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# Designing a Data-Driven Digital Transformation Deployment Model for Iranian Public Organizations: An Empirical Investigation

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## Abstract

This study aimed to design and structurally explain a data-driven digital transformation deployment model for Iranian public organizations using expert judgment and interpretive structural modeling. This applied and exploratory study was conducted using a mixed-methods design with an interpretive structural modeling approach. The study population consisted of senior managers, digital transformation specialists, data governance experts, information technology managers, public administration scholars, and consultants familiar with digital transformation in Iranian public organizations. A purposive sample of 21 experts from Tehran participated in the study. Data were collected through literature review, semi-structured expert interviews, and an ISM questionnaire based on pairwise comparison of the finalized components. The extracted components were refined through expert review, and the contextual relationships among them were determined using the structural self-interaction matrix. The initial and final reachability matrices were then developed, transitivity was applied, hierarchical levels were identified, and MICMAC analysis was used to classify the components according to driving power and dependence power. The ISM results revealed a seven-level hierarchical model. Digital leadership and strategic commitment were positioned at the deepest level and had the highest driving power, indicating their foundational role in the deployment process. Data governance and regulatory alignment, together with inter-organizational coordination and ecosystem collaboration, formed the next driving layer. Integrated digital infrastructure and interoperability and human resource digital competence were identified as key enabling components. Data quality, security, and privacy management emerged as a central linkage variable. Process redesign and organizational agility and evidence-based decision-making culture were placed at the intermediate transformation level. Citizen-centric digital service design and performance monitoring and accountability were identified as highly dependent outcome components. The findings indicate that data-driven digital transformation in Iranian public organizations is a systemic, hierarchical, and interdependent process that should begin with leadership commitment, governance alignment, coordination, infrastructure development, and human capability building before progressing toward service redesign, evidence-based decision-making, and accountability.

**Keywords:** Data-driven digital transformation; public organizations; interpretive structural modeling; data governance; digital leadership; Iranian public sector; MICMAC analysis.



## 1. Introduction

Digital transformation has become one of the central imperatives of contemporary public administration, because governments are increasingly expected to provide faster, more transparent, more integrated, and more citizen-oriented services in complex social, economic, and technological environments. Unlike traditional information technology projects that primarily focus on automation or the digitization of existing procedures, digital transformation involves a deeper reconfiguration of organizational structures, administrative processes, service delivery models, decision-making mechanisms, governance arrangements, and value-creation logics. In the public sector, this transformation is particularly significant because public organizations are responsible not only for internal efficiency, but also for public value, accountability, equity, transparency, and responsiveness. Therefore, digital transformation in government cannot be reduced to the acquisition of digital tools; it must be understood as a systemic process through which public organizations redesign how they collect, govern, analyze, exchange, and use data to improve administrative performance and public service outcomes (Ciancarini et al., 2024; Escobar et al., 2023).

The global movement toward digital government has gradually shifted from simple e-government portals and online services toward data-driven governance, platform-based public administration, smart government, and evidence-based policymaking. In this new paradigm, data are not merely administrative by-products, but strategic assets that support policy design, resource allocation, service personalization, risk identification, monitoring, and accountability. Public organizations that are able to integrate reliable data across departments and institutional boundaries can make more accurate decisions, reduce duplication, identify service gaps, and respond more effectively to citizens' needs. However, this requires strong data governance, interoperable systems, analytical capability, legal clarity, managerial commitment, and a culture that values evidence over routine administrative judgment. Thus, data-driven digital transformation is a complex socio-technical phenomenon that depends simultaneously on technological, organizational, institutional, cultural, and human factors (Alipour et al., 2026; Kamaneh et al., 2026; Sahraei, 2025).

In Iran, the need for digital transformation in public organizations has become increasingly urgent due to the expansion of administrative complexity, citizen demand for efficient services, the growth of digital platforms in daily life, and the need to improve public-sector productivity. Iranian public organizations have implemented various initiatives related to e-government, smart government, digital service provision, information systems, and administrative modernization. Nevertheless, the transition from fragmented digital initiatives to integrated and data-driven digital transformation remains incomplete. One of the persistent challenges is the lack of integration among government systems, which reduces the possibility of real-time data exchange, coordinated decision-making, and unified service delivery. Fragmentation in information systems can create duplicated databases, inconsistent records, parallel administrative procedures, and weak interoperability among public institutions, thereby limiting the effectiveness of digital transformation efforts (Amiri & Sangar, 2023; Nasri et al., 2020; Parsa, 2026).

The Iranian public sector faces a set of structural and contextual challenges that make digital transformation both necessary and difficult. These challenges include bureaucratic rigidity, weak inter-organizational coordination, insufficient digital maturity, limited data-sharing mechanisms, unclear data ownership, uneven technological readiness, resistance to organizational change, and gaps in digital competence among managers and employees. Qualitative investigations of digital transformation in Iran's public sector have emphasized that transformation is constrained not only by technological shortcomings, but also by institutional, managerial, cultural, regulatory, and human-resource barriers. Therefore, any attempt to design a deployment model for data-driven digital transformation must consider the particular administrative and institutional conditions of Iranian public organizations rather than relying exclusively on generic international frameworks (Danaeefard, 2025; Danaeefard et al., 2024; Karimi et al., 2025; Karimi et al., 2024).

At the national level, digital transformation requires a coherent understanding of the elements that influence transformation across sectors and public institutions. Research on digital transformation at the national level has shown that transformation is shaped by interacting factors such as leadership, policy orientation, infrastructure, governance, innovation capacity, organizational readiness, human capital, and institutional support. For Iran, modeling the factors affecting digital transformation is particularly important because public organizations operate within a complex governance environment where administrative



traditions, legal frameworks, resource limitations, technological capabilities, and citizen expectations intersect. As a result, digital transformation should be designed as a structured deployment process, not as a collection of independent technology projects (Alipour et al., 2024, 2026).

Data governance is one of the most critical foundations of data-driven digital transformation. Without clear governance mechanisms, public organizations may collect large volumes of data without being able to use them effectively, ethically, securely, or consistently. Data governance includes the rules, responsibilities, standards, ownership structures, access protocols, privacy safeguards, quality controls, and accountability mechanisms that determine how data are produced, stored, shared, interpreted, and used. In smart government organizations, data governance becomes especially important because decision-making, service design, inter-organizational coordination, and public accountability increasingly depend on the reliability and usability of data. In the Iranian context, studies have emphasized the importance of developing data governance models that are compatible with public-sector structures, information management requirements, and media and communication environments (Kamaneh et al., 2026; Sahraei, 2023, 2025).

Closely related to data governance is the issue of data quality. Even when public organizations possess large databases and digital systems, poor data quality can weaken decision-making and undermine trust in digital government. Inaccurate, incomplete, outdated, duplicated, or inconsistent data can produce flawed analyses, ineffective policies, and unreliable public services. Data quality also affects the success of e-government because citizens and managers depend on the accuracy and timeliness of information. In a data-driven transformation model, therefore, data quality, security, and privacy management should be treated as central operational requirements rather than secondary technical concerns. This is particularly important in public organizations, where data often include sensitive personal, administrative, financial, legal, and service-related information (Chabok et al., 2025; Sahraei, 2025).

Digital transformation in public organizations is also closely tied to the development of e-government, smart government, and platform government. E-government initially emphasized the digital delivery of public services, but contemporary digital governance requires broader integration, platform-based service ecosystems, data sharing, and interaction among government, citizens, businesses, and other stakeholders. The government-as-a-platform approach suggests that public organizations should create shared infrastructures, standards, and services that allow multiple actors to participate in value creation. This perspective is highly relevant to Iranian public organizations because fragmented and organization-centered systems may not be sufficient for integrated citizen services. A platform-oriented approach requires interoperability, legal coherence, organizational coordination, and shared data architectures (Chabok et al., 2025; Fathi et al., 2024; Yousefzadeh Baghbani et al., 2025).

Another important dimension of public-sector digital transformation is the relationship between digital governance and anti-corruption. Digital systems can enhance transparency by reducing unnecessary face-to-face interactions, increasing traceability, standardizing procedures, and enabling monitoring of administrative actions. However, these effects are not automatic. Digital transformation can support anti-corruption only when it is accompanied by accountability mechanisms, reliable data, transparent workflows, and institutional oversight. Therefore, performance monitoring and accountability should be considered among the expected outcomes of data-driven digital transformation rather than merely technical reporting activities. In the Iranian public sector, the development of e-governance has been linked to the need for more transparent, accountable, and corruption-resistant administrative systems (Escobar et al., 2023; Taghva et al., 2023).

Human and cultural dimensions are equally important in the deployment of digital transformation. Public organizations often experience resistance to change when digital transformation is perceived as a threat to established routines, authority structures, job security, or professional identity. Employees may also lack the competencies required to use data systems, digital platforms, analytical tools, and redesigned administrative processes. Therefore, digital competence, organizational learning, intellectual capital, and transformation-oriented culture are key conditions for successful implementation. In Iran, studies on intellectual capital, digital maturity, and soft components of digital transformation have shown that knowledge, skills, leadership, collaboration, cultural readiness, and organizational mindset play a decisive role in transforming digital initiatives into sustainable organizational capabilities (Hajizadeh et al., 2024; Harandi et al., 2025; Modaresi et al., 2024; Shamekhi et al., 2024).

The cultural context of digital transformation is especially significant because technology adoption in organizations is shaped by values, norms, behavioral patterns, managerial expectations, and informal routines. A culturally aligned digital



transformation framework can help organizations adapt transformation principles to their institutional environment rather than applying imported models without contextual fit. In Iranian organizations, cultural alignment is important because digital transformation must be compatible with administrative traditions, managerial practices, national priorities, organizational capacities, and stakeholder expectations. Research on culturally aligned digital transformation frameworks and on cultural drivers and barriers of digital transformation in Tehran-based organizations has highlighted that cultural readiness, managerial support, employee participation, trust, communication, and shared understanding can either accelerate or obstruct digital transformation deployment (Pourmoghaddam et al., 2025a, 2025b; Sanati et al., 2024).

Although digital transformation is commonly associated with public administration, evidence from other sectors also provides useful insights into success factors and challenges. For example, research on the digital transformation of food small and medium-sized enterprises in Iran has shown that managerial perspective, technological readiness, supply chain integration, resource constraints, and organizational adaptability influence transformation outcomes. These findings are relevant to public organizations because they demonstrate that digital transformation depends on the interaction between strategy, resources, capabilities, stakeholders, and environmental conditions. Similarly, sectoral studies show that digital transformation cannot succeed through technology investment alone; it requires alignment among strategy, processes, people, data, and institutional support (Fazlali Dastjerdi, 2022; Harandi et al., 2025).

A major gap in the existing literature is that many studies identify the factors, challenges, components, or requirements of digital transformation, but fewer studies explain how these factors are structurally related within a deployment model. In practice, public managers need to know not only which components are important, but also which components should be prioritized, which ones function as foundational drivers, which ones are intermediate mechanisms, and which ones represent dependent outcomes. For instance, citizen-centric service design and performance accountability may be highly desirable goals, but they are unlikely to be achieved unless leadership, governance, infrastructure, data quality, human competence, and process redesign are already in place. Therefore, a structural modeling approach can provide more actionable insight than a descriptive list of components (Escobar et al., 2023; Karimi et al., 2025; Modaresi et al., 2024).

Interpretive structural modeling is particularly suitable for studying data-driven digital transformation because the phenomenon is complex, multidimensional, and characterized by interdependence among factors. ISM allows researchers to organize expert judgments into a hierarchical structure and identify the driving and dependent relationships among model components. This method is useful when the research problem involves ambiguous, contextual, and systemic relationships that cannot be fully captured through linear statistical analysis alone. In the Iranian digital transformation literature, ISM has been used to examine public-sector transformation challenges as well as cultural drivers and barriers, demonstrating its value for clarifying causal and hierarchical relationships among complex organizational factors (Karimi et al., 2025; Pourmoghaddam et al., 2025a, 2025b).

Despite the growing body of research on digital transformation, e-government, smart government, data governance, digital readiness, and digital maturity in Iran, there remains a need for an integrated data-driven deployment model specifically designed for Iranian public organizations. Existing studies have separately addressed national-level transformation factors, public-sector challenges, data governance indicators, digital maturity, smart government development, cultural frameworks, platform government, and system fragmentation; however, these streams need to be synthesized into a coherent structural model that explains the sequence and influence of the main deployment components (Alipour et al., 2024; Danaeefard et al., 2024; Fathi et al., 2024; Parsa, 2026; Yousefzadeh Baghbani et al., 2025). Such a model can help policymakers and public managers move from scattered digital initiatives toward a more systematic, evidence-based, and accountable approach to digital transformation.

Accordingly, the aim of this study was to design a data-driven digital transformation deployment model for Iranian public organizations using expert judgment and interpretive structural modeling.

## 2. Methods and Materials

The present study was conducted using an applied, exploratory, and mixed-methods design with an emphasis on interpretive structural modeling to design a data-driven digital transformation deployment model for Iranian public organizations. The



research was carried out in Tehran, Iran, because a considerable proportion of national public organizations, policymaking institutions, and administrative headquarters are located in this city, making it an appropriate context for examining digital transformation deployment at the public-sector level. The study population consisted of senior managers, information technology managers, digital transformation specialists, data governance experts, policy analysts, and academic experts with practical or scholarly experience in public-sector digital transformation, organizational change, data-driven decision-making, and e-government implementation. Participants were selected through purposive sampling based on expertise, professional relevance, and direct experience with digital transformation initiatives in Iranian public organizations.

The final expert panel consisted of 21 participants from public organizations and universities located in Tehran. Inclusion criteria were having at least five years of relevant managerial, executive, consulting, or academic experience in the fields of digital transformation, data management, public administration, information systems, or organizational development; familiarity with public-sector structures and administrative processes in Iran; and willingness to participate in the expert judgment process required for interpretive structural modeling. The panel included senior public-sector managers, chief information officers, digital transformation officers, data and analytics specialists, university faculty members, and consultants involved in public-sector modernization projects. Participation was voluntary, and all participants were informed about the purpose of the study, the confidentiality of their responses, and the use of aggregated expert judgments for model development.

Data were collected using a multi-stage expert-based procedure appropriate for interpretive structural modeling. In the first stage, a preliminary list of factors affecting the deployment of data-driven digital transformation in Iranian public organizations was developed through a review of theoretical literature, policy documents, organizational digitalization frameworks, and empirical studies related to digital transformation, data governance, digital public administration, organizational readiness, technological infrastructure, leadership, human resources, regulatory requirements, and inter-organizational coordination. This preliminary list was then refined through expert consultation to ensure its contextual relevance to Iranian public organizations.

In the second stage, a semi-structured expert interview protocol was used to collect qualitative judgments regarding the most important dimensions and components of data-driven digital transformation deployment. The interview questions focused on the prerequisites, drivers, barriers, structural requirements, technological foundations, managerial mechanisms, cultural conditions, and policy-level factors influencing digital transformation in public organizations. The interviews also addressed the role of data quality, data integration, data governance, analytical capability, digital leadership, organizational learning, stakeholder participation, process redesign, and legal-administrative support in the successful deployment of digital transformation initiatives. The content of the interviews was used to validate, revise, merge, and finalize the key components of the proposed model.

In the third stage, an interpretive structural modeling questionnaire was designed to determine the contextual relationships among the finalized components. The questionnaire was prepared in the form of a structural self-interaction matrix, in which experts assessed the direction of influence between each pair of components. For each pairwise comparison, the experts determined whether the first component influenced the second, whether the second influenced the first, whether both components influenced each other, or whether no meaningful relationship existed between them. The conventional ISM symbols were used to record these judgments, including V for the influence of the row component on the column component, A for the influence of the column component on the row component, X for reciprocal influence, and O for the absence of a direct relationship. The face and content validity of the data collection instruments were reviewed and confirmed by a small group of academic and executive experts before the final data collection phase.

The data analysis process was performed using interpretive structural modeling to identify the hierarchical structure and interrelationships among the components of data-driven digital transformation deployment in Iranian public organizations. First, the qualitative data obtained from expert interviews and document analysis were examined to finalize the main components of the model. Similar concepts were combined, overlapping items were removed, and the final set of components was confirmed based on expert consensus and theoretical relevance. The purpose of this stage was to ensure that the model components were sufficiently comprehensive, non-redundant, and applicable to the organizational context of Iranian public administration.

After finalizing the components, the structural self-interaction matrix was formed based on the collective judgments of the 21 experts. The pairwise relationships among the components were analyzed using the ISM logic, and the symbolic relationships in the structural self-interaction matrix were converted into the initial reachability matrix. In this conversion



process, the V, A, X, and O symbols were transformed into binary values according to standard ISM rules. When a component was judged to influence another component, the corresponding cell was coded as 1, while the opposite direction was coded as 0; when the relationship was reciprocal, both corresponding cells were coded as 1; and when no relationship was identified, both cells were coded as 0. The diagonal elements of the matrix were also coded as 1 to indicate that each component reaches itself.

In the next step, the initial reachability matrix was reviewed for transitivity. Transitivity is a central assumption in interpretive structural modeling and means that if one component influences a second component and the second component influences a third component, then the first component may also indirectly influence the third component. Accordingly, indirect relationships were identified and incorporated into the final reachability matrix. The final matrix provided the basis for determining the reachability set and antecedent set for each component. The reachability set included the component itself and all other components that it could influence, while the antecedent set included the component itself and all other components that could influence it. The intersection of these two sets was then calculated for each component.

Level partitioning was conducted by comparing the reachability set and the intersection set of each component. Components for which the reachability set and intersection set were identical were placed at the highest level of the model, because they were considered outcome-level or dependent components. After assigning these components to the first level, they were removed from subsequent iterations, and the process was repeated until all components were classified into hierarchical levels. This procedure enabled the identification of foundational, linkage, intermediate, and dependent components in the deployment of data-driven digital transformation in Iranian public organizations.

Following the level partitioning process, the hierarchical model was developed by arranging the components according to their identified levels and drawing directional relationships among them based on the final reachability matrix. Components located at the lower levels of the model were interpreted as key driving factors that create the foundation for digital transformation deployment, while components at the upper levels were interpreted as dependent outcomes that emerge from the influence of more fundamental organizational, technological, managerial, and policy-related conditions. To complement the ISM results, MICMAC analysis was also used to classify the components based on their driving power and dependence power. Through this analysis, the components were categorized into autonomous, dependent, linkage, and independent variables. This classification helped clarify which factors functioned as strategic drivers of the model, which factors were highly dependent on other conditions, and which factors had reciprocal and unstable relationships within the deployment system.

The use of interpretive structural modeling made it possible to move beyond a simple list of factors and develop a structured explanatory model of data-driven digital transformation deployment in public organizations. This method was appropriate for the present study because digital transformation in the public sector is a complex, multi-dimensional, and interdependent phenomenon that requires systematic analysis of causal and contextual relationships among organizational, technological, human, policy, and data-related components.

### 3. Findings and Results

The expert panel consisted of 21 participants from public organizations, universities, and specialized consulting bodies located in Tehran. In terms of professional position, 8 participants were senior or middle-level managers in public organizations, 5 were information technology and digital transformation managers, 4 were data governance, analytics, or information systems specialists, and 4 were university faculty members or public-sector digital transformation consultants. Regarding educational level, 7 participants held a master's degree and 14 held a doctoral degree in fields related to public administration, information technology management, information systems, industrial management, organizational development, data science, or policy studies. The participants' work experience ranged from 6 to 24 years, with an average professional experience of approximately 13.8 years. All participants had direct professional or academic experience with digital transformation, data-driven decision-making, e-government, organizational modernization, or public-sector information systems. This composition indicated that the expert panel had sufficient theoretical knowledge and practical familiarity with the administrative, technological, managerial, and policy-related conditions influencing digital transformation deployment in Iranian public organizations.

Table 1 presents the final components of the data-driven digital transformation deployment model after reviewing the literature, analyzing expert interviews, removing overlapping concepts, and confirming the contextual relevance of the



extracted components. The final model consisted of 10 main components that collectively represented the strategic, technological, organizational, cultural, data-related, and governance dimensions of deployment.

**Table 1. Final components of the data-driven digital transformation deployment model**

Code	Component	Operational description	Expert confirmation
C1	Digital leadership and strategic commitment	The commitment of senior managers to digital transformation, allocation of organizational resources, creation of a shared digital vision, and continuous support for data-driven reform.	21 of 21 experts
C2	Data governance and regulatory alignment	Establishment of rules, ownership structures, access policies, standards, legal requirements, and institutional mechanisms for the appropriate use and management of organizational data.	21 of 21 experts
C3	Integrated digital infrastructure and interoperability	Availability of reliable technological infrastructure, integrated information systems, shared platforms, secure networks, and interoperability among internal and external databases.	20 of 21 experts
C4	Data quality, security, and privacy management	Ensuring accuracy, completeness, timeliness, protection, confidentiality, and responsible use of data in accordance with administrative and legal requirements.	20 of 21 experts
C5	Human resource digital competence	The knowledge, skills, attitudes, and adaptive capacity of employees and managers to use digital technologies, data systems, analytical tools, and new work processes.	19 of 21 experts
C6	Process redesign and organizational agility	Reengineering administrative procedures, reducing bureaucratic rigidity, simplifying workflows, and enabling rapid organizational response to technological and data-driven changes.	19 of 21 experts
C7	Evidence-based decision-making culture	Institutionalization of decisions based on reliable data, analytics, performance evidence, organizational learning, and systematic evaluation rather than personal judgment or routine administrative habits.	20 of 21 experts
C8	Citizen-centric digital service design	Designing digital services according to citizens' needs, accessibility, usability, transparency, responsiveness, and the improvement of public service experience.	18 of 21 experts
C9	Performance monitoring and accountability	Continuous measurement of digital transformation outcomes, public service quality, efficiency, transparency, responsibility, and organizational performance indicators.	19 of 21 experts
C10	Inter-organizational coordination and ecosystem collaboration	Cooperation among public organizations, regulatory bodies, technology providers, knowledge institutions, and other stakeholders to support integrated and sustainable digital transformation.	18 of 21 experts

As shown in Table 1, digital transformation deployment in Iranian public organizations was not limited to technological infrastructure alone; rather, the experts identified it as a systemic and multi-dimensional process. Digital leadership and strategic commitment, data governance and regulatory alignment, and integrated digital infrastructure were among the most strongly confirmed components, indicating that deployment begins with managerial commitment, institutional regulation, and technological readiness. At the same time, components such as human resource digital competence, process redesign, evidence-based decision-making culture, and citizen-centric service design showed that successful implementation also depends on organizational change, employee capability, administrative flexibility, and service orientation. The inclusion of performance monitoring and inter-organizational coordination further indicated that data-driven digital transformation requires continuous evaluation and collaboration beyond the boundaries of a single organization. Therefore, the final set of components provided a comprehensive basis for developing the interpretive structural model.

Table 2 presents the structural self-interaction matrix developed based on the collective judgments of the expert panel. This matrix shows the perceived contextual relationship between each pair of components. In the matrix, V indicates that the row component influences the column component, A indicates that the column component influences the row component, X indicates reciprocal influence, and O indicates the absence of a direct contextual relationship between the two components.

**Table 2. Structural self-interaction matrix of the model components**

Component	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	—	V	V	V	V	V	V	V	V	V
C2		—	V	V	O	V	V	V	V	X
C3			—	V	O	V	V	V	V	A
C4				—	A	V	V	V	V	A
C5					—	V	V	V	V	O
C6						—	X	V	V	A
C7							—	V	V	A
C8								—	V	A
C9									—	A
C10										—



The structural self-interaction matrix indicated that digital leadership and strategic commitment had a direct influence on all other components of the model. This finding shows that the experts considered leadership commitment to be the primary initiating force for public-sector digital transformation. Data governance and regulatory alignment had direct relationships with most components and a reciprocal relationship with inter-organizational coordination and ecosystem collaboration, suggesting that regulation and collaboration reinforce each other in public organizations. Integrated infrastructure influenced data quality, process redesign, evidence-based decision-making, citizen-centric service design, and performance monitoring, while it was also influenced by inter-organizational coordination. Human resource digital competence was interpreted as a driver of process redesign, evidence-based decision-making, citizen-oriented digital service delivery, and performance monitoring. The reciprocal relationship between process redesign and evidence-based decision-making culture showed that redesigned processes create better conditions for data-based decisions, while data-based decisions also help organizations revise and improve their processes. Overall, the matrix demonstrated that the deployment model has a layered and interdependent structure rather than a linear sequence of isolated factors.

Table 3 shows the final reachability matrix after converting the structural self-interaction matrix into binary values and applying the transitivity rule. The driving power of each component was calculated by summing the values in its row, and the dependence power was calculated by summing the values in its column. These two values were used to identify the relative influence and dependence of each component in the overall structure.

**Table 3. Final reachability matrix, driving power, and dependence power**

Component	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Driving power
C1	1	1	1	1	1	1	1	1	1	1	10
C2	0	1	1	1	0	1	1	1	1	1	8
C3	0	0	1	1	0	1	1	1	1	0	6
C4	0	0	0	1	0	1	1	1	1	0	5
C5	0	0	0	1	1	1	1	1	1	0	6
C6	0	0	0	0	0	1	1	1	1	0	4
C7	0	0	0	0	0	1	1	1	1	0	4
C8	0	0	0	0	0	0	0	1	1	0	2
C9	0	0	0	0	0	0	0	0	1	0	1
C10	0	1	1	1	0	1	1	1	1	1	8
Dependence power	1	3	4	6	2	8	8	9	10	3	—

The final reachability matrix revealed that digital leadership and strategic commitment had the highest driving power, with a score of 10, meaning that it influenced all other components either directly or indirectly. Data governance and regulatory alignment and inter-organizational coordination and ecosystem collaboration each had a driving power of 8, indicating that these components also functioned as major structural drivers of deployment. Integrated digital infrastructure and interoperability and human resource digital competence each had a driving power of 6, showing that both technological readiness and human capability were necessary intermediate enablers of transformation. Data quality, security, and privacy management had a driving power of 5 and a dependence power of 6, suggesting that it operates as a mediating component between foundational governance-infrastructure conditions and higher-level organizational outcomes. In contrast, performance monitoring and accountability had the highest dependence power, with a score of 10, followed by citizen-centric digital service design with a dependence power of 9. This indicates that these two components are primarily dependent outcomes of the deployment system. In other words, accountability, service quality, and citizen-oriented digital transformation are unlikely to emerge unless leadership, governance, infrastructure, human competence, data quality, and process redesign are established first.

Table 4 presents the level partitioning results obtained through iterative comparison of the reachability sets, antecedent sets, and intersection sets. The components whose reachability set and intersection set were identical in each iteration were assigned to the upper levels of the ISM hierarchy and removed from subsequent iterations until all components were classified.



**Table 4. Level partitioning of the ISM model**

ISM level	Component code	Component	Structural interpretation
Level I	C9	Performance monitoring and accountability	Final outcome of the deployment model; highly dependent on all other structural, technological, and organizational conditions.
Level II	C8	Citizen-centric digital service design	Service-level outcome that emerges when internal organizational and data-driven capabilities are sufficiently developed.
Level III	C6	Process redesign and organizational agility	Intermediate transformation mechanism connecting data, infrastructure, and human capability to service improvement.
Level III	C7	Evidence-based decision-making culture	Intermediate cultural and managerial mechanism reinforcing process redesign and enabling data-based transformation.
Level IV	C4	Data quality, security, and privacy management	Central mediating component that converts infrastructure and governance into reliable and responsible data use.
Level V	C3	Integrated digital infrastructure and interoperability	Technological enabler required for data integration, process redesign, analytics, and digital service delivery.
Level V	C5	Human resource digital competence	Human and organizational capability enabler required for using digital systems and institutionalizing new work practices.
Level VI	C2	Data governance and regulatory alignment	Foundational institutional mechanism that structures data ownership, access, legality, and regulatory coherence.
Level VI	C10	Inter-organizational coordination and ecosystem collaboration	Foundational collaborative mechanism supporting integration, shared standards, and cross-organizational implementation.
Level VII	C1	Digital leadership and strategic commitment	Deepest driving component and primary foundation of the entire deployment model.

The level partitioning results showed that the ISM model consisted of seven hierarchical levels. Digital leadership and strategic commitment appeared at the deepest level of the model, indicating that it is the most fundamental driver of data-driven digital transformation deployment in Iranian public organizations. Data governance and regulatory alignment and inter-organizational coordination were placed at the next level, showing that strategic leadership must be translated into institutional rules, legal-administrative arrangements, and collaborative mechanisms. Integrated digital infrastructure and human resource digital competence were positioned above these foundational factors, indicating that transformation requires both technological capacity and capable human resources. Data quality, security, and privacy management occupied a central mediating level, because reliable and secure data use depends on infrastructure, regulation, competence, and coordination while simultaneously enabling process redesign and evidence-based decision-making. Process redesign and evidence-based decision-making culture were located at the same level, suggesting that structural change and cultural change are mutually reinforcing. Citizen-centric digital service design and performance monitoring appeared at the upper levels, confirming that improved public services and accountability are the final outcomes of a properly deployed data-driven transformation system.

Table 5 presents the MICMAC analysis results. The components were classified according to their driving power and dependence power into independent, linkage, dependent, and autonomous clusters. This classification clarifies which components should be treated as strategic drivers, which components are unstable or mutually influential, and which components should be interpreted as outcomes of the deployment process.

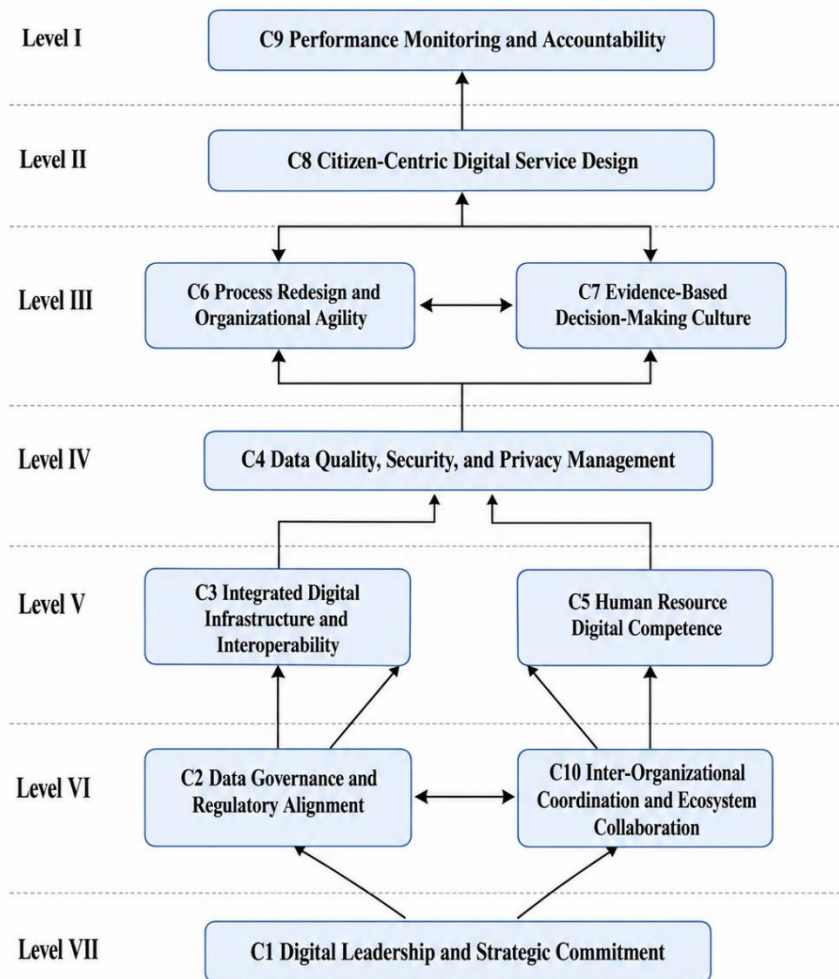
**Table 5. MICMAC classification of model components**

Component code	Component	Driving power	Dependence power	MICMAC cluster
C1	Digital leadership and strategic commitment	10	1	Independent driver
C2	Data governance and regulatory alignment	8	3	Independent driver
C3	Integrated digital infrastructure and interoperability	6	4	Independent driver
C4	Data quality, security, and privacy management	5	6	Linkage variable
C5	Human resource digital competence	6	2	Independent driver
C6	Process redesign and organizational agility	4	8	Dependent variable
C7	Evidence-based decision-making culture	4	8	Dependent variable
C8	Citizen-centric digital service design	2	9	Dependent variable
C9	Performance monitoring and accountability	1	10	Dependent variable
C10	Inter-organizational coordination and ecosystem collaboration	8	3	Independent driver

The MICMAC results showed that digital leadership and strategic commitment, data governance and regulatory alignment, integrated digital infrastructure and interoperability, human resource digital competence, and inter-organizational coordination and ecosystem collaboration were classified as independent drivers. These components had relatively high driving power and



low dependence power, meaning that they strongly influenced the deployment system but were less dependent on other components. Therefore, they should be considered strategic priorities in the implementation of digital transformation in Iranian public organizations. Data quality, security, and privacy management was classified as a linkage variable because it had both considerable driving power and dependence power. This means that it is sensitive to changes in foundational factors such as governance, infrastructure, competence, and coordination, while also influencing process redesign, evidence-based decision-making, citizen service design, and accountability. Process redesign and organizational agility, evidence-based decision-making culture, citizen-centric digital service design, and performance monitoring and accountability were classified as dependent variables. These components represent the visible organizational and service-level consequences of successful deployment. No component was classified as autonomous, indicating that all components had meaningful connections within the model and that none of them was isolated from the overall structure.



**Figure 1. Hierarchical ISM model for deploying data-driven digital transformation in Iranian public organizations**

The hierarchical model demonstrated that the deployment of data-driven digital transformation in Iranian public organizations begins with digital leadership and strategic commitment as the primary foundation. This component provides direction, legitimacy, resource support, and organizational motivation for transformation. At the next level, leadership enables data governance and regulatory alignment as well as inter-organizational coordination and ecosystem collaboration. These two components establish the institutional and collaborative environment necessary for public-sector transformation, especially in contexts where organizations must comply with national regulations, share data across administrative boundaries, and coordinate with multiple stakeholders. The next layer consists of integrated digital infrastructure and human resource digital competence, showing that both technological systems and human capabilities are required before meaningful data-driven change can occur. These factors then support data quality, security, and privacy management, which functions as the central operational mechanism of responsible data use. Once reliable, secure, and high-quality data are available, organizations become better able to redesign processes and institutionalize evidence-based decision-making. These intermediate changes create the

conditions for citizen-centric digital service design, which ultimately supports performance monitoring and accountability. Accordingly, the model suggests that public organizations should not begin digital transformation only by launching digital services or dashboards; instead, they should first develop the deeper managerial, institutional, technological, human, and data-related foundations that make such services sustainable and accountable.

#### 4. Discussion and Conclusion

The present study aimed to design a data-driven digital transformation deployment model for Iranian public organizations using interpretive structural modeling. The findings showed that the deployment of data-driven digital transformation is a hierarchical and interdependent process that begins with foundational managerial and institutional drivers and gradually moves toward technological enablement, data quality, organizational redesign, citizen-centered service delivery, and accountability. The final ISM model consisted of seven levels. Digital leadership and strategic commitment were positioned at the deepest level of the model and were identified as the primary driving force of the entire system. Data governance and regulatory alignment, together with inter-organizational coordination and ecosystem collaboration, were placed at the next foundational level. Integrated digital infrastructure and interoperability and human resource digital competence formed the next enabling layer, followed by data quality, security, and privacy management as a central mediating component. Process redesign and organizational agility and evidence-based decision-making culture were located at the intermediate transformation level, while citizen-centric digital service design and performance monitoring and accountability appeared as the most dependent outcomes of the model. The MICMAC results also confirmed this hierarchical logic by classifying digital leadership, data governance, digital infrastructure, human resource digital competence, and inter-organizational coordination as independent drivers, data quality and security as a linkage variable, and process redesign, evidence-based decision-making, citizen-centered service design, and accountability as dependent variables.

The identification of digital leadership and strategic commitment as the deepest driver of the model indicates that data-driven digital transformation in public organizations is primarily a strategic and governance challenge before it is a technical challenge. This result is consistent with the broader digital transformation literature, which emphasizes that transformation requires active leadership, resource commitment, strategic direction, and institutional legitimacy rather than isolated technological investment (Ciancarini et al., 2024; Escobar et al., 2023). In the Iranian public-sector context, this finding is especially important because public organizations often operate under formalized administrative routines, centralized decision-making structures, and regulatory constraints. Therefore, without explicit commitment from senior managers and policymakers, digital transformation initiatives may remain fragmented, symbolic, or limited to technical modernization. The findings align with studies that describe digital transformation in Iran's public sector as a complex process requiring leadership support, strategic coherence, and policy-level commitment (Danaeefard, 2025; Danaeefard et al., 2024; Karimi et al., 2024). The result also supports national-level research showing that digital transformation must be guided by integrated strategy, governance capacity, and institutional support if it is to generate sustainable public-sector change (Alipour et al., 2024, 2026).

The placement of data governance and regulatory alignment at the second foundational level demonstrates that public organizations cannot become data-driven merely by collecting data or installing information systems. Instead, they need clear rules, standards, ownership structures, access mechanisms, privacy requirements, and legal-administrative alignment. This result is strongly supported by studies emphasizing the centrality of data governance in smart government and digital public administration (Kamaneh et al., 2026; Sahraei, 2023). Data governance is particularly critical in public organizations because public-sector data are often sensitive, distributed across multiple agencies, and subject to legal, ethical, and administrative restrictions. The finding also corresponds with research showing that data quality and data governance are closely connected in Iran's e-government context and that weak governance mechanisms reduce the reliability and usability of public data (Sahraei, 2025). In this sense, data governance functions as a structural precondition for evidence-based policy, digital service integration, and accountability. It also clarifies why digital transformation in public organizations must be supported by regulatory coherence and not simply by technology procurement.

The model also showed that inter-organizational coordination and ecosystem collaboration operate as a foundational driver alongside data governance. This result reflects the reality that public-sector digital transformation requires interaction among ministries, agencies, municipalities, regulatory bodies, technology providers, citizens, and knowledge institutions.



Fragmentation among government systems has been identified as one of the major obstacles to effective digital transformation in Iran, because disconnected systems prevent data exchange, integrated services, and coordinated decision-making (Parsa, 2026). The finding also aligns with studies on ICT development in Iranian cities, which show that digital advancement depends on coordinated infrastructure, institutional collaboration, and urban-level digital readiness (Amiri & Sangar, 2023). Moreover, the government-as-a-platform approach emphasizes that modern public administration should create shared infrastructures and interoperable service ecosystems rather than maintaining isolated organizational systems (Yousefzadeh Baghbani et al., 2025). Therefore, the reciprocal relationship identified between data governance and inter-organizational coordination is theoretically meaningful: governance provides the rules for collaboration, while collaboration increases the need for shared standards, common protocols, and institutional trust.

Integrated digital infrastructure and interoperability were positioned as key enabling components in the model. This finding indicates that data-driven transformation depends on the existence of reliable platforms, integrated information systems, secure networks, interoperable databases, and technological architecture capable of supporting cross-organizational data flows. This result is consistent with public-administration digital transformation research, which emphasizes that technological infrastructure and interoperability are necessary for moving from isolated digital services toward integrated digital government (Ciancarini et al., 2024; Escobar et al., 2023). In the Iranian context, studies on smart government development and e-government governance similarly suggest that infrastructure, integrated platforms, and digital service architecture are central to public-sector transformation (Chabok et al., 2025; Fathi et al., 2024). However, the position of infrastructure at the middle rather than the deepest level of the model is important. It suggests that infrastructure is not the initial cause of transformation; rather, it becomes effective when supported by leadership, governance, and coordination. This interpretation challenges technology-centered views of digital transformation and supports a more systemic perspective in which technology is an enabler embedded within institutional and managerial conditions.

Human resource digital competence was also identified as an independent driver, confirming that transformation depends on people as much as on systems. Public employees and managers must be able to understand digital tools, interpret data, use information systems, adopt new workflows, and participate in organizational learning. This result is consistent with studies emphasizing digital maturity, competence, intellectual capital, and soft organizational capabilities as essential components of digital transformation (Harandi et al., 2025; Modaresi et al., 2024; Shamekhi et al., 2024). It also aligns with readiness-based approaches that identify organizational capability, human capital, and preparedness as key indicators of digital transformation readiness (Hajizadeh et al., 2024). In the Iranian public sector, the importance of human competence is heightened by the fact that many transformation barriers are not purely technical but cultural, behavioral, and administrative. Similar findings have been reported in studies of digital transformation culture drivers and barriers, which show that employee participation, managerial support, digital awareness, and cultural readiness can facilitate or obstruct transformation (Pourmoghaddam et al., 2025a, 2025b). Thus, the present model confirms that developing digital competence should be treated as a strategic deployment requirement, not as a secondary training activity.

One of the most important findings was the classification of data quality, security, and privacy management as a linkage variable. This means that this component is both influenced by foundational drivers and capable of influencing higher-level transformation outcomes. In practical terms, data quality, security, and privacy management convert leadership, governance, infrastructure, competence, and coordination into usable and trustworthy data resources. If data are inaccurate, duplicated, insecure, inaccessible, or inconsistent, public organizations cannot rely on them for decision-making, service design, or accountability. This result strongly supports previous findings on the importance of data quality in e-government and its impact on data governance in Iran (Sahraei, 2025). It also corresponds with research on digital government and e-government governance models, which emphasizes that trustworthy data management is required for the development of digital services and digital businesses (Chabok et al., 2025). The linkage position of this component is theoretically significant because it explains why data quality problems can destabilize the entire transformation system: weaknesses at this level can reduce the effectiveness of infrastructure, undermine evidence-based decisions, weaken public trust, and limit performance monitoring.

The placement of process redesign and organizational agility and evidence-based decision-making culture at the same intermediate level shows that digital transformation requires both structural and cultural change. Public organizations cannot



achieve meaningful transformation if they digitize inefficient procedures without redesigning them. Process redesign allows organizations to simplify workflows, reduce unnecessary bureaucracy, clarify responsibilities, and create more responsive service pathways. At the same time, evidence-based decision-making culture ensures that data are actually used in managerial and policy decisions rather than being collected without strategic value. This finding is consistent with studies that conceptualize public-sector digital transformation as a process of organizational change, not merely technological adoption (Danaeefard et al., 2024; Karimi et al., 2025). The reciprocal relationship between process redesign and evidence-based decision-making is also meaningful because redesigned processes generate better data, while data-based analysis reveals inefficiencies and supports further redesign. This result also aligns with broader evidence from digital transformation studies in Iranian organizations and supply chains, where transformation success depends on the alignment of processes, managerial decisions, technological capabilities, and organizational adaptability (Fazlali Dastjerdi, 2022; Sanati et al., 2024).

Citizen-centric digital service design was identified as a highly dependent component located near the top of the ISM hierarchy. This result indicates that citizen-centered services are not the starting point of transformation but rather an outcome that becomes possible when deeper foundations are established. In other words, public organizations can design accessible, transparent, responsive, and user-oriented digital services only when they possess strategic leadership, governance rules, integrated systems, competent employees, reliable data, redesigned processes, and evidence-based decision-making mechanisms. This finding is consistent with the public-sector digital transformation literature, which identifies citizen value, service quality, and user-centered design as key success outcomes of transformation (Ciancarini et al., 2024; Escobar et al., 2023). It also corresponds with smart government and platform government research, which emphasizes that public services should be designed around citizens' needs and supported by integrated platforms and shared public infrastructures (Fathi et al., 2024; Yousefzadeh Baghbani et al., 2025). Therefore, the model suggests that citizen-centricity should be understood as a strategic outcome of system-level transformation rather than as a superficial interface improvement.

Performance monitoring and accountability appeared at the highest and most dependent level of the model. This finding indicates that accountability is the final manifestation of a mature data-driven digital transformation system. When leadership, governance, infrastructure, competence, data quality, process redesign, and citizen-centered services are properly aligned, public organizations become better able to measure outcomes, evaluate performance, monitor service quality, identify inefficiencies, and demonstrate responsibility to citizens and oversight institutions. This result aligns with e-governance studies that connect digital government development with transparency and anti-corruption capacity (Taghva et al., 2023). It also supports the argument that digital transformation success in the public sector should be assessed not only through technical implementation, but also through organizational performance, service improvement, accountability, and public value (Escobar et al., 2023). In this respect, the present study contributes to the literature by showing that accountability is not an isolated control mechanism; it is the dependent result of a broader deployment architecture.

Overall, the findings extend previous research by integrating separate streams of literature on digital transformation, data governance, e-government, smart government, digital readiness, public-sector challenges, cultural barriers, and organizational capabilities into a single hierarchical model. Prior studies have identified many relevant factors affecting digital transformation in Iran, including national-level transformation elements, structural challenges, digital maturity, cultural alignment, data governance, platform government, and system fragmentation (Alipour et al., 2024, 2026; Danaeefard, 2025; Karimi et al., 2024; Parsa, 2026). The contribution of the present study is that it clarifies how these factors are structurally related and which components should be prioritized in deployment. The results suggest that Iranian public organizations should not begin transformation from visible outputs such as digital portals, dashboards, or citizen-facing services. Instead, they should first establish leadership commitment, governance structures, ecosystem coordination, infrastructure, human competence, and data quality mechanisms. Only then can process redesign, evidence-based decision-making, citizen-centric service design, and accountability become sustainable outcomes.

The present study had several limitations. First, the research relied on expert judgment, and although the selected experts had relevant experience in digital transformation, data governance, public administration, and information systems, the findings may still reflect the perceptions and interpretive assumptions of this particular expert panel. Second, the study was conducted in Tehran, where many national organizations and expert communities are concentrated; therefore, the findings may not fully



represent the conditions of public organizations in smaller cities or less digitally developed provinces. Third, the ISM approach is useful for identifying structural relationships and hierarchical influence, but it does not statistically test causal effects or measure the strength of relationships in a large sample. Finally, the study focused on the deployment model at a general public-sector level and did not examine differences among specific types of organizations, such as municipalities, ministries, regulatory bodies, service agencies, or public enterprises.

Future studies are suggested to validate the proposed model using quantitative methods such as structural equation modeling, partial least squares modeling, or fuzzy DEMATEL in larger samples of public-sector managers and employees. Researchers can also compare the model across different types of public organizations to determine whether the hierarchy of components differs according to organizational mission, size, regulatory environment, service type, or technological maturity. Longitudinal studies would also be valuable because digital transformation is an evolving process, and the relationships among leadership, governance, infrastructure, competence, data quality, process redesign, citizen service design, and accountability may change over time. In addition, future research can examine the role of artificial intelligence, open data, cybersecurity governance, digital ethics, and platform-based public service ecosystems within the proposed model.

From a practical perspective, public managers should approach data-driven digital transformation as a staged and systemic deployment process rather than as a set of disconnected technology projects. The findings suggest that the first managerial priority should be to secure digital leadership commitment, define strategic objectives, allocate resources, and create a shared transformation vision. The next priority should be to establish data governance structures, clarify regulatory requirements, strengthen inter-organizational collaboration, and develop interoperable digital infrastructure. Public organizations should also invest in digital competence development, employee participation, process redesign, and mechanisms for improving data quality, security, and privacy. Once these foundations are established, organizations can more effectively design citizen-centered digital services, institutionalize evidence-based decision-making, and create reliable systems for performance monitoring and public accountability.

### Ethical Considerations

All procedures performed in this study were under the ethical standards.

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### Conflict of Interest

The authors report no conflict of interest.

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