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Analysing the factors for effective data governance: Indian e-governance context

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Abstract

Purpose – This study aims to identify the critical factors and their inter-relationship structure as framework for data governance in e-governance in perspective of India. These critical factors are also been further explored for their priority along with classification into cause and effect categories.

Design/methodology/approach – For this paper, semi-structured interviews were conducted with experts to collect the data. The collected data are further analysed by applying ISM (interpretive structural modeling), MICMAC (matrix impact cross multiplication applied to classification) and DEMATEL (decision-making trial and evaluation laboratory) methodology.

Findings – This study finds 13 critical factors for success of data governance in government. Out of these, "Clear Role and Responsibility" is the most critical factor and "Stakeholder Selection" is the least critical factor. An inter-relationship stricture also been developed using these factors.

Practical implications – The study reveals the critical factors and their relationship for data governance in government. Overall, the results demonstrate a framework that can help public and private organizations to handle important factors for effective and successful data governance in e-governance.

Originality/value – There is lack of study for development of framework for critical factors of data governance in government. This study empirically contributes to literature by exploration and analysis of critical factors and their inter-relationship framework for data governance in government as first study and fill the research gap.

Keywords Data governance, E-governance, Factors, Relationship, ISM, DEMATEL, India

Paper type Research article

Introduction

Under the digital initiative, the Indian government has launched various web and mobile-based applications for facilitating services to citizens. Such digital initiatives, popularly termed e-governance also enable policymakers to make data-driven decisions. Data governance plays an important role for effective e-governance. By establishing clear policies, procedures and standards, data governance helps to manage data assets effectively for compliance with regulatory requirements. To harness the full potential of e-governance, there is a need for effective data governance across the government organization. Effective data governance, ensure that data are accurate, accessible and protected throughout its lifecycle. This enables organizations to make informed decisions, reduce risks and enhance overall operational efficiency. Therefore, the critical factors of data governance for e-governance and interrelationships among these factors are required to be identified and analysed methodically.

Data governance is gaining popularity in government due to the impact of data-related aspects under Digital India initiatives such as data quality, data exchange, data privacy, data security, data mis-utilization, data breach and non-compliance with government guidelines.

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Poor data governance leads to misrepresentation of information due to inappropriate data quality, violation of data privacy and security guidelines, non-adherence to information technology regulations, data decay, etc. (Al-Ruithe & Benkhelifa, 2020). These data assets are required to be governed through well-defined guidelines under data governance. For government, data governance involves adequate governance for data management and planning activities based on defined data strategy. The major challenges associated with data governance are data value recognition, data overview, promoting collaboration, capability development, dealing with multiple practices and navigating across the organizations (Borgman, 2016; Bible, 2020). Nowadays, data governance for e-governance is a necessity because of the involvement of associated operational aspects like accountability, compliance, information exchange, accessibility, security and stewardship of resources. Data governance represents a combination of control and planning for data management challenges while defining responsibility for action (Khatri & Brown, 2010). The data governance also aims to increase the data value assets and control data associated risks (Abraham, Schneider, & Brocke, 2019).

Multiple studies have been conducted on data governance and related topics, including activities, design, maturity model, implementation, suitable framework, critical factors and issues in general, as well as for a specific organization. Limited literature has been reported regarding the framework for data governance in e-governance. Since this study is of multi-criteria decision type, a combination of interpretive structural modeling (ISM), matrix impact cross multiplication applied to classification (MICMAC) analysis and decision-making trial and evaluation laboratory (DEMATEL) is used for analysis. The combination of ISM and DEMATEL method is highly applicable for decision-making process in complex scenarios involving multiple interrelated factors. This hybrid approach allows decision-makers to identify and analyse the hierarchical structure of factors (using ISM) and understand the cause-and-effect relationships among them (using DEMATEL). DEMATEL provides a quantitative assessment of direction and intensity of interactions among factors. ISM-DEMATEL is widely used method for analysis and decision-making in complex systems. ISM is useful for developing hierarchical relations among factors and analysis of the systems, whereas DEMATEL provides a quantitative assessment of direction and intensity of interactions among factors. By integrating these methods, organizations can prioritize critical factors, address key barriers and develop effective strategies for problem-solving and decision-making. This approach has been successfully applied in various fields, such as waste management, automotive, policy planning, manufacturing, demonstrating its versality and effectiveness. The ISM–MICMAC–DEMATEL technique seems appropriate given the similarities in both causal links that can be described by the prominence and relation value in the DEMATEL and the driving and dependent power in the MICMAC. This combined approach allows for a more comprehensive understanding of the relationships among factors, which is not possible with other techniques like AHP (analytical hierarchical process) or SEM (structural equation modeling) alone (Chen, 2021). AHP primarily focuses on pairwise comparisons and may not capture the intricate interdependencies as effectively (Kobryń, 2017), whereas SEM is more rigid and requires a predefined model structure, which may not be suitable for all decision-making scenarios (Zhou, Hu, Deng, Chan, & Ishizaka, 2018). This study addresses the development of a framework by investigating the critical factors that influence data governance execution in e-governance. The study conducted in the Indian context has the following objectives:

(1) To identify factors pertaining to data governance implementation in e-governance

(2) To explore relationship among critical factors of data governance in e-governance using ISM and MICMAC analysis technique.

(3) To identify the order of importance among factors and categorize them as cause and effect using the DEMATEL method

This study analysed the various factors of data governance in Indian e-government context and suggests the critical factors for data governance implementation through a framework based on ISM–MICMAC–DEMATEL method. The findings of this study are expected to help government organizations in terms of developing and implementing a suitable data governance system.

Data governance in e-governance

Data governance is the organizational principle that guides the administration of data, including its gathering, storing, processing, use, sharing and destruction. Data governance is helpful for the delivery of data and reporting services in an effective manner and increases trust in the data. Enhancing the data value and reducing risks and expenses associated with data is the aim of data governance (DAMA International, 2009; Morabito, 2015). The data governance framework encourages shared ownership and self-sovereign identities, risk-based governance, trusted information sharing, stewardship of data and processes (Janssen, Brous, Estevezn, Barbosa, & Janowski, 2020). The procedures, rules, organizational structures, technology and implemented policies constitute a data governance framework. Several other components which contribute for data governance are data quality, data security, technology, architecture, roles and responsibilities, data exchange and integration, etc. Data quality includes many dimensions: accuracy, completeness, timeliness, objectivity, consistency, relevance and believability, which all determine the fitness of data for its use (Strong, Lee, & Wang, 1997). The benefits of effective data governance include enabling decision-making, operational smoothness, a standard approach, enhanced effectiveness, coordinated efforts, cost reduction and ensuring transparency of processes (Kamioka, Luo, & Tapanainen, 2016; Al-Ruithe, Benkhelifa, & Hameed, 2016). All these benefits are also applicable in the context of government organizations through the adoption of a suitable data governance framework.

Good data governance is helpful at the organizational as well as government level for clear digital mission, establish accountabilities, clarity and confidence in data use and comply with related guidelines. For the success of data governance, a suitable, flexible framework is required that can easily be implemented across government bodies as per needs, plans and resource availability. A good data governance framework is able to help organizations with effective data utilization, an achievable mission, clarity about targets, accountability establishment and the definition of measurable successes (Prinzo & Group, 2012). There are various approaches for data governance program implementation at the organizational level. The indicators of data governance in e-governance include: data utilization trends, business innovation and productivity, data-enabled technologies, trust and risks of data misuse, data policies and regulations, and measurement and evaluation of data flow. In India, the data governance framework policy document for the government has been released by the Ministry of Electronics and Information Technology (www.meity.gov.in). It discusses the establishment of rules and guidelines regarding data storage and retention, data quality and meta-data standards, capacity and skill building, ethical and fair data use, policy monitoring and enforcement, awareness, and the institutional framework with the involvement of the state government. From the data collection to the government service output, the data governance framework helps to adapt to the new attributes of digital government (Mao, Wu, Qiao, & Yao, 2022).

Literature review

Governance refers to who take decisions and what decisions are made to ensure efficient management and effective resource utilization, and management refers to decisions for implementation (Fu, Wojak, Neagu, Ridley, & Travis, 2011; Khatri & Brown, 2010). Data governance is an organizational-level framework for assigning roles and responsibilities in

order to sufficiently handle data as an asset (Otto, 2011). Practitioners view data governance as a viable strategy that may help in business operations and enhance the quality and usage of data. Data governance is also considered as an assurance approach by practitioners to maintain and enhance data quality for its utilization. The understanding of data as an asset is the key driver of data governance (Panian, 2010). The consideration of data as a strategic resource and inter-organizational data operations are of significance to gain research attention in the context of data governance. Through data governance, data standards, policies and guidelines in line with an organization's strategy, values, conventions and culture are developed and put into effect (Wende & Otto, 2007). Monitoring of data governance-related activities is important for a fruitful data management program (Alhassan, Sammon, & Daly, 2019a, b).

The data governance framework is beneficial for organizational-level operations, data asset value, improved data auditing and facilitated communication (Mao *et al.*, 2022). For data-driven transformation in the public sector, transparency and trust are crucial, and robust data governance establishes these for enabling effective public services (Wimmer, Neuroni, & Frecè, 2020). The data governance framework comprises a suitable set of accountability measures with emphasis on the purpose of data use (Pascal & König, 2021). ISM and MICMAC analysis help to develop a macro-level conceptual framework for identifying the linkages and hierarchies of factors in problem statements. Literature explains that ISM and MICMAC analysis are used to solve the limited problems of government, particularly for supply chain management, healthcare, cloud ecosystems, technology management, sustainability, etc. (Chen, Nellore, Lin, & Lin, 2021; Novela, Syarief, Fahmi, & Arkeman, 2022). Based on graph theory, the DEMATEL method helps to analyse the contextual relationship between the factors under study along with their criticality order (Mishra, 2021).

The majority of the explored literature related to data governance and e-governance has discussed its applicability and challenges in various government sectors. Some studies have discussed data governance from the perspectives of privacy, law and ethics (Pascal & König, 2021; Marta & Juan, 2022). The literature about data governance applicability for government mainly discusses topics like big data governance, cloud data governance, technology-specific issues, etc. (Changwen & Kuisheng, 2018; Marijn, Paul, Estevez, Barbosa, & Janowski, 2020; Mukhametov, 2021). The available literature pertaining to data governance for government mainly emphasizes data, its movement and stewardship with privacy and security. There is a lack of comprehensive studies aiming at a framework for data governance in e-governance context by considering operational, management and technical aspects. This study attempts to address this gap methodically by using an integrated ISM–MICMAC–DEMATEL approach. Limited literature is available in contexts related to the identification of factors and the hierarchy structural model for data governance in e-governance. Even though, ISM has been widely used in studies such as analysis of cloud computing adoption barriers (Raut, Priyadarshinee, Jha, Gardas, & Kamble, 2018), and the interaction of e-governance implementation barriers for effective service quality (Gupta, Suri, & Singh, 2019).

Research methodology

For developing the government data governance framework, firstly the critical factors are identified, which is followed by establishing relationships among them with their priorities and cause-and-effect categorization. For identification of critical factors, thematic content analysis was conducted based on semi-structured interviews. Interviews were organized with experts from a techno-managerial background in the domain of e-governance. Thematic content analysis is a qualitative data analysis method in which collected information is analysed for the identification of themes. This analysis organizes and describes the data set in detail to interpret different aspects of the interest element. The patterned responses found in the data set are represented by the themes.

In this study, a strategic framework has been developed for data governance implementation in e-governance using ISM, MICMAC and DEMATEL methods. ISM is a decision-support and research method following a systematic approach to deal with complex situations. ISM creates logical links between elements of interest presented as a hierarchical view. In the ISM-based model, the basic assumption is that the identified factors have a dominant influence on data governance in e-governance. The application of ISM has led to a directed graph that represents inter-relationship among factors. The driving and dependence powers of factors are analysed through MICMAC analysis. Further, the priority among factors and the cause–effect relation categorization are established using DEMATEL method. The DEMATEL method is helpful in analysing the cause–effect associations between the components under investigation (Mohammad, Ali, Daria, Mehrbakhsh, & Saeed, 2019). In DEMATEL, the relationships among factors are presented through a map for ease of understanding. In this study, the DEMATEL method is applied to explore the cause–effect relationship among the 13 factors of data governance in the e-governance context. For applying DEMATEL, responses have been collected from experts with practical experience in the areas of data management, data-related project management and policy applications within the government sector.

Semi-structured interviews were conducted with 18 experts working mainly on government projects for data-related work. For data governance, the majority of strategic decisions are taken by higher management and executed by middle and lower management. Therefore, middle and higher management profiles working on data-related activities in the government were found to be appropriate respondents for this study. The respondent possessed knowledge about information technology, project management and data management. After explaining context of the study, the respondents were interviewed in person with open-ended questions pertaining to data governance in e-governance. The excerpts and identified factors from literature were also informed to the experts at the time of interview. The respondents were asked about the critical factors and the corresponding activities related with data governance Two stages of the expert interview were carried out: first, to identify the factors, and then, to gather replies about the ISM approach. For both phases, the same experts were interviewed. The key points of each respondent were noted down for further thematic analysis. The methodology for conducting the study is depicted in Figure 1.

Factors identification

The important factors for the success of data governance in e-governance context were first identified based on review of literature. Relevant articles were searched from Scopus database and Google Scholar using the keywords “data governance”, “government”, “e-governance” and “factors”. Factors identified from the review are presented in Table 1.

Subsequently, semi-structured interviews were conducted with experts to validate these factors from their perspective. The interview contents were analysed using thematic content analysis approach. The emerging factors were discussed again with experts. The finalized factors in relation to data governance in e-governance context along with excerpts from the interviews are summarized below.

F1: Monitoring Data Quality – For data governance, data quality is the condition of data for its usability as per its intended purpose. Monitoring data quality is about the development and observation of data activities for the enhancement and maintenance of data quality. Regular audits of data help to identify and rectify inconsistencies or inaccuracies. High-quality data can be trusted, while low-quality data may lead to misunderstandings, mistakes and misleading outcomes. Data quality can be monitored on various metrics, depending on the planned target aspect of data quality. Good data quality facilitates compliance with policy and standards, data sharing, data storage and management, data utilization and data integration across other systems or data sources.

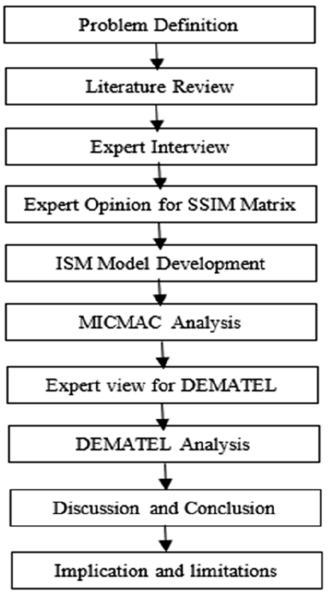

Figure 1. Research methodology. Source(s): Authors' compilation

F2: Policies and Standards – Defined data policy and standards are the foundational blocks for a good data governance program, this helps in achieving defined goals and targets by a government organization. Data standards are a set of defined rules for describing, storing, cleaning, processing and sharing data within or outside a government organization. The primary function of data policy is to develop transparency within organizations about how data is collected, processed, protected and used. Validation and verification of data standards compliance are the responsibilities of the data processing team within the government. Defined policies and standards contributes to high scores of other factors. The defined policy and standards at the organization level are required to be evaluated and updated periodically.

F3: Technology Upgradation – The goal of technology has always been to automate processes and increase efficiency for its users. Technology upgrades can make systems more efficient and reliable to handle operational responsibilities. Old technology-based operations hold the organizations back, and technology acts opposite of what was expected. With advancement and innovation, the pace of technology upgrades is very high. The latest technologies are faster and capable of improving the efficiency of government operations. Technological upgradation is an investment to overcome these hurdles and cost barriers. Since technology is applied for monitoring and management of all defined factors, these factors directly impact others too. Upgradation of technology depends upon know-how of employees, security guidelines and policies, the need for data integration with data quality enhancement, role and responsibility, maintenance, etc.

F4: Clear role and responsibility – For government, the collaborative effort across many roles results in effective data governance. These roles and related responsibilities can be at two levels: operational and tactical. Operational roles are critical for defining and measuring the data governance strategy of the government. These are mainly responsible for defining guidelines for data access cutting across different stages of data life, from creation to archiving and deletion of data. The tactical roles include data steward coordinators and data domain stewards. These roles are for people from cross-functional units of business.

Table 1. Data governance factors

Factors	Description	Sources
Accountability	For data governance, a data stewardship approach based on accountability is advised. The accountability aspect of data governance involves relationships between risk and trust, accountability, privacy and security controls	Felici and Pearson (2015)
Citizen participation	Since the output of data governance affects citizens services in direct and indirect ways, citizen participation is an important element of data governance. Changing needs of citizens also require modifications to the existing governance framework and associated information flow	Zoonen (2020)
Organization perspective	Data sharing between organizations is a feature of the inter-organizational approach to data governance. Collaborative governance mechanisms enable co-value creation by linking the internal perspective with the external sphere of an organization	Lis, Dominik, Otto, and Boris (2020)
Objectives	The major objectives to drive data governance are: data value and its alignment; performance measurement; accountability; and risk management. Data governance ensures alignment between business technology and expected results	Rifaie, Alhajj, and Ridley (2009)
Organization strategy	For data governance implementation, organization strategy is critical. The organization strategy for data governance includes data security, data integration and further development scope as per government guidelines	Ramadhan, Tajudeen, and Jaafar (2024)
Cross divisional issues	For data governance applicability, participation from all levels of the organization is essential to reconcile priorities, encourage the data quality support and expedite conflict resolution	Cheong and Chang (2007)
Organizational and technological factors	For data governance, the success factors at organizational level are clear roles and responsibilities definitions, executive sponsorship, involvement of technology with in business, integration competency and data integration life cycle automation	Al-Ruithe *et al.* (2016)
Clear data roles and responsibilities	The role and responsibility and mapping with individuals for the data activities in the organization are critical for data governance. Ambiguity in roles and responsibilities for data activities have adverse effect on the data governance	Alhassan *et al.* (2019b)
Flexible data tool and technologies	This includes all tools and technologies for the storage, presentation, use and sharing of data. Within data governance, flexible data tools and technologies, appropriate information technology infrastructure is recommended	Alhassan *et al.* (2019a)
Data quality management	A flexible data governance model of organization consists of data quality management guidelines through data quality decision, roles and responsibilities	Weber, Kristin, Otto, Boris, Österle, and Hubert (2010)

(*continued*)

Table 1. Continued

Factors	Description	Sources
Policy and process	The basis of effective data governance is establishment and enforcement of defined processes and policies around the data management	Panian (2010), Brous, Janssen, and Vilminko-Heikkinen (2016)
Data privacy	Despite any general policy limitations, data governance policies must be perceptive to privacy concerns	Tallon (2013)
Compliance	Data governance guides mechanisms for monitoring compliance and benchmarking against established baselines. Checks and balances are applied to the routine work processes to ensure compliance	Thompson, Ravindran, and Nicosia (2015)
Conformance and monitoring	Defining the data and the availability of audit reports to stakeholders. Detection and monitoring of activities related to data and visibility of output	Lee, Zhu, and Jeffery (2017)
Employee data competencies	Within organizations, human activities, including the skills and capabilities of employees, are critical during data governance activities. A definition of the required skills and competencies for each data role is required	Alhassan *et al.* (2019a)

Source(s): Authors' compilation

F5: Measure and Monitor – For effective data governance, monitoring and measurement of data governance activities are also essential. Measurement is critical for determining the effectiveness of operational data governance practices and their improvement. Organizations can assess progress, identify gaps and drive improvements in data governance practices by tracking parameters. Compliance, security, effective measurement, and data quality are critical areas to be considered at the time of parameter selection. The data governance software and tools enable monitoring of parameters and applicable compliance.

F6: Data Communication and Sharing – The data are the centre of data governance, but its true potential can only be harnessed when it is shared across other systems or stakeholders with controlled regulations. Through data sharing, the same data are available to various users and applications within or among the organizations. Data sharing can help organizations to improve operational efficiencies, optimize resources, and drive a defined agenda across the organization. To ensure a long-term data governance program, a clear data communication plan is required, which should be in sync with organizational policy and defined rules. Data sharing is directly related to data storage and management, integrated information, data quality, and policy and standards of organization.

F7: Capacity Building – Capacity building enables workers and organizations to develop competencies and skills that can help them become more effective. For data governance, the capacity-building area includes both managerial and technical skillset enhancement to act as per their defined roles and responsibilities. The capacity-building process enables us to understand and act in a systematic and repetitive manner, considering the roles of the stakeholders. Capacity building helps to improve all other factors of data governance through enhancement of their technical and operational know-how, which ultimately upgrades the data governance of the organization.

F8: Change Management – Data governance sets the scope of change management related to the data cycle, technology and operations and oversees change management activities. Change management refers to the systematic approach for planning, implementing and managing changes related to practices. Through change management, organizations adopt a

continuous improvement culture to ensure long-term success of data governance. The important role of change management in an effective data governance initiative includes overcoming resistance, managing complexity, adoption assurance and continuous improvement.

F9: Privacy and Security – Data security deals with the technical framework for the secure availability of data, and data privacy deals with how the data are collected, shared and used as per the requirements of government organizations. Data governance ensures the consistent and proper handling of data through data availability, consistency, data integrity and data security. Through defined strategic planning, data governance in e-governance improves data security by defining and verifying the requirements of data sharing and distribution policies. Defined policy and standards, technological upgradation, along with capacity building on operations and related aspects, will help to maintain and enhance the data privacy of an organization.

F10: Integration and Collaboration – For data governance, data integration and collaboration have a critical role in uniform and systematic information flow within and across the organization. Data integration and collaboration can be achieved by best practices, software tool capabilities and cross-functional workflows among the technical and business initiatives. Master data management supported by good data quality enables effective data integration and collaboration, ultimately achieving the target through data governance in e-governance. Data integration and collaboration directly depend on data quality, privacy, security maintenance and the organization's existing policies and standards. Changes in any of these factors also impact the others too from the perspective of data governance.

F11: Data Utilization – With the help of data quality, related techniques and defined guidelines, data governance is used to ensure the usability of data for government organizations. Data utilization may be in reference to the current time or for future, considering the business circumstances. Through proper and restricted sharing, data can be utilized in a collaborative manner. Eventually, the target of data governance is to utilize the data at various steps as per outlined roles and responsibilities.

F12: Data Storage and Management – This represents the technical implementation of defined data governance through data storage, data management, its usage and data archiving and deletion policies. Data management creates a trustworthy data foundation to empower data governance. This enables the implementation and enforcement of defined data processes and policies for government organizations. Data management protects the organization from data thefts, losses and breaches with the help of associated authentication and encryption tools.

F13: Stakeholder Selection – The engagement of stakeholders is one of the important catalysts of data governance. Stakeholder engagement at an early and active level can be very rewarding for data governance. Key stakeholders for data governance in government include government bodies, the private sector, civil society, academia and individual producers and users of data. Active stakeholder engagement can be ensured through a clear vision and roadmap for the data governance program that resonates with the stakeholders. Stakeholders must be trained on data governance concepts and their methodologies using interactive learning processes and tools.

Development of ISM model

vvThe ISM model development started with an explanation of the purpose and understanding of this study to the identified experts. The experts are also made aware of the identified factors. Formal interview was conducted with experts. Factors derived from the opinions of experts have been inter-related using ISM. Based on the concept that "factor 'x' will influence factor 'y'", the contextual relationship among factors was developed. With the help of experts' replies after discussion over identified factors, a reachability matrix was developed. After analysing the responses in light of the expert interpretations, a unified statement was created. In Table 2, the symbols for relationships are V, A, X and O. "V" indicates row factors influences corresponding column factor; "A" is a symbol for row factor is influenced by corresponding column factor;

Table 2. Factor matrix with responses

Factors	F13	F12	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1
1. Monitoring Data Quality	O	X	V	V	V	A	A	V	A	A	A	A	
2. Policies and Standards	V	V	V	V	V	X	V	V	V	V	V		
3. Technology Upgradation	X	V	X	X	V	X	X	X	V	V			
4. Clear Role and Responsibility	X	V	V	A	V	X	V	X	V				
5. Measure and Monitor	O	V	O	O	A	X	A	O					
6. Data Communication and Sharing	O	V	V	A	X	O	O						
7. Capacity Building	O	V	O	O	O	X							
8. Change Management	V	O	O	O	O								
9. Privacy and Security	O	A	A	A									
10. Integration and Collaboration	O	V	V										
11. Data Utilization	O	A											
12. Data Storage and Management	V												
13. Stakeholder Selection													

Source(s): Authors' own creation

"X" represents columns and corresponding row factors influence each other; and "O" is symbolic for no relationship among column and corresponding row factors.

Some of the initial reachability matrix's cells are filled by inference and the idea of transitivity for the development of the reachability matrix. Transitivity is explained as follows: if element "a" is related to element "b" and element "b" is related to element "c", then transitivity implies that element "a" is related to element "c". For ISM, transitivity is the basic assumption that is helpful for maintaining conceptual consistency. Table 3 displays the reachability matrix. The final list of factors with their levels is presented in Table 4.

From the reachability matrix, the antecedents and reachability of each factor are developed. The antecedent is a group of factors that may help to accomplish the set objective, and the reachability set indicates factors that may help to realize it (Attri, Dev, & Sharma, 2013). At the intersection, the common factors among the antecedent and reachability sets are allocated. The factors in the highest-level group share the same sets of intersections and reachability. For further level factors identification, the top-level factors are removed. This process is repeated until factors are identified at each level. The final list of factors with their levels is presented in Table 4. For directed graph (digraph) development, the interaction matrix is prepared by translating the direct and significant transitive links of the digraph to "1" and no connections to "0". A diagraph is a directed graph presentation that demonstrates the relationship among factors. With the use of the final reachability matrix and level partitions, the diagraph is prepared. For ISM diagraph, only significant and direct transitive links are considered. The hierarchical relationship among factors is depicted through the developed ISM model as in Figure 2.

MICMAC analysis

MICMAC analysis is applied to explore the indirect relationships among elements of interest. This analysis provides a comprehensive analysis of ISM through the calculation of dependencies and driving forces using a reachable matrix. It avoids the grey area between 0 and 1 and instead explores the link between "yes" and "no." In MICMAC analysis, a graph is developed to classify elements of interest according to their driving and dependent powers. The MICMAC method analyses the driver power and the dependence power of the interest

Table 3. Reachability matrix

	Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	Driving power
F1	Monitoring Data Quality	1	0	0	0	0	1	0	0	1	1	1	0	0	5
F2	Policies and Standards	1	1	1	1	1	1	1	1	1	1	1	1	1	13
F3	Technology Upgradation	1	0	1	0	0	1	1	0	1	1	1	1	1	9
F4	Clear Role and Responsibility	1	0	1	1	1	1	1	0	1	1	1	1	1	11
F5	Measure and Monitor	1	0	1	1	1	1	1	0	1	1	1	1	1	11
F6	Data Communication and Sharing	0	0	0	0	0	1	0	0	0	1	1	0	0	3
F7	Capacity Building	1	0	0	0	0	1	1	0	1	1	1	0	0	6
F8	Change Management	1	0	1	1	1	1	1	1	1	1	1	1	1	12
F9	Privacy and Security	1	0	0	0	0	1	0	0	1	1	1	0	0	5
F10	Integration and Collaboration	0	0	0	0	0	1	0	0	0	1	1	0	0	3
F11	Data Utilization	0	0	0	0	0	1	0	0	0	1	1	0	0	3
F12	Data Storage and Management	1	0	1	0	0	1	1	0	1	1	1	1	1	9
F13	Stakeholder Selection	1	0	1	0	0	1	1	0	1	1	1	1	1	9
	Dependence Power	10	1	7	4	4	13	8	2	10	13	13	7	7	

Source(s): Authors' own creation

Table 4. Factors list and their levels in ISM

SN	Factor code	Factors	Levels
1	F6	Data Communication and Sharing	*I*
2	F10	Integration and Collaboration	*I*
3	F11	Data Utilization	*I*
4	F1	Monitoring Data Quality	*II*
5	F9	Privacy and Security	*II*
6	F7	Capacity Building	*III*
7	F3	Technology Upgradation	*IV*
8	F12	Data Storage and Management	*IV*
9	F13	Stakeholder Selection	*IV*
10	F4	Clear Role and Responsibility	*V*
11	F5	Measure and Monitor	*V*
12	F8	Change Management	*VI*
13	F2	Policies and Standards	*VII*

Source(s): Authors' own creation

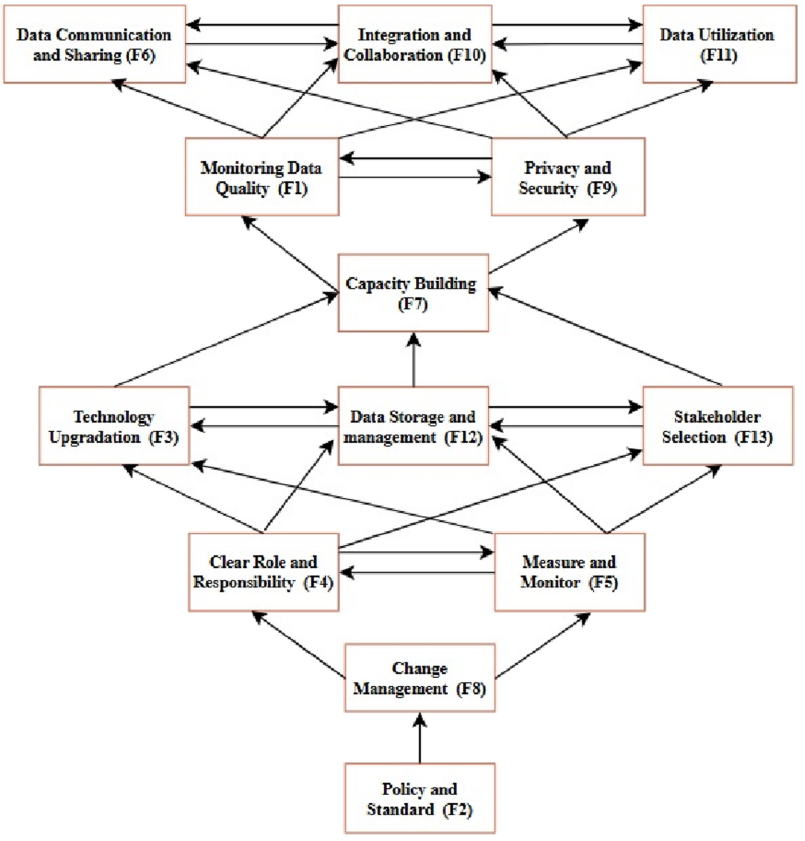

Figure 2. Developed ISM model. Source(s): Authors' compilation

factors. In order to arrive at the study's results and conclusions, MICMAC analysis categorized the elements and validated the interpretative structural model factors. Using the final reachability matrix, the driver power for every factor is determined by summing all of the "1's" in the associated row. Similarly, the dependence power of every element is computed by summing all of the "1's" in the associated column. Following the determination of the driver and dependence power for each factor, the data are plotted in a grid with driving power on the Y-axis and dependence power on the X-axis.

In MICMAC analysis, with identified driving power and dependence power, 13 factors of data governance in e-governance are grouped into four clusters, presented in Figure 3. Cluster I represents autonomous factors that are comparatively away from the system and have null or less dependence on other factors. The cluster of autonomous factors is composed of weak dependence and weak driving power. Dependent factors are in Cluster II, which are mainly dependent on other factors and have low driving power but high dependence. Factors F1, F6, F7, F9, F10 and F12 are positioned in cluster II. These factors are perceived at the upper levels of the ISM model (Figure 2) and are hence considered vital for data governance in e-governance. These factors need high attention of the senior management. Cluster III signifies linkage factors that are unstable and have high influence on other factors. Cluster III comprises factors with high driving power and high dependence. Factors in this cluster are F3, F12 and F13. Because of their comparatively unstable nature, these factors should be handled

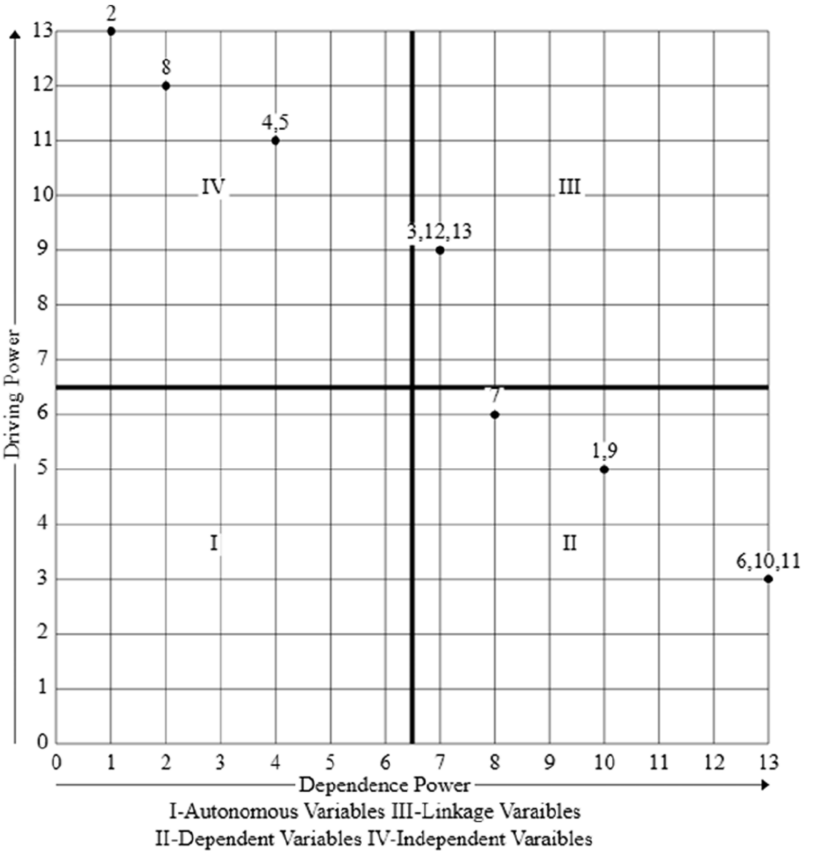

Figure 3. MICMAC analysis – factors plotting. Source(s): Authors' compilation

with care by managers during the execution of data governance planning. Making changes to these factors will have a strong impact on other factors. Cluster IV consists independent factors that are weakly influenced by other factors but need maximum attention. Cluster IV consists of factors with high driving power and low dependence. Factors F2, F4, F5 and F8 are in this cluster. They are positioned at the bottom level of the ISM model hierarchy. These factors are more strategic and basic for the successful execution of data governance in e-governance context. MICMAC analysis shows that "Technology upgradation", "Data Storage and Management" and "Stakeholder Selection" are significant factors for data governance in the context of e-governance, whereas data governance factors "Policies and Standards" and "Change Management" has emerged as least significant.

Analysis with DEMATEL

DEMATEL is one of the methods of multiple-criteria decision-making, which is applied to solve complex problems by evaluating different factors and assigning numerical evaluations to the alternatives. DEMATEL is able to determine the interdependence among factors through a causal structure, in contrast to analytical hierarchy process techniques that rely on the assumption that factors are independent (Shieh, Wu, & Huang, 2010). DEMATEL is applied through these major steps: direct relationship matrix preparation, normalization of the direct relationship matrix, estimation of the total relationship matrix, calculation of the total influence matrix, determination of threshold values and development of the cause relationship diagraph. A direct relationship matrix is prepared from the responses collected from experts on a five point Likert Scale with values as 0 (no importance), 1 (low importance), 2 (medium importance), 3 (high importance), and 4 (very high importance). The identified factors of data governance in e-governance (in Section "Factor Identification") are used for the DEMATEL application. The direct relationship matrix for DEMATEL is finalized by averaging the responses from 18 experts, and after normalization, the total influence matrix is presented in Table 5, which is calculated by formula $T = (t_{ij}) = D * (I - D)^{-1}$. Here T = total influence matrix, t_{ij} = corresponding values in matrix T, D = normalized direct relationship matrix and I = identity matrix. The relationship between cause and effect is investigated in the T matrix after the analysis of the sum of rows and the sum of columns. The sum and difference values of row sum (Ri) and column sum (Cj) are presented in Table 6. Positive value of (Ri-Cj) represents "cause", and negative value represents the "effect" relationship. The values (Ri + Cj) represent the priority order of components for data governance in e-governance, presented in Table 7.

Discussion and conclusion

The study has brought out a framework for data governance in e-governance in terms of important factors, the relationship among these factors along with their position in the hierarchical structure and the categorization of these factors as cause and effect with their importance. Based on review of literature and content analysis of interviews held with experts, thirteen factors have been identified for data governance in e-governance. Linkages and hierarchical relationships among the critical factors have been identified using ISM method. In this hierarchical model, the factor "Policy and Standards" has emerged as the starting node, which indicates that defined government policies are the foundation of data governance. Policies lead to Change Management for further compliance. At the central position in the model are "Technology Upgradation", "Data Storage and Management", and "Stakeholder Selection". All three are related to technological aspects of data governance and are interrelated. The selected technology determines the methodology for data storage and management. The top-level factors are "Data Communication and Sharing", "Integration and Collaboration" and "Data Utilization"; and an action on any one of these three factors affects the remaining two. These are connected with the middle layer through "Capacity Building",

Table 5. Total influence matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	Sum
F1	0.60	0.71	0.78	0.78	0.75	0.77	0.67	0.75	0.76	0.64	0.81	0.66	0.69	9.36
F2	0.66	0.64	0.76	0.76	0.70	0.78	0.64	0.74	0.75	0.64	0.80	0.68	0.66	9.19
F3	0.72	0.75	0.74	0.82	0.74	0.82	0.70	0.79	0.81	0.68	0.82	0.70	0.71	9.81
F4	0.73	0.77	0.86	0.77	0.77	0.83	0.73	0.82	0.84	0.69	0.86	0.72	0.77	10.15
F5	0.65	0.72	0.78	0.78	0.64	0.76	0.65	0.76	0.76	0.64	0.78	0.68	0.68	9.29
F6	0.64	0.72	0.75	0.77	0.70	0.68	0.64	0.72	0.75	0.63	0.75	0.65	0.67	9.08
F7	0.62	0.67	0.75	0.73	0.68	0.72	0.55	0.72	0.70	0.58	0.69	0.61	0.63	8.67
F8	0.63	0.67	0.75	0.75	0.69	0.76	0.63	0.65	0.74	0.62	0.76	0.65	0.68	8.98
F9	0.70	0.76	0.83	0.84	0.74	0.80	0.70	0.79	0.73	0.67	0.85	0.69	0.73	9.83
F10	0.65	0.72	0.79	0.79	0.66	0.74	0.65	0.76	0.76	0.58	0.79	0.67	0.69	9.26
F11	0.68	0.72	0.80	0.78	0.73	0.78	0.70	0.73	0.80	0.66	0.72	0.69	0.71	9.49
F12	0.63	0.70	0.75	0.74	0.69	0.75	0.60	0.71	0.74	0.62	0.78	0.58	0.67	8.94
F13	0.57	0.60	0.65	0.66	0.62	0.64	0.56	0.64	0.64	0.56	0.65	0.57	0.53	7.88
Sum	8.47	9.16	9.99	9.95	9.12	9.82	8.43	9.59	9.75	8.20	10.06	8.54	8.84	

Source(s): Authors' own creation

Table 6. Output of DEMATEL

SN	Ri	Cj	Ri + cj	Ri−Cj
F1	9.36	8.47	17.82	0.89
F2	9.19	9.16	18.34	0.03
F3	9.81	9.99	19.80	−0.18
F4	10.15	9.95	20.10	0.19
F5	9.29	9.12	18.40	0.17
F6	9.08	9.82	18.90	−0.75
F7	8.67	8.43	17.10	0.24
F8	8.98	9.59	18.57	−0.62
F9	9.83	9.75	19.59	0.08
F10	9.26	8.20	17.46	1.07
F11	9.49	10.06	19.56	−0.57
F12	8.94	8.54	17.48	0.40
F13	7.88	8.84	16.72	−0.96

Source(s): Authors' own creation

Table 7. Factors of data governance in e-governance in decreasing order of importance

Code	Factors	Cause/ effect	Value
F4	Clear Role and Responsibility	Cause	20.10
F3	Technology Upgradation	Effect	19.80
F9	Privacy and Security	Cause	19.59
F11	Data Utilization	Effect	19.56
F6	Data Communication and Sharing	Effect	18.90
F8	Change Management	Effect	18.57
F5	Measure and Monitor	Cause	18.40
F2	Policies and Standards	Cause	18.34
F1	Monitoring Data Quality	Cause	17.82
F12	Data Storage and Management	Cause	17.48
F10	Integration and Collaboration	Cause	17.46
F7	Capacity Building	Cause	17.10
F13	Stakeholder Selection	Effect	16.72

Source(s): Authors' own creation

"Monitoring Data Quality", and "Privacy and Security". "Monitoring Data Quality" and "Privacy and Security" are at the same layer and influence each other within the model.

Application of the DEMATEL method explores the cause-and-effect relationship among factors. Out of 13 factors, 8 are in the "Cause" category, and 5 are in the "Effect" category. The factors under the "Cause" category are "Privacy and Security", "Policies and Standards", "Clear Role and Responsibility", "Measure and Monitor", "Capacity Building", "Integration and Collaboration", "Integration and Collaboration", and "Data Storage and Management". The remaining 5 effect category factors are: "Technology Upgradation", "Data Communication and Sharing", "Change Management", "Data Utilization", and "Stakeholder Selection". Out of 8 "Cause" factors, "Clear Role and Responsibility" is of the highest importance, and "Capacity Building" is of the lowest importance. Among the "Effect" category, the factor "Technology Upgradation" is of the highest importance. The cause-and-effect diagraph depicting the position of factors of data governance in e-governance is presented in Figure 4. The analysis based on applications of ISM, MICMAC and

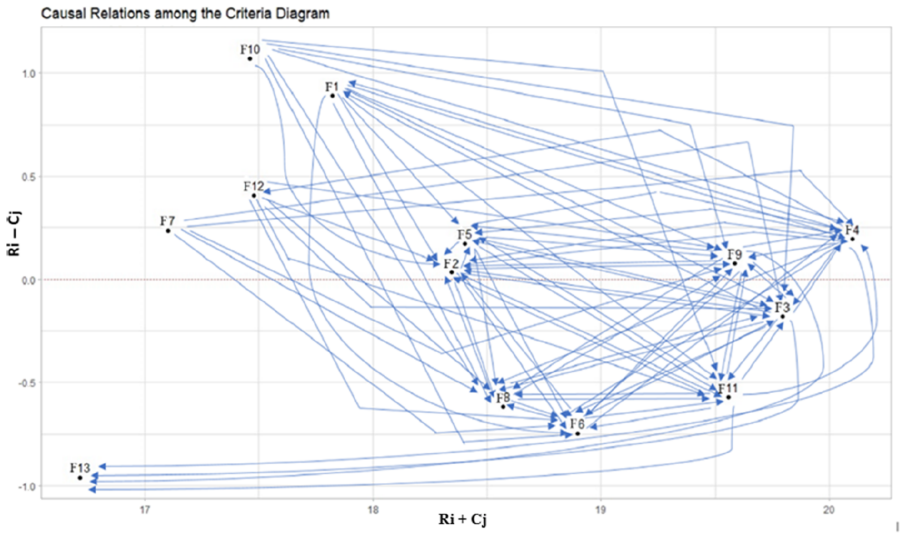

Figure 4. Causal relation diagram. Source(s): Authors' compilation

DEMATEL methodologies has helped in understanding the interplay of important factors of data governance in e-governance, particularly in Indian context. Through the integrated ISM–MICMAC–DEMATEL model, the factors are ranked and the importance and effect of each factor are quantified.

This study emphasizes the factors of data governance in government, which are essential for effective implementations of e-governance projects and ensure informed decision-making and public trust. Effective data governance practices by timely handling of key factors as per their inter-relationship enable seamless data quality across the system, data integration among different data sets, enhance transparency and enablement for compliance with regulatory guidelines. By prioritizing the identified factors of data governance, governments can leverage data to drive sustainable development, improve public services and enhance civic engagement. This research underscores the importance of key factors, their roles and relationship for effective data governance in government and establishing path for execution of e-governance projects. Additionally, the developed frameworks mitigate risks associated with data breaches and privacy protection, system security, and technology management, fostering a culture of accountability and efficiency within government institutions.

Through this study, an attempt has been made for the identification and establishment of interactions among the important factors as a framework for data governance in e-governance. Previous works have explored the factors influencing the data aspects of government projects but were not specific to the development and implementation of data governance. The ISM–MICMAC–DEMATEL combined method is found suitable to understand the relationship among critical factors. The study has contributed by suggesting hierarchical and cause–effect relationship of the identified factors for data governance in e-governance. By adopting the ISM–MICMAC–DEMATEL methodologies, the study offered new understandings over the earlier research in recognizing the importance and impact of factors.

This study addresses a literature gap by generating insights about the factors related to data governance in governments. Efficient digital transformation through this developed framework will be very helpful for strategic planning related to data governance in e-governance. For government policymakers, robust data governance is essential in ensuring that data are accurate, secure, and ethically used, which is fundamental for making informed

decisions and building public trust. Effective data governance practices facilitate the integration of data from diverse sources, enhance data quality, and promote transparency. By prioritizing data governance factors, policymakers can fully leverage data to drive sustainable development, improve public services and ultimately enhance the quality of life for citizens. This ISM–MICMAC–DEMATEL based research on data governance has significant implications for academic research, particularly for the government sector. The insights developed can guide policymakers in formulating strategies for effective data governance in government.

Limitation and future direction

In this study, an effort has been made to establish a theory regarding factors affecting data governance in e-governance. The applied ISM methodology is based on the views of the experts, which may be biased, and the findings of the study may be affected. This may also have a negative impact on the overall data governance plan. This study is based on the inputs from experts from India only. As such, the results may differ for other countries. This study focused on a model for overall data governance in e-governance. Further studies can be conducted for subcomponents of data governance like data quality, policy and standards, technology management, change management, etc. Similarly, the interrelationships among factors might be developed through fuzzy-ISM or TISM or an alternate methodology. This study can also be expanded by utilizing fuzzy MICMAC to determine the binary digits' confinements. The study is generic in nature and based on all government services to citizens through e-governance. Application, to further domains like banking, legal, taxation, human resource, etc. and in the context of other developing countries may be further explored. A survey based research can also be conducted for statistical validation of the framework development. Such studies can also be conducted specific to a country or domain or project. Additionally, a questionnaire-based survey based on sector-specific data governance can be used to provide statistical validation. Future research related to data governance may focus on the integration of emerging technologies like artificial intelligence (AI) and blockchain technologies to enhance transparency, efficiency and security in government operations. By fostering interdisciplinary collaboration and innovation, future research can pave the way for more accountable and responsive government institutions.

About the authors

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