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Coordination Efficacy and Risk Control in Digital Governance of Public Sector Infrastructure Projects

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Abstract: This research investigates the critical role of Digital Governance (DG) in enhancing the performance of public-sector infrastructure projects. The study employs a quantitative research design and collects data through a structured survey of 521 public-sector infrastructure professionals. The data were analyzed using Structural Equation Modeling (SEM). The results provide empirical support for a positive and significant direct effect of DG on Project Performance (PP), Coordination Efficacy (CE), and Risk Control (RC). The efficacy of coordination and RC also positively influences PP. Mediation analysis reveals that both CE and RC act as significant partial mediators. These findings suggest that DG is a primary driver of success, and its impact largely stems from improving the project team's ability to synchronize stakeholder efforts and proactively mitigate risks through data-driven oversight. In practice, the findings suggest that policymakers and managers should prioritize institutionalizing digital governance to shift from reactive administrative oversight to a proactive, transparent management model. By fostering a digital-first environment, public agencies can improve efficiency, accountability, and performance of large-scale infrastructure projects.

Keywords: Digital Governance (DG); Project Performance (PP); public sector infrastructure; Coordination Efficacy (CE); Risk Control (RC).

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1. Introduction

Public sector infrastructure projects are the foundational pillars of national development, yet they have historically been characterized by systemic inefficiencies, including staggering cost overruns and chronic delays that threaten national economic stability (Sadat et al., 2025). As governments worldwide face unprecedented pressure to deliver high-quality infrastructure amid tightening fiscal constraints, the adoption of Digital Governance (DG) has emerged as the most viable means of modernizing project delivery (Rashid and Rasheed, 2026). Prior research has made significant strides in understanding how technology use affects Project Performance (PP), yet a critical synthesis is still lacking. For instance, scholars have established that DG is vital for ensuring accountability and optimizing resource allocation in public projects (Harun, 2026). Similarly, recent studies have demonstrated that digital technology can improve evidence-based decision-making and stakeholder engagement in sustainable infrastructure (Tumpa and Naeni, 2025). In the realm of operational project management, studies have explored the management of Information and Communications Technology (ICT) macroprocesses in specific government contexts to identify risks associated with resource distribution (Catapan, 2026).

Though existing literature acknowledges that digital governance influences project success, there is a lack of empirical evidence regarding the internal mechanisms that translate digital mandates into project outcomes. Sitanggang and Rizkin (2026) noted a need to connect ICT-driven governance practices with PP goals, yet the quantitative evidence remains fragmented. Current studies rarely examine the effects of DG on coordination and RC as mediating drivers for PP (Rashid et al., 2024). This research addresses this 'governance-performance gap' by answering five research questions in the context of public sector projects: 1) What is the relationship between DG and PP? 2) What is the effect of DG on Coordination Efficacy (CE) and RC? 3) How do CE and RC influence PP? 5) What is the role of CE in the relationship between DG and PP? 6) What is the role of RC in the relationship between DG and PP?

Unlike prior studies that treat coordination or risk in isolation (Sitanggang and Rizkin, 2026), this study investigates them as concurrent pathways through which DG operates. The urgency of this research is underscored by the governance gap, in which rapid technological advancement often outstrips traditional administrative frameworks, leading to wasted public funds and compromised infrastructure (Noorzai et al., 2026). The study highlights the role of DG in large-scale public-sector projects, which are mostly managed manually through tedious approval processes. The major contribution of DG in public-sector projects seems to be improved coordination among different government departments and private entities, which is a fundamental cause of inefficiency, delays, and jurisdictional impediments (Topalić et al., 2026). This study is novel in that it focuses on public sector projects whose outcomes are usually non-profit and public welfare-oriented, and the waste of resources due to a lack of digitization, coordination, or RC is seldom documented. This study provides policymakers with the empirical evidence needed to justify digital investments and offers project managers a strategic roadmap to leverage coordination and RC as levers for success.

2. Literature Review

2.1. Digital Governance in Public Sector Infrastructure Projects

DG can be defined as the adoption of ICT technologies and supportive institutional frameworks to improve an organization's operations (Topalić et al., 2026). In public administration, the adoption of DG represents a revolutionary shift from traditional bureaucratic methods towards a new era of agile and transparent systems (Tariq, 2025). From an infrastructure investment perspective, DG provides the necessary structural framework for coordinating various infrastructure investment programs with digitalization objectives (Rashid and Rasheed, 2026).

DG is a distinct construct and is defined as "an all-encompassing package of hardware, software, and connectivity along with digital policies, procedures, and standards for effective use of digitization and technology for development, use, and management of resources" (Mahmood et al., 2025). It involves centralized control, aligning digital strategies with institutional authority to drive project design and oversight across all stages (Khatib et al., 2022). DG forms a multi-level structure that connects higher-level digitalization strategies with operational-level project implementation (Tariq, 2025). In modern theory, DG establishes digital standards and performance indicators (matrices) for monitoring projects in real time (Tumpa and Naeni, 2025). By establishing digital maturity and policy stewardship, DG institutionalizes accountability within the digital system with human oversight mediated by algorithms and automated data streams. Other related constructs lack one or the other aspect of DG, as explained in Table 1.

Table 1. Distinguishing DG from related constructs

Construct	Primary Focus	Key Distinction from DG
ICT Adoption	Procurement and installation of hardware and software.	It is a precursor or antecedent; DG is the subsequent oversight for decision-making (Mahmood et al., 2025).
E-Governance	Citizen-facing service delivery and democratic processes.	While E-governance focuses on external relationships with citizens, DG focuses on internal management and regulatory standards (Mohammed and Taborda, 2023).
Digital Project Management	Operational use of tools for day-to-day tasks.	Digital Project Management is tactical; DG is strategic and institutional, setting the standards to follow (Liu et al., 2023).
Information Systems	Data storage and retrieval mechanisms.	Information systems are the repositories; DG is the normative framework that defines access, accountability, and the use of data in governance-level choices (Khatib et al., 2020).

2.2. Project Performance (PP) in Public Sector Infrastructure Projects

Time, cost, and quality were traditionally used to assess the performance of public works, but current perspectives on project success have expanded to include stakeholder satisfaction and sustainability (Tariq, 2025). A high-performing project is one that can control coordination variables and reduce the gap between planned and actual results (Topalić et al., 2026). For infrastructure projects, performance tends to suffer due to a lack of coherence among stakeholders and the magnitude of the required investment; efficiency thus becomes an important national issue (Tumpa and Naeni, 2025). Public sector projects are usually resource-constrained and require a higher degree of effort synchronization and risk management to avoid wastage and delays (Tanveer et al., 2025).

2.3. Coordination Efficacy in Infrastructure Projects

CE refers to the ability of project participants to coordinate their activities, communicate effectively, and work towards shared objectives. Studies reveal that coordination-related variables are the leading contributors to efficiency in construction projects, as they affect resource allocation (Rashid et al., 2025). Coordination effectiveness in the context of complex public works entails coordinating among government organizations, contractors, and suppliers to prevent information gaps that could hinder the project (Tumpa and Naeni, 2025). Through effective coordination, conflicts are avoided, thus maximizing the use of available resources.

2.4. Risk Control in Infrastructure Projects

RC is the systematic approach to recognizing, evaluating, and controlling threats that could compromise the project's successful implementation. In relation to the digitalization of government operations, risk management processes play a key role in identifying potential risks related to resource allocation and the deployment of ICT infrastructure (Catapan, 2026). Infrastructure development is inherently risky due to its lengthy time frame and the complexity of stakeholder relationships. Failure to manage these risks results in major cost overruns (Tariq, 2025). Effective RC measures enable projects to withstand unexpected challenges without compromising efficiency (Rashid et al., 2024).

2.5. Relationship Between DG and PP

DG has emerged as a critical catalyst for ensuring successful project implementation, guiding decision-making and resource allocation. The adoption of digital technology in project management makes the processes transparent and efficient (Topalić et al., 2026). Evidence suggests that e-governance systems help make timely decisions based on real-time data, a crucial element in the success of large infrastructure projects (Tumpa and Naeni, 2025). Moreover, DG makes public project handlers more accountable by maintaining an indisputable audit trail. The transparency thus created serves as a deterrent to corruption and inefficiencies, which have long impeded infrastructure performance. With such controls now embedded in DG systems, the government will be able to use its resources efficiently and ensure the success of its projects (Sadat et al., 2025). The positive link between DG and PP stems from the effective management of administrative processes through digitization. Therefore, it is hypothesized that:

Hypothesis 1: DG has a positive and significant relationship with PP in public sector infrastructure projects.

2.6. Relationship Between DG and CE

The adoption of DG facilitates coordination among various actors throughout all stages of implementing a large-scale public project. Through a common platform, DG reduces the gaps between government departments and private firms working on the project (Tumpa and Naeni, 2025). The use of such a platform facilitates coordination. Additionally, the DG framework establishes the rules necessary for interoperability among the organizational frameworks used by various stakeholders in the implementation process (Canedo et al., 2022). Through DG, coordination barriers are greatly diminished. In addition, digital technology makes real-time communication possible. This is vital to maintain coordination efficiency in a dynamic environment. Real-time updates and problem solving through digital technology reduce delays (Tariq, 2025). Hence, the speed and accuracy of information exchange improve significantly, leading to better coordination. Creating an atmosphere of openness and information sharing through DG allows people to function as one cohesive team (Harun, 2026). It is hypothesized below:

Hypothesis 2: DG has a positive and significant relationship with CE in public sector infrastructure projects.

2.7. Relationship Between DG and RC

The concept of DG is crucial to improving RC. With the help of automated risk reporting and analytics, project managers can detect any possible risks long before they occur (Noorzai et al., 2026). DG helps embed risk-management macroprocesses into the regular activities of government organizations (Canedo et al., 2022). Through DG, it is possible to standardize the processes of threat detection and prevention for all members of the project team. DG provides the visibility needed to manage risks in resource administration (Rashid and Rasheed, 2026). Because everything is recorded digitally, it is easier to spot deviations in resource usage or schedule delays, enabling quick intervention. It is essential to have such oversight to manage risks in public-private partnerships for large-scale projects. Actually, DG provides the necessary digital infrastructure and governance framework for effective risk management, making it an ongoing digital activity rather than a periodic evaluation (Tumpa and Naeni, 2025). It leads to the following hypothesis:

Hypothesis 3: DG has a positive and significant relationship with RC in public sector infrastructure projects.

2.8. Relationship Between CE and PP

Coordination efficiency plays a crucial role in determining project success, particularly in the construction and infrastructure industries, due to the high level of interdependence among the tasks being executed. Coordination efficiency leads to better delivery of manpower and materials at the right place and time, thereby reducing wastage of time and materials (Rashid et al., 2025). If coordination efficiency is in place, project processes will flow smoothly. Studies conducted using structural equation modeling have shown that coordination variables play a strong direct role in determining the performance of construction projects (Sitanggang and Rizkin, 2026). Coordination enables better use of technical capabilities, helping consultants, contractors, and suppliers work together effectively. Highly efficient coordination also reduces rework costs, since everyone agrees on the required project specifications at the outset (Catapan, 2026). Misunderstandings between the customer and the construction company can be problematic in large-scale projects. However, proper coordination would eliminate such problems (Tumpa and Naeni, 2025). Those projects with higher coordination efficiency will perform better. Consequently, it is hypothesized below:

Hypothesis 4: CE has a positive and significant relationship with PP in public sector infrastructure projects.

2.9. Relationship Between RC and PP

Risk management is crucial to ensuring that public infrastructure projects continue on their performance trajectory. RC systems aim to mitigate issues such as cost overruns, technological glitches, and environmental risks to ensure that projects remain within their budgetary and time parameters (Rashid et al., 2024). It has been found that effective RC mechanisms in public institutions are instrumental in protecting resource allocation and project implementation processes from inefficiencies and delays (Sitanggang and Rizkin, 2026). In addition, risk management increases stakeholder confidence, which indirectly improves PP through sustained backing and the availability of resources from government sponsors (Khatib et al., 2020). Consequently, the achievement of the time lines and objectives of the project in the long run becomes easy (Tumpa and Naeni, 2025). Actually, risk management is the protective factor that safeguards PP in rapidly changing internal and external environments. These arguments lead to the following hypothesis:

Hypothesis 5: RC has a positive and significant relationship with PP in public sector infrastructure projects.

2.10. Mediating Role of CE

DG creates an environment in which CE can bolster PP (Tariq, 2025). The mediating influence of CE is, in fact, generated by DG, which creates suitable conditions for effective communication among all stakeholders (Rashid and Rasheed, 2026). The platform for digital cooperation enables easy coordination necessary for an enhanced PP (Tumpa and Naeni, 2025). The project may possess state-of-the-art DG technology, but it will still not yield any positive outcome if that technology fails to foster coordination between the project contractor and the public body involved. Indeed, CE is the process by which DG benefits are delivered (Yi and Nie, 2024). DG improves coordination, which ultimately improves performance. It achieves its full value only when it produces better coordination. Accordingly, it is hypothesized that:

Hypothesis 6: CE mediates the relationship between DG and PP in public sector infrastructure projects.

2.11. Mediating Role of RC

It is also suggested that RC serves as a mediator in the relationship between DG and PP. In other words, DG facilitates RC. It offers a rich data environment that allows managers to recognize any risk. However, mitigating risk helps safeguard the project (Rashid and Rasheed, 2026a). This means that DG enables RC, which in turn protects the project's outcome. The reason DG mediates itself and PP through RC is that the former helps to develop transparent governance. In this way, managers can implement RC strategies easily (Canedo et al., 2022). Through RC, projects are protected against problems caused by budget overruns and time delays (Harun, 2026). DG serves as an effective mechanism for managing certain ICT-related risks that would hinder performance if left unchecked. In essence, by mitigating these risks, RC enables the DG process to serve as a valuable resource rather than a potential threat (Rashid and Rasheed, 2026). Therefore, it is hypothesized that:

Hypothesis 7: RC mediates the relationship between DG and PP in public sector infrastructure projects.

2.12. Theoretical Framework

The theoretical framework underlying this research largely draws on Sociotechnical Systems Theory, which posits that organizational performance depends on the simultaneous optimization of technical and social subsystems within an organization (Chen et al., 2025). Digital transformation in project management entails behavioral, strategic, and institutional shifts. Moreover, this study incorporates the Dynamic Capability View (DCV), focusing on how organizations leverage digital technology to enhance their performance (Tumpa and Naeni, 2025). DCV implies that DG is not merely a resource but a capability that project managers can use to inform their decision-making processes with real-time information (Seddiki, 2025). This capability enables organizations to detect potential risks and capitalize on efficiency gains. The framework for this study integrates DG as an independent variable, PP as a dependent variable, and CE and RC as two mediating variables (Fig. 1).

The selection of CE and RC as the mediating mechanisms is based on their role in the most important elements of project delivery (time, cost, and quality). Other mechanisms, such as transparency, leadership support, and stakeholder trust, are also important but serve as precursors or contextual factors (Zafar et al., 2026). Contemporary studies treat them as inherent dimensions of DG rather than as distinct mediators (Fathoni et al., 2025). Accountability and transparency are the characteristics of organizations with good governance. In contrast, CE and RC are operational factors that form essential mechanisms for project execution/performance. The Coordination synchronizes efforts while RC regulates uncertainty. Both are essential for DG to produce better PP (Chen et al., 2025; Seddiki, 2025). The CE is the universal mediator that actually forges stakeholders into a productive network (Lin et al., 2019). Similarly, RC serves as the bridge between digital oversight and initiative-taking threat mitigation (Hammouri et al., 2024). By focusing on these two, the model captures the functional reality of infrastructure delivery. Purely environmental factors, such as trust, readiness or leadership, may not adequately capture PP, as they are typical antecedents of good governance (Tariq, 2025).

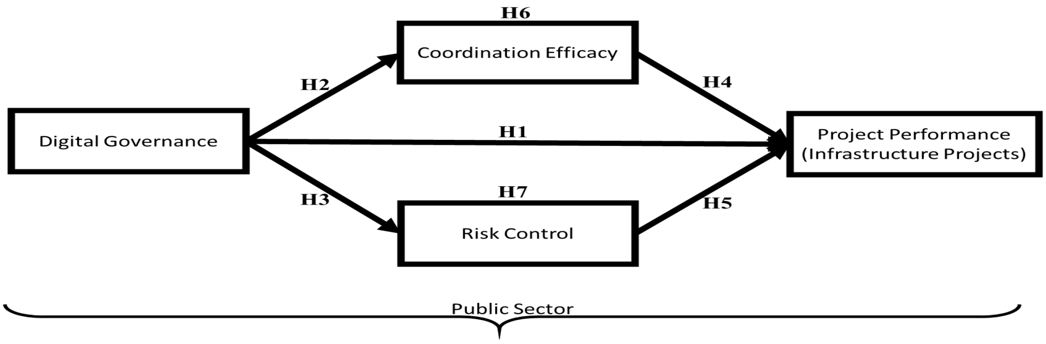

Fig. 1. Theoretical framework for the study

2.13. Research Gap

Despite the tremendous pace of technological advancement, the interaction between digitalization and project management remains incoherent and insufficiently addressed in the existing literature (Chen et al., 2025). Although systematic reviews conducted in recent years have identified governance and leadership as key enablers, there is also an apparent gap in the literature regarding the embedding process of such digital means through methodological intermediation (Tariq, 2025; Najafi et al., 2024). Existing studies mainly focus on the practical application of specific innovations, such as blockchain or BIM, rather than exploring the operational channels of coordination and risk management that lead to improved performance (Yi and Nie, 2024). Additionally, an important knowledge gap remains regarding the consistency of risk factors (Abdelhafiez, 2024). Still, the need for a quantitative investigation into the concurrent mediating roles of coordination effectiveness and risk management is evident (Tumpa and Naeni, 2025). Existing studies tend to focus on conventional, agile, or mixed governance approaches in isolation, without presenting an integrated quantitative model that demonstrates the impact of DG on performance through operational mechanisms (Sitanggang and Rizkin, 2026).

3. Methodology

3.1. Research Design

This study employs a quantitative, cross-sectional, and explanatory research design. A quantitative approach was selected because it enabled objective measurement of relationships between variables and testing of the established hypotheses through statistical analysis (Hammouri et al., 2024; Khasabah et al., 2025). Due to the explanatory nature of this design, it was considered essential for uncovering the underlying mechanisms, specifically the mediating roles of coordination and risk, which explained the way in which DG influenced project outcomes.

3.2. Population and Sampling

The target population comprised people involved in public-sector infrastructure development, including government officials from various ministries, contractors, consultants, and suppliers. Purposive sampling will be used to collect data in this research. The diversity of samples across the entire project ecosystem, with a large sample size, was maintained, providing a high-fidelity view of DG from multiple perspectives. The reason for using purposive sampling in this case is that it enables researchers to select respondents with the necessary skills and experience in managing infrastructure development projects (Tumpa and Naeni, 2025). In this study, 521 valid data points were collected to ensure that the sample size was sufficient for Structural Equation Modeling (SEM) analysis. The projects were related to the construction of transport infrastructure and land-trade cargo processing zones located on the Pak-China border and their inland extensions on both sides of the border (Central Asia Regional Economic Cooperation-Regional Infrastructure Bilateral System (CAREC-RIBS) and China-Pakistan Economic Corridor (CPEC)). Projects were different and were being executed at large-scale. The respondents were selected through personal contacts and were approached via email and WhatsApp links. It was ensured that all respondents had more than two years of association with their respective projects.

3.3. Data Collection and Response Rate

The data-gathering technique employed an adapted questionnaire administered via both electronic and in-person methods with public sector agencies. The total number of questionnaires distributed was initially set at 900. To improve the response rate, three follow-ups were sent, spaced two weeks apart. An improved response rate of 33.3% (176) was observed after the third follow-up attempt. Overall, 521 responses were collected (response rate = 56.3%). To assess non-response bias, an independent-samples t-test was conducted comparing early responders (345, before reminders) and late responders (176, after reminders). The t-test revealed no statistically significant differences in the mean scores of constructs between early and late responders. The test result for DG (mean values 3.87 and 3.84) showed values of $t=0.375$ ($p=0.618$), PP (mean values 4.01 and 4.08) $t= 0.583$ ($p=0.560$), CE (mean values 3.79 and 3.76) $t=0.690$ ($p=0.491$), and RC (mean values 3.94 and 3.90) $t=0.531$ ($p=0.596$). As means remained statistically uniform in both response groups, non-response bias was not detected.

3.4. Research Instruments

The measurement instruments were adapted from validated scales in the existing literature to ensure they were contextually relevant to public-sector infrastructure projects (Appendix A). Adaptation involved refining the terminology to better reflect the nuances of DG and coordination found in construction environments (Table-2). As the instrument was being used for the first time, its content validity was checked by a panel of three experts. After minor adjustments to the language, the instrument was pilot tested with 30 respondents (similar to the actual participants). Pilot testing indicated satisfactory results and the instrument's suitability for the main data collection effort.

Table 2. Adapted measurement instruments

Construct	Operational Definition	Instrument	Reference
Digital Governance	An all-encompassing package of hardware, software, and connectivity, along with digital policies, procedures, and standards for effective use of digitization and technology for development, use, and management of resources.	5-item scale.	(Mahmood et al., 2025; Katib et al., 2020)
Project Performance	The achievement of project goals related to cost, time, quality, and stakeholder satisfaction.	4-item scale.	(Tumpa and Naeni, 2025)
Coordination Efficacy	The capacity of project participants to synchronize efforts and share critical data effectively.	5-item scale.	(Tariq, 2025)
Risk Control	The systematic process of identifying and mitigating threats within digital project environments.	5-item scale.	(Seddiki, 2025)

3.5. Participants Profile

The sample of 521 respondents consisted of a diversified representation of the life cycle of an infrastructure project (Table-3). The largest proportion of respondents, 42%, were employed by government departments, whereas 28% were employed by construction companies. Thus, the viewpoints of both "the governor" and "the governed" were adequately represented in the sample. Regarding respondents experience levels, the sample was experienced, with 52% having more than 10 years of work experience. Education-wise, 53% of the sample had a postgraduate degree.

Table 3. Demographic profile of participants (N = 521)

Variable	Category	Frequency	Percentage (%)
Organization Type	Public Sector Department	219	42.0%
	Contractor	146	28.0%
	Consultant	104	20.0%
	Supplier	52	10.0%
Years of Experience	1–5 Years	94	18.0%
	6–10 Years	156	30.0%
	11–15 Years	182	35.0%
	Over 15 Years	89	17.0%
Job Role	Project Manager	167	32.1%
	Site Engineer/Architect	135	25.9%
	Procurement/Supply Officer	109	20.9%
	Government Administrator	110	21.1%
Education Level	Bachelor's Degree	245	47.0%
	Master's Degree	214	41.1%
	Ph.D./Other Professional	62	11.9%

3.6. Data Analysis Strategy

This study used a two-step approach using the Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS) software for data analysis. This particular technique was appropriate for complex models, especially those that included multiple mediators and distributed data (Xie et al., 2024; Yi and Nie, 2024). Reliability and validity were evaluated using a measurement model, while the structural model was analyzed using path coefficients (beta values) via bootstrapping (Khasabah et al., 2025).

3.7. Ethical Considerations

Ethical considerations were strictly observed throughout the research process. Informed Consent was obtained as part of the questionnaire. This document describes the nature of the study and states that participants can withdraw at any time. Anonymity and confidentiality were strictly observed by not collecting personal data and only giving aggregate data reports. Approval was obtained from the Ethics Committee of School of Sociology and Social Policy, University of Leeds, UK (approval#177-EP23, 26 January 2026).

4. Research Findings

4.1. Descriptive Statistics and Correlation Analysis

The values of all means were greater than 3.70, indicating that the majority of respondents graded all variables above average; however, the standard deviations, ranging from 0.68 to 0.81, indicated that the variables had a comparatively wide spread of grading scores. Such patterns in the means and standard deviations are considered common and not indicative of anything unusual. Similarly, all correlations were as expected. DG was found to be significantly and positively correlated to CE ($r = 0.58$, $p < 0.01$), RC ($r = 0.52$, $p < 0.01$), and PP ($r = 0.64$, $p < 0.01$). Furthermore, the strong relationship between the mediators and PP (0.55 and 0.61) provided initial evidence for the proposed structural model (Table 4).

Table 4. Descriptive statistics and correlation matrix (N = 521)

Serial	Construct	Mean	SD	1	2	3	4
1	Digital Governance	3.85	0.72	1			
2	Coordination Efficacy	3.78	0.81	0.58**	1		
3	Risk Control	3.92	0.68	0.52**	0.45**	1	
4	Project Performance	4.05	0.75	0.64**	0.61**	0.55**	1

Note: N = 521; ** Correlation is significant at the 0.01 level (2-tailed).

4.2. Common Method Variance/Bias

To assess common method variance, a single-factor CFA was conducted by loading all items from all variables onto a single factor. The results showed a poor fit to the data (Chi-Square = 945.5, degrees of freedom (DF) = 152, CMIN/DF = 6.21, CFI = .528, TLI = .495, IFI = .512, RMSEA = .172), which indicated that common method variance/bias was not a concern. A Chi-Square difference test was also conducted by comparing the chi-square values of the two models. The single-factor CFA model (as above) was compared with the measurement model ($\chi 2$ = 348.46, DF = 146, CMIN/DF = 2.866, CFI = 0.962, TLI = 0.951, RMSEA = 0.046). The model comparison revealed a statistically significant Chi-Square difference of 596.9 ($p < 0.001$); hence, common method variance was not detected.

4.3. Validity and Reliability Results

Internal consistency was assessed using Cronbach's Alpha and Composite Reliability. Consistent with established methodological standards, all constructs in this study (DG, CE, RC, and PP) demonstrated high reliability. As shown in Table-5, Cronbach's alpha values ranged from 0.844 to 0.901, and CR values ranged from 0.887 to 0.926. Since all values significantly exceeded the recommended threshold of 0.70, the instruments were taken as highly dependable for measuring the intended constructs.

4.4. Convergent Validity

Convergent validity was verified through Loadings and the Average Variance Extracted (AVE). It was essential to assess the loading of each item on its respective construct using Exploratory Factor Analysis (EFA) because all items of the instrument were adapted, and this was the first time the instrument was being used in a large-scale study, which required validation and reliability tests. During EFA, no loading was found to be less than 0.6. AVE values for all constructs ranged from 0.602 to 0.715 (more than 0.50 threshold), which confirmed that more than 50% of the variance was captured by the construct (Table-5).

Table 5. Construct reliability and validity results

Construct	Items	Factor Loadings	Cronbach's	CR	Average Variance Extracted
Digital Governance	DG1	0.824	0.885	0.912	0.635
	DG2	0.795			
	DG3	0.811			
	DG4	0.768			
	DG5	0.782			
Coordination Efficacy	CE1	0.788	0.862	0.898	0.602
	CE2	0.812			
	CE3	0.754			
	CE4	0.776			
Risk Control	RC1	0.805	0.844	0.887	0.611
	RC2	0.781			
	RC3	0.766			
	RC4	0.792			
	RC5	0.765			
Project Performance	PP1	0.842	0.901	0.926	0.715
	PP2	0.821			
	PP3	0.855			
	PP4	0.838			
	PP5	0.871			

4.5. Discriminant Validity

Discriminant validity ensured that a construct was truly distinct from other constructs in the model. Discriminant validity was verified using the Heterotrait-Monotrait ratio (HTMT) and the Fornell-Larcker criterion. The HTMT values were all below 0.85, indicating that each construct was empirically distinct from the others in the model. As per the Fornell-Larcker criterion, the square root of AVE must be greater than the highest correlation with another construct. It was found that all the values on the diagonal line in the Fornell-Larcker table (square root of AVE) were greater than their corresponding correlations on the off-diagonal lines. These results confirm the measurement model's suitability (Table 6).

4.6. Assessment of Measurement Model

The measurement model (Fig. 2) was formulated in AMOS SEM and consisted of four variables: DG, CE, RC and PP. For improvement of the model, no item was deleted as suggested by scholars like Hier et al. (2020) because the fit indices were within acceptable values and resulted in $\chi 2$ (146) = 348.468, $\chi 2$/df = 2.866, GFI = 0.941, IFI = 0.953, TLI = 0.931, CFI = 0.948, and RMSEA = 0.032, showing that the measurement model had a good fit with the data. EFA and CFA were also necessary because the adapted items were being jointly used in a survey for the first time, and their validity and reliability needed verification. The loadings of all 19 indicators for four constructs of this study were between 0.718 and 0.928, showing high indicator reliability. For construct reliability, all Cronbach's Alpha values exceeded 0.80, which was significantly higher than the conservative standard of 0.70, acceptable for social sciences. Similarly, the composite reliability values were also higher than 0.70. The convergent validity was checked based on the AVE, and all constructs exceeded the benchmark value of 0.50, confirming the reliability of the theoretical constructs. This affirmed that the instrument effectively measured the intended constructs without being affected by measurement errors.

Table 6. Discriminant validity based on Fornell-Larcher criterion

Construct	1	2	3	4
1. Digital Governance	**0.822**			
2. Coordination Efficacy	0.590	**0.781**		
3. Risk Control	0.510	0.420	**0.803**	
4. Project Performance	0.670	0.490	0.550	**0.845**

Note: Bold diagonal values represent the square root of the AVE.

4.7. Collinearity Assessment

Prior to hypothesis testing, the structural model was analyzed for collinearity problems using the Variance Inflation Factor (VIF). Collinearity among independent variables may distort the results since it may lead to biased path coefficients. In the present case, the VIF for DG (1.68), CE (1.54), and RC (1.82) varied between 1.54 and 1.82, which was quite low in comparison with the conservative value of 3.3 or even the popular 5.0. It was evident that there were no problems with multicollinearity, and the structural model was fit for further analysis.

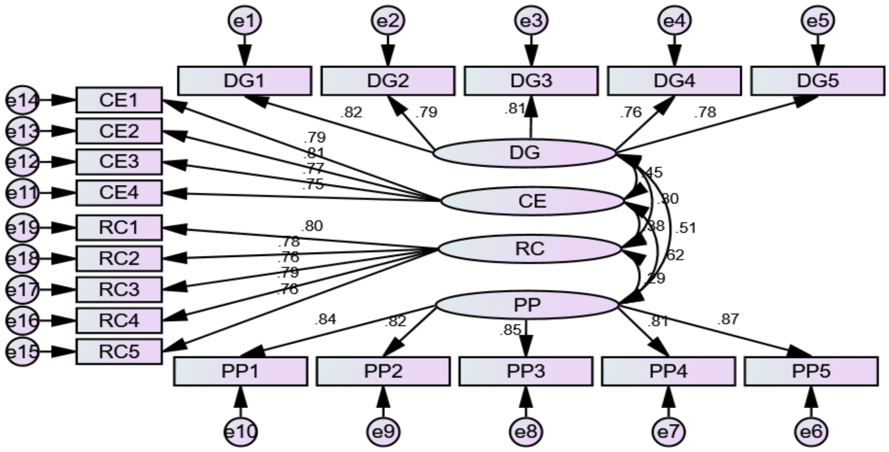

Fig. 2. Measurement model

4.8. Assessment of Structural Model

After successfully validating the measurement model, the second stage of the SEM analysis assessed the structural model (Fig. 3). This stage evaluated the hypothesized relationships among DG, CE, RC, and PP. Model fit indices were $\chi 2$ (146) = 348.468, $\chi 2$/df = 2.866, GFI = 0.945, IFI = 0.956, TLI = 0.934, CFI = 0.952, and RMSEA = 0.034, showing that the structural model had a good fit with the data. Therefore, the associations indicated by the model results were dependable.

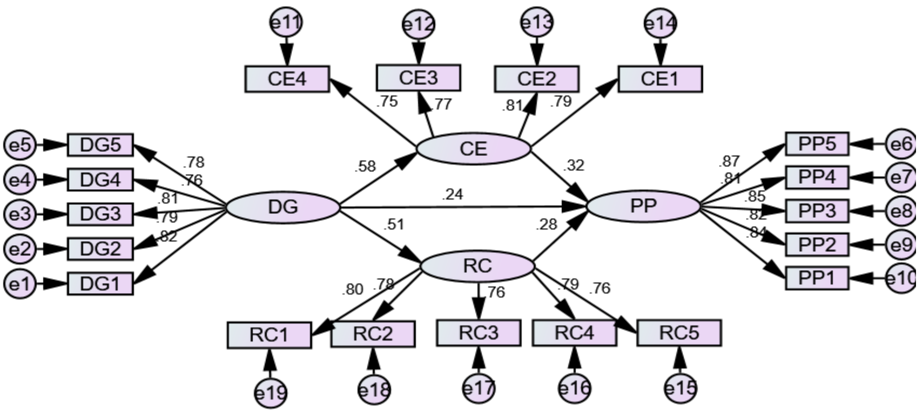

Fig. 3. Structural model

4.9. Path Coefficients and Hypotheses Testing

The analysis of the data provided evidence of a significant and positive effect of DG on the two variables, namely CE and RC, in the context of public sector projects. The greatest effect of DG was observed on CE (β=0.582, p<0.001), confirming the hypothesis that digital architecture played an important role in initiating coordination among stakeholders. In addition, DG was a significant predictor of PP ($\beta = 0.245$, $p < 0.001$). The model's predictive power was evaluated by the Coefficient of Determination (R^2). It showed the amount of variance in the dependent variables explained by the model (Table 7). Thus, for PP, $R^2 = 0.542$ (54.2%). This meant that almost half of the variance in PP was explained by the combined impact of DG, CE, and RC. For CE, the value was 0.338 (33.8%). For RC, the R^2 equaled 0.268 (26.8%). The Effect Size was examined to evaluate the relative influence of each exogenous variable on the endogenous variables. DG had a significant impact on CE (Effect Size = 0.512). At the same time, the Effect Size for RC was 0.366, indicating a medium-to-large impact.

Table 7. Results of Structural model and hypothesis testing

Hypothesis	Relationship	Path Coefficient	T-Value	P-Value	Confidence Interval Lower	Higher	Decision
Direct Effects							
H1	DG→ PP	0.245	4.821	0.000	0.078	0.316	Supported
H2	DG→ CE	0.582	12.354	0.000	0.412	0.743	Supported
H3	DG→ Risk Control	0.518	10.912	0.000	0.362	0.671	Supported
H4	Coordination Efficacy→ PP	0.315	6.542	0.000	0.144	0.386	Supported
H5	Risk Control →PP	0.278	5.891	0.000	0.107	0.448	Supported
Indirect Effects							
H6	DG→ CE →PP	0.183	3.774	0.001	0.021	0.254	Supported
H7	DG→ Risk Control →PP	0.144	3.425	0.001	0.019	0.241	Supported
Total Effects							
	DG→ CE →PP	0.498	10.231	0.001	0.321	0.664	-
	DG→ Risk Control →PP	0.422	9.623	0.001	0.252	0.592	-

Note: PP – Project Performance; CE – Coordination Efficacy; Confidence Interval at 95%.

4.10. Mediation Analysis

The mediation analysis confirmed that both CE and RC served as significant partial mediators in the relationship between DG and PP. The indirect effect of DG on PP through CE was significant and positive (beta = 0.183, $p < 0.001$). Since the direct relationship between DG and Performance (beta = 0.245) was significant, this indicated a state of complementary partial mediation. Similarly, RC partially mediated the relationship between DG and PP. The indirect effect of DG on PP via RC was also significant and positive (beta = 0.144, $p < 0.001$). This represented the impact of DG macroprocesses on performance through the systematic identification and mitigation of threats/risks.

4.11. Robustness Assessment

To ensure robustness of findings against potential biases and default estimation specification errors, the hypothesized parallel mediation model was re-estimated using Generalized Least Squares (GLS). The global fit indices under the GLS estimator revealed an acceptable fit to the data (chi-square/df = 2.88, GFI = 0.937, AGFI = 0.912, NFI = 0.921, RMSEA = 0.047), aligning closely with the primary Maximum Likelihood (ML) fit metrics. A comparative review of the structural paths across both estimation methods demonstrated strict stability. The direct effect of DG on the PP remained positive and statistically significant under both ML (beta = 0.24, $p < 0.01$) and GLS (beta = 0.22, $p < 0.01$). Similarly, the mediating associations through CE and RC showed no directional or significant changes, reinforcing the robustness of the structural findings.

5. Discussion on Findings

The association between DG and PP exhibited that leadership and decision-making in a digital environment greatly enhanced PP within the public sector. This finding was aligned with recent studies conducted by Al Alyani and Lee (2024), according to which DG was crucial for controlling the factors affecting the performance of public projects. Similarly, Chen et al. (2025) pointed out that DG in project management served as a powerful instrument for improving efficiency. The rationale for this finding could be found in the 'transparency effect,' meaning that DG facilitated open communication and reduced information asymmetry (Tumpa et al., 2025). The influence of DG on the coordination of project processes implied that DG was an important structure that integrated all project stakeholders into a single entity. This finding was in consonance with a study by Tumpa and Naeni (2025) arguing that digital technology could help engage stakeholders and synchronize decision-making in sustainable infrastructure projects. Regarding risk, Hammouri et al. (2024) found that information technology significantly enhanced risk identification, which was a prerequisite for effective control.

DG influenced PP and could generate its effects through improvement in the working environment of the project (Topalić et al., 2026). The linkage of CE and PP was in line with the findings of Yi and Nie (2024), where relational governance, assisted by the use of digital technology, was a key factor for construction performance. From a theoretical perspective, this associate was supported by the Socio-Technical Systems Theory on the rationale that better coordination could lead to superior performance (Chen et al., 2025). The mediation of RC leading to PP was supported by the results of a study by Seddiki (2025). This finding could be explained by control theory dictating that teams can engage in micro-level RC to ensure minimum cost and schedule overrun (Abdelhafiez, 2024; Canedo et al., 2022).

The findings of the current study indicated the need to adopt multiple governance mechanisms to enhance performance in large public construction projects, as suggested by Xie et al. (2024). Contrary to prior research efforts that considered governance solely from an administrative perspective, the study, along with studies such as Al Khasabah et al. (2025), adopted a dynamic approach to governance that encouraged teamwork and risk mitigation. In light of this study, it became evident that the digitalization of governance was inevitable in the public sector, given the complexity and stakeholder involvement (Noorzai et al., 2026). In the public sector, digitalization could be an instrumental transformation in providing the necessary Information Infrastructure to bridge the communication gap among stakeholders (Sadat et al., 2025). From the perspective of Information Processing Theory, information-processing requirements can increase in uncertain environments. DG could meet this need in real time by ensuring adequate information flow, thereby improving coordination efficiency and the precision of risk management (Hammouri et al., 2024).

5.1. Theoretical Implications

This study contributes to Project Governance Theory by moving away from the conventional approach of contrasting contractual and relational governance to improve PP. This study takes a more holistic view to understand the present-day realities of managing infrastructures with the integration of technology and governance. From a purely theoretical perspective, the study infers that while the 'Social System' (CE) should work well, there is also the need to focus on the 'Technical System' (DG structures). This study also contributes to Control Theory by revealing DG's nature as a 'macro-level control tool.' An important theoretical contribution lies in identifying two distinct yet equally important ways in which CE and RC mediate between the DG and PP. The results of this study suggest that DG enhances the "information processing capacity" of an organization. From the perspective of the public sector, DG's capabilities can be used to transform real-time information into actions to mitigate risks.

5.2. Practical Implications

In light of this study, public-sector institutions need to focus on implementing DG structures beyond mere documentation. They need to ensure the use of tools that would help in the decision-making process. Project managers should use digital technologies that would provide all parties with uniform information. Practitioners need to use digital dashboards to coordinate the activities of all stakeholders, which would help eliminate potential tensions typical of large-scale projects. Public agencies and departments need to establish digital macroprocesses that cover the entire project from its inception to completion. Policies and regulations should cover the sensitive aspects like competitive bidding, procurement, and quality control through digital platforms. Ethical and operational standards must be clearly set for the digital environment to ensure data integrity, transparency, and accountability. Implementing uniform digital protocols for the development, use, and management of resources ensures that all stakeholders utilize the same metrics for tracking costs, schedules, and quality. Through vertical governance alignment, a structured link can be established between national e-standards and project-specific DG. A transition from periodic paper-based reporting to continuous, real-time digital oversight and faster corrective actions has to be formalized.

To implement these practices, public agencies should follow a multi-phased approach. First, the DG platforms have to be recognized as strategic assets. Second, agencies should adopt open data standards and interoperable systems to ease stakeholders' work. Third, a phased upskilling program for digital literacy of the public sector workforce may be implemented. Lastly, it is essential to ensure policy stewardship by assigning responsibility and accountability for overseeing compliance with digital protocols. Implementing these practices poses a challenge of high initial investment costs. Resistance to organizational change is another barrier posed by stakeholders who seek to avoid the transparency and accountability inherent in digital systems. Similarly, a lack of technical expertise among existing staff may lead to underutilization of sophisticated governance tools. Cybersecurity attacks, information leakage and poor connectivity are significant challenges. In addition, legal and regulatory ambiguity can lead to exploitation by nefarious litigators. Interoperability issues may lead to system failures and reversion to conventional systems.

5.3. Limitations of the Study

The main limitation of this study was the use of a cross-sectional approach, which cannot capture the dynamic changes occurring throughout the project lifespan. The study was limited to infrastructure projects in the public sector; thus, its conclusions cannot be considered universal for the private sector or all industrial sectors. The sample size was limited to specific Chinese regions; legal and cultural peculiarities might have affected the findings. In the current study, DG was considered an integral macro-construct, encompassing numerous technological dimensions. It is likely that the inclusion of all technologies and processes under a single DG umbrella might obscure specific aspects of their impact on project performance and coordination. The use of purposive sampling limited generalizability, but the diversity of participants helped to some extent by adding different perspectives to the data. Self-reported data could be affected due to 'social desirability' and common method bias. Similarly, it is acknowledged that the instrument consisted of adapted items, which could limit construct measurement. This aspect was minimized by the pilot, who evaluated the instrument and then assessed its reliability and validity prior to data collection for hypothesis testing.

5.4. Recommendations for Future Research

To overcome the limitations of a cross-sectional methodology, future studies need to consider adopting longitudinal frameworks to examine how DG affects various stages of an infrastructure project. DG was regarded as a wholesome macro-concept in this study. Future research can focus on dissecting the same by considering particular technologies such as AI, Blockchain, and IoT. Future models ought to incorporate other moderating factors that can affect the association between DG and PP. Some moderating factors to consider include organizational digital readiness, government policy consistency, and organizational culture. Future researchers can enhance generalization by conducting comparative studies in public and private infrastructure projects. Another possibility is to compare green/ sustainable infrastructure projects and traditional projects to see the unique benefits of DG.

6. Conclusion

This study concludes that DG is positively associated with project success and functions in tandem with mediators such as CE and RC. The results indicate that efficient completion of complex infrastructure projects requires a system that minimizes information disparities and supports data-driven monitoring. The probability of mediation paths suggests that DG may be an effective factor in the success of projects, functioning as an informational bridge that enables stakeholders to coordinate their actions and undertake risk mitigation measures. The results obtained from this research also show that DG helps companies adopt initiative-taking management practices beyond standard digital macroprocesses, thereby helping them control project risks. Therefore, the transition of government bodies to a DG approach is crucial. This study is novel as it integrates responses from diverse participants, in addition to the project leaders. The study's framework jointly uses major implementation-oriented variables as mediators, a practice rarely used in other studies. Similarly, DG was considered a performance-based construct, instead of its commonly perceived technical version.

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Institutional Review Board

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Declaration of Artificial Intelligence (AI) Tools

The author used AI tools solely for language editing and readability. The author reviewed and verified all content and takes full responsibility for the accuracy and integrity of the manuscript.

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Appendix A

Measurement Instrument

Code	Measurement Item	1	2	3	4	5
Digital Governance						
DG1	Our project follows a comprehensive framework of digital policies, procedures, and standards.					
DG2	We utilize an integrated system of hardware and software for effective project oversight.					
DG3	Digital protocols are strictly implemented for the management of project resources.					
DG4	Digital governance structure ensures clear identification of accountabilities for data-related processes.					
DG5	Our organization maintains high digital connectivity to support effective decision-making.					
Project Performance						
PP1	The project is effectively achieving its predetermined cost targets.					
PP2	The project activities are within the scheduled timeframe.					
PP3	The infrastructure construction abides by all established quality and technical standards.					
PP4	The project is to achieve an elevated level of satisfaction among all key stakeholders.					
Coordination Efficacy						
CE1	Project participants synchronize their efforts effectively through shared digital platforms.					
CE2	There is a smooth exchange of critical data and information among all project stakeholders.					
CE3	Stakeholders are consistently aligned toward common project goals and objectives.					
CE4	Coordination mechanisms effectively prevent information silos between departments and contractors.					
CE5	Our team demonstrates a high capacity for collaboration during project execution.					
Risk Control						
RC1	We utilize a systematic process for identifying potential risks in the project environment.					
RC2	Initiative-taking measures are being taken to mitigate likely disruptions.					
RC3	The project utilizes data-driven frameworks for objective and rigorous risk assessment.					
RC4	Our risk control mechanisms are fully integrated with cost and schedule monitoring systems.					
RC5	Quantitative methods are continuously used to monitor and control project-related risks.					