (25, 26). It also complements work on government incentive mechanisms for data governance, which demonstrates that institutional instruments—such as incentives, compliance architectures, and rule systems—can be designed to steer data practices, implying that policy design can directly condition downstream transparency and sharing behavior (51).

Finally, the study's results reinforce the broader claim that digital transformation contributes to resilience when it is implemented as an integrated institutional program rather than as a portfolio of isolated technologies. Digital transformation and resilience research in supply chain networks emphasizes that resilience outcomes emerge from network-level reconfiguration of information flows and coordination patterns rather than from single-firm optimization (52). In humanitarian contexts, the pursuit of "fast, fair, and safe" logistics likewise depends on system-level institutional alignment that supports technology-enabled coordination and trusted information exchange (53). The present model operationalizes this insight by revealing which institutional dimensions act as root drivers and which operate as downstream capacity areas. It also complements systematic review evidence on the emergent role of digital technologies in humanitarian supply chains, which suggests that research and practice must move beyond

enumerating technologies toward understanding governance, collaboration, and capability dynamics that determine digital transformation trajectories (54). Viewed together, the findings provide a structured explanation for the observed empirical variability in digital adoption and performance across humanitarian operations, while offering a practical prioritization map that emphasizes governance reform and leadership capability-building as the first-order levers for accelerating digitalization.

Limitations. The study relies on expert judgment to populate the DEMATEL matrices, and although the experts were selected based on relevant experience, the causal estimates may reflect contextual interpretations and subjective assessments rather than fully objective causal effects. The sample size for interviews and expert panels was appropriate for qualitative saturation and structured judgment elicitation, but the findings may not generalize to all humanitarian ecosystems, especially those with substantially different governance models, technology infrastructures, or donor coordination regimes. In addition, the cross-sectional nature of the data limits the ability to observe how institutional roles and causal strengths evolve over time across phases of digital transformation.

Suggestions for future research. Future studies could validate the proposed causal structure using longitudinal designs that track institutional reforms, digital capability development, and operational performance across multiple crisis events. Comparative multi-country research could examine whether the primacy of governance and leadership persists under different regulatory environments, coordination architectures, and levels of digital maturity. Mixed-method studies integrating DEMATEL with structural equation modeling or system dynamics could further quantify mediation pathways, test alternative causal configurations, and explore how feedback loops emerge as digitalization scales.

Suggestions for practice. Policymakers and humanitarian leaders should prioritize governance reforms that clarify data stewardship, interoperability requirements, accountability, and cross-agency mandates before investing heavily in specific technologies. Leadership development programs focused on digital change management should be institutionalized to ensure that policies translate into executable implementation roadmaps, aligned incentives, and sustained stakeholder engagement. Operational teams should treat data governance, coordination protocols, and cultural readiness as structured workstreams that follow from governance and leadership decisions, with explicit sequencing, resourcing, and performance monitoring to ensure durable digitalization outcomes.

Acknowledgments

We would like to express our appreciation and gratitude to all those who helped us carrying out this study.

Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

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