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# The Influence of Financial Planning, Budget Control, And Risk Management on Project Performance Through the Mediation of Technological Innovation

Ir. Eko Budi Satoto, M.MT<sup>1</sup>, Budi Santoso, SE., MM, M.Akun<sup>2</sup>

## Abstract

*This research is motivated by the importance of improving the performance of infrastructure construction projects in the midst of limited resources and efficiency demands in developing countries such as Indonesia. Managerial practices such as financial planning, budget control, and risk management are often considered to be key factors, but have not been able to fully explain variations in project performance without considering the role of technological innovation. This study aims to analyze the influence of financial planning, budget control, and risk management on project performance with technological innovation as an intervening variable. The research method used is a quantitative approach by collecting data through surveys of respondents involved in infrastructure construction projects, then analyzed using a structural modeling approach. The results of the study show that budget control has a significant effect on project performance both directly and indirectly, while financial planning and risk management do not have a direct effect, but have a significant effect through technological innovation. In addition, technological innovation has proven to have an important role in improving project performance as the main mediator. The implications of this study confirm that organizations need to integrate managerial practices with the development of technological innovations to improve the effectiveness and sustainability of project performance.*

**Keywords:** *Financial Planning, Budget Control, Risk Management, Technology Innovation, Project Performance.*

## Introduction

"Organizations must be able to adapt rapidly to changing environments to sustain competitive advantage" (David J. Teece, Gary Pisano, 1997). The future vision of the organization, especially in the infrastructure construction sector, cannot be separated from the dynamics of increasing complexity of project management, the demands of cost efficiency, and the pressure on timeliness and quality of work results. Project performance is no longer solely determined by the technical capabilities of the implementation, but also by the extent to which the organization is able to accurately plan finances, control budgets disciplinedly, and manage risks systematically (Ahiabu et al., 2024; Chynybaev et al., 2025). Increasingly intense digital transformation has shifted the project management paradigm from a conventional approach to a technology-driven approach that prioritizes data integration, automation, and analytics-based decision-making (Rajapakshe, 2025). The fundamental question that arises is the extent to which project financial management practices that include planning, control, and risk mitigation are able to adapt to technological innovations to produce optimal project performance.

Various empirical data show that financial planning, budget control, and risk management in

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<sup>1</sup> Universitas Muhammadiyah Jember, Indonesia, ORCID ID: 0000-0003-4668-0091, Email: [ekobudisatoto@unmuhjember.ac.id](mailto:ekobudisatoto@unmuhjember.ac.id)

<sup>2</sup> Universitas Muhammadiyah Jember, Indonesia, Email: [budisantoso@unmuhjember.ac.id](mailto:budisantoso@unmuhjember.ac.id)



infrastructure construction projects still face significant problems. Reports (Audit Board (BPK), 2025) In recent years, it has been revealed that around 30%–40% of government infrastructure projects experience budget deviations and delays in completion, which are largely due to poor initial planning and suboptimal cost control. Data from (Directorate General of Construction, 2021) shows that around 25% of national strategic projects (NSPs) experience implementation delays, mainly due to design changes, field risks that are not identified from the outset, and limited coordination between stakeholders. Study released by (Transparency International Indonesia, 2023) It noted that more than 35% of infrastructure projects experience increased costs due to systematically unmanaged risks, such as fluctuations in material prices, land acquisition constraints, and regulatory uncertainty. This condition shows that although the organization has conceptually understood the importance of these three aspects, their implementation in the field is still not optimal, thus creating a real gap between project planning and realization and having a direct impact on the overall low performance of the project.

Technological innovation has emerged as a key variable that has the potential to bridge this gap. Technologies such as Building Information Modeling (BIM), Internet of Things (IoT), and digital-based project management systems enable increased planning accuracy, budget control transparency, and effectiveness in risk identification and mitigation (Mazzetto, 2024). Technological innovation not only serves as an operational tool, but also as a strategic mechanism capable of integrating various managerial functions in construction projects. The adoption of technological innovation does not always run optimally (Abdulmaksoud et al., 2025). Many organizations still face obstacles in the form of limited human resources, resistance to change, and unpreparedness of digital infrastructure. This condition shows that technological innovation does not automatically result in an improvement in project performance without the readiness of the organization to integrate the technology into the overall project management system.

This research departs from the integration of two main frameworks, namely Resource-Based View (RBV) and Project Management Theory. RBV emphasizes that an organization's competitive advantage is determined by its ability to manage internal resources that are valuable, scarce, difficult to replicate, and irreplaceable (Eisenhardt & Martin, 2000; Makhija, 2003). Financial planning, budget control, and risk management can be seen as strategic internal capabilities that determine the success of a project. One of the main weaknesses of RBV is its tendency to be static and less able to explain the dynamics of environmental change and the role of technology as a catalyst for organizational transformation. Project Management Theory provides an operational framework in managing projects through the stages of planning, implementation, control, and evaluation. This theory often focuses on procedural and technical aspects, so it does not highlight the role of technological innovation as a strategic factor that is able to change the pattern of relationships between variables in a project (Dvir, 2007; Project Management Institute, 2021; Turner, 2006). The limitations of these two theories open up space for a more comprehensive conceptual integration by including technological innovation as a mediating variable that explains the transformation mechanism from managerial capabilities to project performance.

A number of previous studies have confirmed that transformation in construction project management is not solely determined by technological sophistication, but relies heavily on the organization's ability to integrate financial and risk management aspects adaptively. Research by (Sovacool & Ryu, 2025) shows that the imbalance between planning and budget realization is one of the main causes of cost overruns and delays in large-scale infrastructure projects. The findings are reinforced by (Alshihri et al., 2022) which states that failure to identify and manage

risks from the early stages of the project contributes significantly to cost and time inefficiencies. The role of technological innovation in improving project performance has also been widely proven, where (Abiodun Benedict Adeyemi et al., 2024) emphasizing that the application of technology such as Building Information Modeling (BIM) is able to improve planning accuracy and transparency of project control. Research by (Tumpa & Naeni, 2025) It shows that the use of digital technology in project management can speed up decision-making and improve coordination between stakeholders. The effectiveness of such technology is highly dependent on the readiness of the organization in managing its internal resources, as stated by (Teece, 2007) which confirms that organizational capabilities are a determining factor in converting technology into superior performance.

Although various previous studies have examined the relationship between project financial management and project performance, most are still partial in nature by only highlighting the direct relationship between variables without considering the role of technological innovation as a connecting mechanism. Research that integrates the perspective of RBV and Project Management Theory in a comprehensive analytical framework is still relatively limited, especially in the context of developing countries such as Indonesia. The characteristics of construction projects in Indonesia, which are colored by regulatory complexity, limited resources, and unstable environmental dynamics, demand a more contextual and adaptive approach. This gap shows the need for research that is able to explain how technological innovation plays a mediating variable in strengthening the relationship between project financial management practices and project performance.

Based on this description, this study aims to analyze the influence of financial planning, budget control, and risk management on project performance with technological innovation as a mediating variable in infrastructure construction projects. Theoretically, this research is expected to contribute to developing integration between Resource-Based View and Project Management Theory by including technological innovation as a key element in explaining the mechanism of improving project performance. This study seeks to provide evidence on the importance of the role of technological innovation in improving the effectiveness of project financial management practices. This research not only fills gaps in the literature, but also provides practical implications for construction industry players in designing more adaptive, efficient, and technology-based project management strategies amid increasingly complex infrastructure development dynamics.

## **LITERATURE REVIEW**

### **Resource-Based View (RBV)**

The Resource-Based View (RBV) emphasizes that an organization's competitive advantage is determined by the ability to manage internal resources that have valuable, rare, inimitable, and non-substitutable (VRIN) characteristics, so as to be able to produce superior and sustainable performance (Barney et al., 2021; Eisenhardt & Martin, 2000; Makhija, 2003). Financial planning, budget control, and risk management can be seen as a form of strategic capability that represents the quality of organizational resource management. Advanced research shows that organizations that are able to effectively optimize their internal resources tend to have higher levels of project efficiency and are able to reduce the risk of project failure (Ahn et al., 2022; Gerhart & Feng, 2021; Suoniemi et al., 2020). RBV is often criticized for being static and incapable of explaining how organizations adapt to dynamic environmental changes, especially in the face of technological disruption (Eisenhardt & Martin, 2000; Makhija, 2003). These

limitations suggest that although RBV is able to explain the source of excellence, this theory is not yet fully able to explain the mechanism of transformation from resource to performance in the context of rapidly evolving technological innovation.

### **Project Management Theory**

Project Management Theory explains that the success of a project is determined by the effectiveness of systematically managing the planning, implementation, control, and evaluation processes to achieve project goals within time, cost, and quality constraints (Kerzner, 2009; Turner, 2006). In this perspective, financial planning serves as the basis for allocating resources, budget control as a cost control mechanism, and risk management as a tool to anticipate project uncertainty. Empirical studies show that structured and integrated project management practices significantly contribute to improved project performance, especially in minimizing delays and cost overruns (A. J. Shenhar & Dvir, 1996). Nonetheless, Project Management Theory is often criticized for focusing too much on procedural approaches and not considering the role of technological innovation as a strategic factor that can change the dynamics of relationships between variables in a project (Project Management Institute, 2021; Turner, 2006). Therefore, it is necessary to develop a more adaptive conceptual framework by integrating technological innovation as an important element in improving the effectiveness of project management in the digital era.

### **Financial Planning**

Financial Planning is a strategic process in systematically allocating financial resources to ensure the sustainability and efficiency of project implementation (Riinawati et al., 2024). Financial planning plays an important role in determining cost estimates, budget scheduling, and projected funding needs during the project cycle. Research shows that accurate and data-driven financial planning can improve decision-making accuracy and reduce potential budget deviations (Myers & Brealey, 2005). Structured planning also allows organizations to anticipate uncertainty and increase flexibility in the face of changing project conditions (Kamau et al., 2023). However, weaknesses in financial planning, such as unrealistic estimates and lack of information integration, are often the main causes of cost overruns and decreased project performance.

### **Budget Control**

Budget Control is a monitoring mechanism that aims to ensure that the realization of project costs remains within the planned limits (Fedchenko et al., 2022). Budget control not only functions as a monitoring tool, but also as an evaluation instrument to detect irregularities and take corrective action in a timely manner. Empirical studies show that an effective budget control system can improve the efficiency of resource use as well as strengthen accountability in project management (Horngren et al., 2010). Technology-based budget control allows for greater transparency and real-time data integration, accelerating responses to changing field conditions (Khuluq & Rahmawati, 2025). Nonetheless, the main challenges in its implementation lie in the lack of an integrated information system and weak coordination between project teams.

### **Risk Management**

Risk Management is a systematic process of identifying, analyzing, and controlling risks that have the potential to affect the success of a project (Bhatti & Nazir, 2024). In construction projects, risks can come from various sources, such as environmental uncertainty, design

changes, fluctuations in material prices, and regulatory constraints. Research by (Hillson, 2016) emphasizing that proactive risk management is able to increase the chances of project success by minimizing negative impacts and maximizing existing opportunities. In addition, a risk management approach that is integrated with the project planning and control process has been proven to be able to improve the stability of project performance (Aladağ, 2023). However, many organizations still implement risk management reactively, making it less effective in dealing with complex project dynamics.

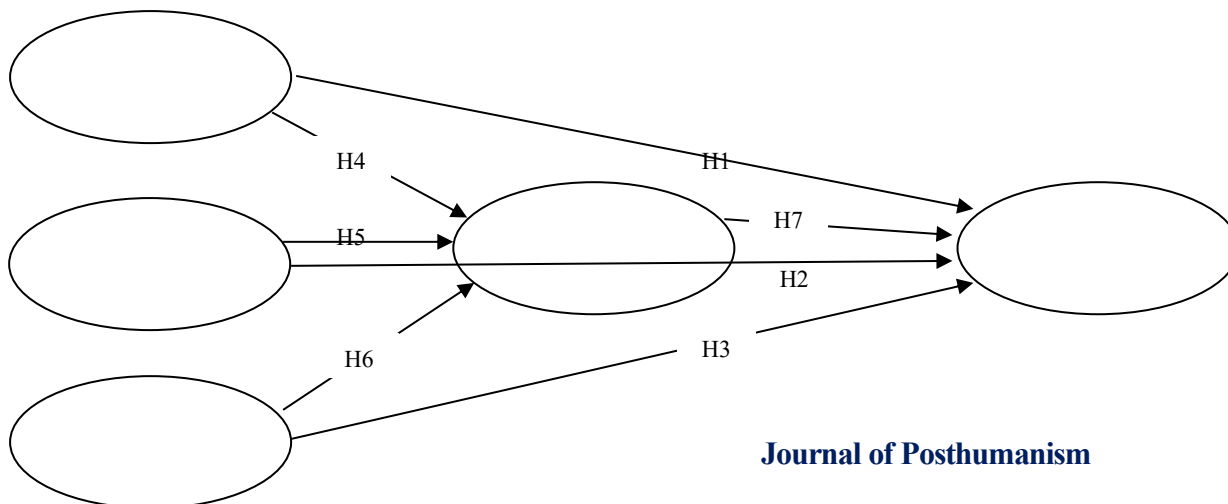
### **Technological Innovation**

Technological Innovation in the context of construction projects refers to the application of digital technology and information systems to improve the efficiency, accuracy, and quality of project management (Qadir et al., 2026). Technologies such as Building Information Modeling (BIM), Internet of Things (IoT), and digital-based project management systems have been proven to improve data integration, accelerate decision-making, and increase transparency in project implementation (Oesterreich & Teuteberg, 2016). Technological innovations also enable process automation as well as improved predictive capabilities in project management, thereby reducing uncertainty and the risk of project failure (Wang & Li, 2022). Technology adoption often faces obstacles in the form of limited resources, organizational resistance, and lack of digital infrastructure readiness.

### **Project Performance**

Project performance is the main indicator in assessing the success of a project which is generally measured based on the achievement of time, cost, quality, and stakeholder satisfaction (Ingle et al., 2023). According to (A. Shenhar & Dvir, 1996), project performance reflects not only operational success, but also strategic success in providing added value to the organization. Research shows that project performance is greatly influenced by the effectiveness of planning, control, and the ability of organizations to manage risks and utilize technology (Aladağ, 2023). In addition, the integration between managerial and technological aspects is a key factor in increasing the success of projects in the digital era. However, many projects still fail to meet the targets that have been set due to poor coordination, lack of control, and inability to adapt to changes in the project environment.

### **Conceptual Framework and Hypothesis Development**



**Source:** Developed by the authors based on prior studies (2026)

**Figure 1.** Conceptual Framework of the Study

Based on the conceptual framework illustrated in Figure 1, this study proposes several hypotheses regarding the relationships among financial planning, budget control, risk management, technological innovation, and project performance in infrastructure construction projects. The model assumes both direct and mediated effects, where technological innovation plays a crucial mediating role in strengthening the relationship between financial management practices and project performance. This framework reflects the integration of Resource-Based View (RBV) and Project Management Theory in explaining how internal managerial capabilities are transformed into superior project outcomes through technological innovation. Therefore, the research hypotheses are formulated as follows.

**H1: Financial planning has a positive effect on project performance in infrastructure construction projects.**

Financial planning plays a fundamental role in determining the efficiency of resource allocation and the feasibility of project execution. Effective financial planning enables organizations to anticipate cost requirements and minimize financial uncertainty throughout the project lifecycle. (Kamau et al., 2023) emphasized that accurate financial planning significantly improves decision-making quality and project outcomes. This finding is supported by (Dabirian et al., 2021), who highlighted that structured financial planning contributes to cost efficiency and sustainability. (Shibani et al., 2024) found that poor financial estimation often leads to cost overruns, indicating inconsistencies in empirical findings.

**H2: Budget control has a positive effect on project performance in infrastructure construction projects.**

Budget control functions as a monitoring mechanism to ensure that project expenditures remain aligned with planned budgets. Effective budget control enhances transparency, accountability, and cost efficiency in project implementation. (Khuluq & Rahmawati, 2025) stated that strong budget control systems improve organizational performance by reducing financial deviations. (Barros et al., 2023) also argued that cost control is a critical determinant of project success. (Chukwuma-Eke et al., 2021) revealed that weak cost control mechanisms still frequently result in budget overruns in construction projects.

**H3: Risk management has a positive effect on project performance in infrastructure construction projects.**

Risk management is essential in addressing uncertainties that may disrupt project execution. Proactive identification and mitigation of risks enable organizations to minimize negative impacts on cost, time, and quality. (Aladağ, 2023) emphasized that effective risk management enhances project success rates. (Song et al., 2025; Unegbu et al., 2022) further highlighted that integrated risk management contributes to improved project stability. Nevertheless, many organizations still adopt reactive approaches, which reduce the effectiveness of risk mitigation strategies.

**H4: Financial planning has a positive effect on technological innovation.**

Well-structured financial planning provides the necessary resources for adopting and

implementing new technologies in project management. Adequate financial allocation enables organizations to invest in digital tools and innovation-driven systems. (Chen et al., 2021) found that financial readiness significantly influences technology adoption in construction projects. However, limited financial planning often constrains the ability to implement innovative technologies effectively.

**H5: Budget control has a positive effect on technological innovation.**

Effective budget control ensures the efficient utilization of financial resources, enabling organizations to allocate funds for technological innovation. Transparent and disciplined cost monitoring supports strategic investment in digital transformation. (Zeng et al., 2023) demonstrated that cost control mechanisms facilitate the adoption of digital technologies such as BIM. However, rigid budget systems may also limit flexibility in innovation investment.

**H6: Risk management has a positive effect on technological innovation.**

Risk management encourages organizations to adopt innovative technologies as tools to reduce uncertainty and improve project predictability. Technologies such as BIM and data analytics enhance risk identification and mitigation processes. (Zhang & Aumeboonsuke, 2022) highlighted that technological innovation significantly improves risk management efficiency. However, the adoption of such technologies depends on organizational readiness and risk perception.

**H7: Technological innovation has a positive effect on project performance in infrastructure construction projects.**

Technological innovation enhances project performance by improving efficiency, accuracy, and coordination among stakeholders. The use of digital technologies enables real-time monitoring, faster decision-making, and improved project outcomes. (Wang & Li, 2022) found that BIM implementation significantly improves project performance. (Dagou et al., 2025) emphasized that digital transformation enhances productivity in construction projects. However, the impact of technology is contingent upon its effective integration into project management practices.

## **RESEARCH METHODS**

### **Research Design**

This study employed a quantitative explanatory research design with a cross-sectional survey approach to examine the causal relationships between Financial Planning (X1), Budget Control (X2), and Risk Management (X3) on Project Performance (Y), with Technological Innovation (Z) as a mediating variable. The explanatory approach was selected to test the proposed hypotheses and provide empirical evidence on the influence of financial management practices on project outcomes in infrastructure construction projects (J. Hair, 2017). All constructs were modeled as reflective latent variables and measured using indicators adapted from prior studies on a five-point Likert scale, while data were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) due to its suitability for prediction-oriented models and its ability to handle complex relationships involving mediation (J. F. Hair et al., 2019).

### **Population, Sample, and Sampling Methods**

The population of this study consisted of professionals involved in infrastructure construction projects in Indonesia, including project managers, site engineers, supervisors, and financial staff

working in construction companies and infrastructure development projects. This population was selected due to their direct involvement in financial planning, budget control, risk management, and the adoption of technological innovation within project execution. Infrastructure projects were chosen as the research context because they are characterized by high complexity, large financial scale, and significant exposure to uncertainty (Scott, 2021). Data were collected through an online questionnaire distributed to infrastructure project professionals between January and February 2026. Participation was voluntary, with informed consent obtained and data collected anonymously.

**Table 1.** Distribution of Research Samples by Project Type

Yes	Project Type	Estimated Population	Sample Size	Sample Proportion (%)
1	Road and Highway Projects	4,500	150	25.0%
2	Building Construction Projects	3,500	120	20.0%
3	Bridge Construction Projects	2,500	90	15.0%
4	Water Infrastructure Projects	2,000	80	13.3%
5	Energy and Power Projects	1,800	70	11.7%
6	Transportation Infrastructure	1,700	60	10.0%
7	Other Infrastructure Projects	1,500	30	5.0%
	<b>Total</b>	<b>17,500</b>	<b>600</b>	<b>100%</b>

**Source:** Data processed (2026)

The sampling technique used in this study was a combination of purposive sampling and convenience sampling. Purposive sampling was applied to ensure that respondents met specific criteria relevant to the research objectives, while convenience sampling was used during data collection to select respondents who were accessible and willing to participate. The inclusion criteria established in this study included:

1. Individuals actively involved in infrastructure construction projects.
2. Having at least one year of experience in project-related roles.
3. Involved in financial planning, budgeting, or risk management activities.
4. Having experience in using or being exposed to technological tools in project management (e.g., BIM, project management systems).
5. Willing to complete the research questionnaire in full.

This study employed purposive and convenience sampling to ensure respondents had relevant experience with the research variables. Table 1 presents the sample distribution across infrastructure project types. The sampling was not intended to proportionally represent the population but to ensure analytically relevant participants in line with the predictive nature of SEM-PLS. The total sample of 600 respondents exceeds the minimum requirement based on the ten-times rule, ensuring sufficient statistical power (Hair Jr. et al., 2019). Demographic variables were collected descriptively but not included as control variables to maintain the study's theoretical focus.

### Measures

The measurement of constructs in this study was developed based on established literature to ensure the validity and reliability of each variable within the research model. Each construct is

operationalized into dimensions and indicators that reflect the theoretical foundation and empirical relevance of financial management practices, technological innovation, and project performance. The detailed measurement of variables can be seen in Table 2 below:

**Table 2.** Construct Measurement and Indicators

Variable	Dimensions	Indicator	Notation	References
Financial Planning (X1)	Cost Planning	Accurate estimation of project costs	FP1	(Myers & Brealey, 2005)
		Project budget allocation planning	FP2	
	Cash Flow Planning	Project cash flow projections	FP3	
		Availability of funds during the project	FP4	
	Investment Planning	Determination of project investment priorities	FP5	
		Evaluation of the financial feasibility of the project	FP6	
	Financial Flexibility	Budget customization capabilities	FP7	
		Anticipate changes in project costs	FP8	
Budget Control (X2)	Cost Monitoring	Monitoring project cost realization	BC1	(Horngren et al., 2010)
		Comparison of budgets and realizations	BC2	
	Deviation Control	Identify cost deviations	BC3	
		Corrective action against cost overruns	BC4	
	Budget Transparency	Financial information disclosure	BC5	
		Access budget data in real-time	BC6	
	Cost Efficiency	Optimize budget usage	BC7	
		Reduced cost wastage	BC8	
Risk Management (X3)	Identify Risks	Identify potential project risks	RM1	(Hillson, 2016)
		Analysis of project risk sources	RM2	
	Risk Analysis	Risk impact assessment	RM3	
		Risk probability evaluation	RM4	
	Risk Mitigation	Risk reduction strategies	RM5	
		Implementation of mitigation measures	RM6	
	Risk Monitoring	Regular risk monitoring	RM7	
		Evaluate the effectiveness of risk mitigation	RM8	
Technological Innovation (Z)	Project Digitization	Use of digital project management systems	TI1	(Oesterreich & Teuteberg, 2016)

		Implementation of BIM technology	TI2	
	System Integration	Digital integration of project data	TI3	
		Synchronization of information between teams	TI4	
	Process Automation	Project reporting automation	TI5	
		The use of technology for work efficiency	TI6	
	Decision Making	Real-time data usage	TI7	
		Technology support in project decisions	TI8	
	Technology Adaptation	New technology adoption capability	TI9	
		Evaluation of the use of technology	TI10	
	Operational Efficiency	Technology increases productivity	TI11	
		Reduced project operating costs	TI12	
Project Performance (Y)	Performance Time	Timeliness of project completion	PP1	(A. Shenhar & Dvir, 1996)
		Minimal project delays	PP2	
	Cost Performance	Projects on budget	PP3	
		Minim cost overrun	PP4	
	Project Quality	Conformity of results with standards	PP5	
		Quality level of project work	PP6	
	Stakeholder Satisfaction	Project user satisfaction	PP7	
		Stakeholder satisfaction	PP8	
	Project Efficiency	Resource use effectiveness	PP9	
		Project implementation productivity	PP10	

**Source:** Data processed (2026)

### Data Analysis Method

Quantitative data in this study were analyzed using Partial Least Squares Structural Equation Modeling (SEM-PLS) with SmartPLS version 4, due to its suitability for complex models involving latent constructs and mediation analysis. The measurement (outer) model was evaluated using outer loadings ( $\geq 0.60$ ), Average Variance Extracted ( $AVE \geq 0.50$ ), Cronbach's Alpha, Composite Reliability ( $\geq 0.70$ ), and discriminant validity through the Heterotrait monotrait ratio (HTMT), while multicollinearity was assessed using VIF. The structural (inner) model was assessed through R-square ( $R^2$ ), predictive relevance ( $Q^2$ ), and overall model fit (FIT Model), whereas hypothesis testing was conducted using bootstrapping with 5,000 subsamples to examine path coefficients and mediation effects (J. F. Hair et al., 2021).

## RESULTS

### Respondent Demographics

The profile of respondents is an important component in understanding the characteristics of consumers involved in this study. Demographic information provides a contextual basis for interpreting behavioral patterns and decision-making tendencies. The detailed distribution of respondents is presented in Table 3:

**Table 3.** Respondent Demographics

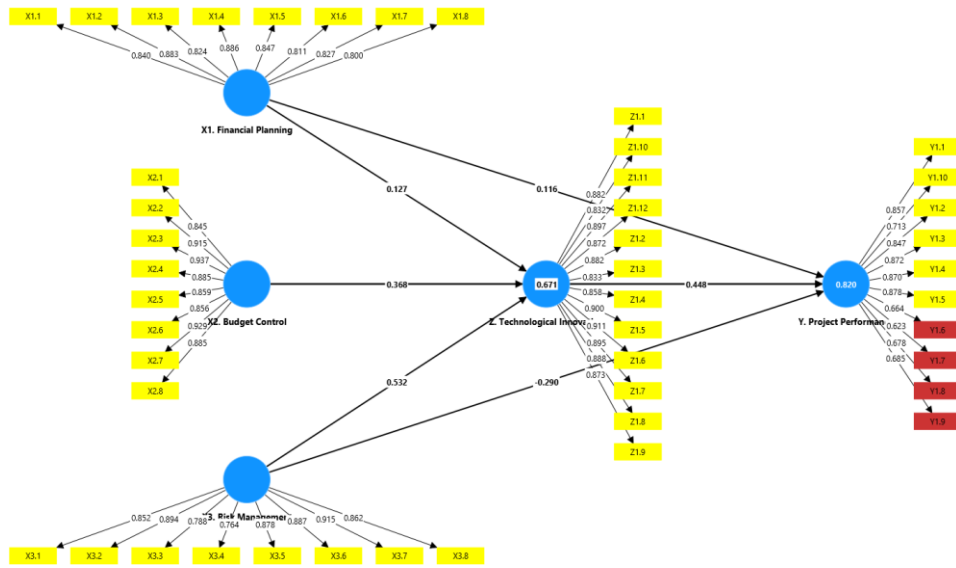
Category	Description	Frequency	Percentage (%)
Gender	Male	206	34.3
	Female	394	65.7
Age	< 21	26	4.3
	21–30	136	22.7
	31–40	147	24.5
	41–50	197	32.8
Occupation	Student	63	10.5
	Civilian Serving	80	13.3
	State-Owned Employee	25	4.2
	Private Employee	249	41.5
	Entrepreneur	66	11.0
	Housewife	117	19.5
Education	Primary School	3	0.5
	Junior High School	43	7.2
	Senior High School	284	47.3
	Bachelor's Degree	266	44.3
	Master Degree	4	0.7

**Source:** Processed data (2025)

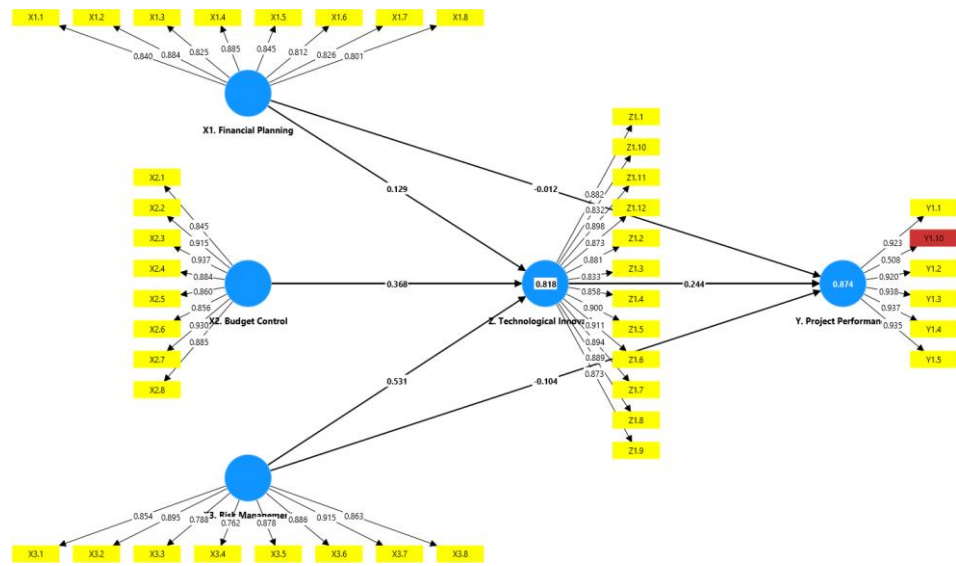
The data indicate that the sample is dominated by female respondents, suggesting that women play a more active role in micro retail purchasing activities. In terms of age, the majority of respondents are within the 41–50 range, followed by those in the 31–40 and 21–30 groups, reflecting that most participants are in productive stages of life. Occupationally, private employees constitute the largest proportion, while the educational background is largely concentrated at the senior high school and bachelor levels, indicating that respondents generally possess a moderate to relatively high level of education that may influence their purchasing behavior.

### Evaluation Analysis of Measurement Model

The evaluation of the measurement model is conducted to ensure that the constructs used in this study meet the required standards of validity and reliability. This stage involves several key assessments, including outer loading to examine indicator reliability, the Heterotrait-Monotrait ratio (HTMT) to assess discriminant validity, as well as convergent validity and construct reliability to confirm the consistency and adequacy of the measurement instruments. In addition, multicollinearity is evaluated using the Variance Inflation Factor (VIF), while the overall model fit is examined through model fit test indicators. Through these comprehensive evaluations, the measurement model is expected to demonstrate its suitability for further structural analysis.



Source: SmartPLS output (2026)  
**Figure 2.** Initial Measurement Model (Outer Loading Results)



Source: SmartPLS output (2026)  
**Figure 3.** Refined Measurement Model after Indicator Elimination

Figures 2 and 3 present the evaluation of the measurement model through outer loading assessment at the initial and refined stages. In Figure 2, the initial model shows that most indicators already meet the acceptable threshold, although several items exhibit relatively low loadings and require elimination to improve construct validity. After the purification process, Figure 3 illustrates a more refined measurement model where only indicators with strong loadings are retained, resulting in improved consistency and clearer representation of each construct. The elimination of weak indicators enhances

the reliability and validity of the measurement model, as reflected by more stable loading values across all constructs. Overall, this refinement process ensures that the final measurement model is more robust and suitable for subsequent structural analysis.

**Table 4.** Final Measurement Model (Validated Outer Model)

	X1. Financial Planning	X2. Budget Control	X3. Risk Management	Y. Project Performance	Z. Technological Innovation
X1.1	0.840				
X1.2	0.884				
X1.3	0.825				
X1.4	0.885				
X1.5	0.845				
X1.6	0.812				
X1.7	0.825				
X1.8	0.801				
X2.1		0.845			
X2.2		0.915			
X2.3		0.937			
X2.4		0.884			
X2.5		0.860			
X2.6		0.856			
X2.7		0.930			
X2.8		0.885			
X3.1			0.854		
X3.2			0.895		
X3.3			0.788		
X3.4			0.761		
X3.5			0.878		
X3.6			0.885		
X3.7			0.915		
X3.8			0.863		
Y1.1				0.928	
Y1.2				0.927	
Y1.3				0.944	
Y1.4				0.942	
Y1.5				0.935	
Z1.1					0.881
Z1.10					0.831
Z1.11					0.898
Z1.12					0.873
Z1.2					0.881
Z1.3					0.833
Z1.4					0.858
Z1.5					0.900
Z1.6					0.911
Z1.7					0.894
Z1.8					0.889
Z1.9					0.874

**Source:** SmartPLS output (2026)

Table 4 presents the final measurement model after the indicator purification process, showing that all retained indicators have strong outer loading values and meet the recommended threshold of 0.70. The results indicate that each construct Financial Planning, Budget Control, Risk Management, Project Performance, and Technological Innovation is measured reliably by its respective indicators, with loading values generally ranging from high to very high. In particular, the indicators for Project Performance and Budget Control demonstrate very strong loadings, reflecting a high level of consistency in measuring these constructs, while Financial Planning and Risk Management also show stable and acceptable values across all items. Technological Innovation exhibits consistently high loadings, indicating that the construct is well represented by its indicators.

**Table 5.** Discriminant Validity Assessment Using HTMT (Heterotrait–Monotrait Ratio)

	X1. Financial Planning	X2. Budget Control	X3. Risk Management	Y. Project Performance	Z. Technological Innovation
X1. Financial Planning					
X2. Budget Control	0.348				
X3. Risk Management	0.650	0.475			
Y. Project Performance	0.335	0.565	0.461		
Z. Technological Innovation	0.759	0.671	0.847	0.678	

**Source:** SmartPLS output (2026)

The HTMT value in Table 5 shows that the entire relationship between constructs is below the general threshold of 0.90, so it can be concluded that the discriminant validity has been well met. The relationship between Financial Planning and Budget Control of 0.348 shows a very clear level of construct difference, while the relationship between Financial Planning and Risk Management of 0.650 and with Technological Innovation of 0.759 is still in the moderate and acceptable category. The highest value can be seen in the relationship between Risk Management and Technological Innovation of 0.847, which although close to the upper limit, remains within the permissible range so as not to cause discriminatory problems. The relationship of Project Performance to other constructs ranges from 0.335 to 0.678, which indicates that each variable has different characteristics and does not conceptually overlap each other.

**Table 6.** Convergent Validity and Construct Reliability Results

Construct	AVE	Cronbach's Alpha	Composite Reliability
Financial Planning (X1)	0.706	0.940	0.950
Budget Control (X2)	0.792	0.962	0.968
Risk Management (X3)	0.734	0.948	0.956
Project Performance (Y)	0.874	0.964	0.972

Technological Innovation (Z)	0.770	0.973	0.976
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**Source:** SmartPLS output (2026)

Table 6 shows that all constructs in this study have met the criteria of convergent validity and construct reliability very well. The AVE value of all variables is above 0.50, which indicates that each construct is able to adequately explain the variance of its indicators, even Project Performance has the highest value of 0.874 which reflects the very high power of representation. Cronbach's Alpha and Composite Reliability values across constructs also exceeded the minimum limit of 0.70, with values tending to be very high, indicating strong internal consistency in measurements. The Technological Innovation variable even has the highest reliability value, which indicates the excellent stability of the indicator.

**Table 7.** Full Collinearity VIF

	Financial Planning (X1)	Budget Control (X2)	Risk Management (X3)	Project Performance (Y)	Technological Innovation (Z)
Financial Planning (X1)				3.431	2.361
Budget Control (X2)				1.887	1.309
Risk Management (X3)				2.204	2.000
Project Performance (Y)					
Technological Innovation (Z)				3.278	

**Source:** SmartPLS output (2026)

Table 7 shows the results of the full collinearity VIF test used to detect potential multicollinearity problems in the research model. The VIF value of all variables is below the general threshold of 5.00, and even most of them are below 3.00, which indicates the absence of significant collinearity problems between constructs. Financial Planning has the highest VIF value for Project Performance at 3,431, but it is still within acceptable limits, while other variables such as Budget Control and Risk Management show lower and stable values. Technological Innovation also has a safe VIF value, so it does not cause bias in model estimation.

**Table 8.** Model Fit Test Results

Indicator	Rule of Thumb	Value Results (Estimated Model)	Model Evaluation
SRMR	< 0.08	0.058	Good Fit
d_ ULS	Lower is better	2.930	Acceptable
d_ G	Lower is better	3.626	Acceptable
Chi-square	Lower is better	3120.314	Marginal
NFI	≥ 0.70 (acceptable)	0.744	Acceptable

**Source:** SmartPLS output (2026)

Table 8 shows that the research model has a fairly good level of conformity overall. The SRMR value of 0.058 is below the limit of 0.08 which indicates that the model is included in the good fit category, while the NFI value of 0.744 also meets the minimum criteria so that it can be categorized as acceptable. The  $d_{ULS}$  and  $d_G$  indicators are at acceptable levels, indicating the absence of significant deviations in the model. Although Chi-square values are relatively large and categorized as marginal, this condition is common in the PLS approach and is not a key indicator in the model's feasibility assessment. Overall, these results show that the model has met the eligibility criteria and is feasible for use in advanced analysis.

**Structural Model Evaluation Analysis**

The evaluation of the structural model is conducted to assess the explanatory power and predictive relevance of the proposed research framework. This stage includes the analysis of R-square values to determine the extent to which endogenous variables are explained by the model, as well as  $Q^2$  to evaluate predictive relevance. Furthermore, hypothesis testing is carried out using bootstrapping procedures to examine the significance and strength of the relationships between variables. Through these analyses, the structural model is expected to provide robust evidence regarding the proposed relationships and the overall effectiveness of the model in explaining the research phenomena.

**Table 9.** R-Square Value

	R-square	R-square adjusted
Project Performance	0.873	0.871
Technological Innovation	0.766	0.763

**Source:** SmartPLS output (2025)

Table 9 shows that the model has a very strong ability to explain endogenous variables. The R-square value for Project Performance of 0.873 indicates that 87.3% of the variation in project performance can be explained by independent variables in the model, while the rest is influenced by other factors outside the study. Technological Innovation has an R-square value of 0.766 which also indicates a high level of explanation. The very small difference between R-square and R-square adjusted on both variables indicates that the model is stable and does not experience overfitting. Overall, these results confirm that the research model has a strong explainability and is suitable for further analysis.

**Table 10.** Predictive Relevance ( $Q^2$ ) of Endogenous Constructs

Endogenous Construct	$Q^2$
Project Performance (Y)	0.748
Technological Innovation (Z)	0.582

**Source:** SmartPLS output (2025)

Table 10 shows that the model has strong predictive capabilities against endogenous variables. The  $Q^2$  values for Project Performance of 0.748 and Technological Innovation

of 0.582, both of which are above the minimum limit of 0, indicate that the model has high predictive relevance. This value indicates that the variables in the model are able to predict observational data well and have strong prediction quality. Overall, these results confirm that the model not only has high explainability, but also has good predictive ability of the endogenous variables studied.

**Table 11.** Bootstrapping Test Results and Hypothesis Testing

Structural Path	$\beta$ (O)	Red (M)	STDEV	T-stat	p-value	95% CI		Results
						Lower	Upper	
Financial Planning → Project Performance	-0.066	-0.069	0.071	0.938	0.348	-0.214	0.067	Not Supported
Financial Planning → Technological Innovation	0.729	0.742	0.058	5.190	0.034	0.689	0.732	Supported
Budget Control → Project Performance	0.855	0.854	0.043	19.807	0.000	0.747	0.921	Supported
Budget Control → Technological Innovation	0.368	0.360	0.063	5.884	0.000	0.254	0.492	Supported
Risk Management → Project Performance	-0.024	-0.018	0.084	0.285	0.776	-0.195	0.142	Not Supported
Risk Management → Technological Innovation	0.530	0.523	0.118	4.513	0.000	0.311	0.768	Supported
Technological Innovation → Project Performance	0.167	0.165	0.075	2.219	0.027	0.026	0.321	Supported

**Source:** SmartPLS output (2026)

The results of the bootstrapping test in table 11 were used to determine the significance and direction of the relationship between variables in the research model. The values of the path coefficient, t-statistic, and p-value are the basis for determining the acceptance or rejection of the hypothesis:

1. The influence of Financial Planning on Project Performance shows a negative coefficient of -0.066 with a p-value of 0.348, so it is not significant. This indicates that the financial planning carried out has not been able to directly improve project performance. Thus, Financial Planning is not the main factor in encouraging the improvement of Project Performance directly.

2. The influence of Financial Planning on Technological Innovation has a positive coefficient of 0.729 with a p-value of 0.034, which is significant. This shows that good financial planning is able to encourage increased technological innovation in the organization. In other words, structured financial management provides space for organizations to develop innovation more optimally.
3. The effect of Budget Control on Project Performance shows a positive coefficient of 0.855 with a p-value of 0.000, so it is very significant. This indicates that effective budget control plays a big role in improving project performance. The better the budget control, the more efficient and optimal the implementation of the resulting project.
4. The influence of Budget Control on Technological Innovation has a coefficient of 0.368 with a p-value of 0.000, which is significant. This shows that budget control also contributes to increased technological innovation. With good budget management, organizations can allocate resources appropriately to support technology development.
5. The effect of Risk Management on Project Performance showed a negative coefficient of -0.024 with a p-value of 0.776, so it was not significant. This indicates that risk management has not directly impacted project performance. Possibly, the role of risk management is more indirect or through other variables in the model.
6. The influence of Risk Management on Technological Innovation has a coefficient of 0.530 with a p-value of 0.000, which means significant. This shows that good risk management is able to encourage increased technological innovation. With risk control, organizations become more confident in exploring and developing innovations.
7. The influence of Technological Innovation on Project Performance showed a coefficient of 0.167 with a p-value of 0.027, which means significant. This indicates that technological innovation contributes to improving project performance. The higher the level of innovation carried out, the better the project performance results achieved.

### Structural Mediation Analysis

Mediation analysis was conducted to determine the role of Technological Innovation in bridging the relationship between independent variables and Project Performance. This test provides a deeper understanding of the mechanisms of indirect influence in the research model. The full results of the mediation analysis are presented in Table 12:

**Table 12.** Mediation Analysis Summary

Independent Variable	Direct Effect on Project Performance	Effect on Technological Innovation	Technological Innovation → Project Performance	Mediation Type
Financial Planning	Not significant ( $\beta = -0.066$ , $p = 0.348$ )	Significant ( $\beta = 0.729$ , $p = 0.034$ )	Significant ( $\beta = 0.167$ , $p = 0.027$ )	Full mediation
Budget Control	Significant ( $\beta = 0.855$ , $p = 0.000$ )	Significant ( $\beta = 0.368$ , $p = 0.000$ )	Significant ( $\beta = 0.167$ , $p = 0.027$ )	Partial mediation
Risk Management	Not significant ( $\beta = -0.024$ , $p = 0.776$ )	Significant ( $\beta = 0.530$ , $p = 0.000$ )	Significant ( $\beta = 0.167$ , $p = 0.027$ )	Full mediation

**Source:** SmartPLS output (2026)

1. Financial Planning does not have a significant direct influence on Project Performance, but it does have a significant influence on Technological Innovation. In addition, Technological Innovation has been proven to have a significant effect on Project Performance, thus showing the existence of full mediation. This indicates that financial planning does not directly improve project performance, but rather through increasing technological innovation first. In other words, the effectiveness of Financial Planning will be more optimal if it is directed to support the development of innovation in the organization.
2. Budget Control has a significant influence both directly on Project Performance and indirectly through Technological Innovation. This condition shows the existence of partial mediation, in which both lines of influence play an equal role. This means that budget control not only has a direct impact on improving project performance, but also strengthens technological innovation which ultimately improves that performance. Thus, Budget Control is the most powerful variable in driving project performance both directly and indirectly.
3. Risk Management does not show a significant direct influence on Project Performance, but has a significant effect on Technological Innovation. Because Technological Innovation also has a significant effect on Project Performance, full mediation occurs. This shows that risk management plays a greater role in creating an environment that supports innovation than directly improving project performance. Thus, the effectiveness of Risk Management will be more visible when it is associated with its ability to drive technological innovation in the organization.

## **DISCUSSION**

### **The Influence of Financial Planning, Budget Control, and Risk Management on Project Performance through the Mediating Role of Technological Innovation**

The findings of this study show a pattern of relationships that are not completely linear between Financial Planning, Budget Control, Risk Management, and Project Performance, but work through an intermediary mechanism in the form of Technological Innovation. Empirically, only Budget Control has been shown to have a strong direct influence on Project Performance, while Financial Planning and Risk Management do not show a significant direct influence (Dabirian et al., 2021; Shibani et al., 2024). These two variables still have an important contribution because they are able to increase Technological Innovation which ultimately has an impact on project performance (Chukwuma-Eke et al., 2021; Kamau et al., 2023). This indicates that in the context of organizations, especially in dynamic sectors, performance improvement does not always come from managerial practices directly, but through the organization's ability to process and transform these practices into relevant forms of innovation.

In the context of developing countries such as Indonesia, this finding has a significant significance because organizational characteristics, especially at the micro and project levels, still face limited resources, both in terms of finance, technology, and managerial capabilities. Financial Planning and Risk Management are often administrative and not yet fully integrated with innovation strategies, so their impact on performance is not directly visible (Aladağ, 2023; Riinawati et al., 2024). However, when these two aspects are able to be directed to support technological innovation, for example through process digitization, operational efficiency, or

work system development, the impact on performance becomes more real. This shows that the main challenge in developing countries is not only the availability of resources, but in how they are used strategically.

From the perspective of the Resource-Based View (RBV), these results confirm that resources such as financial planning and risk management do not necessarily have strategic value if they have not been converted into productive capabilities (Anders, 2021). In this study, Technological Innovation acts as a bridge that converts these resources into advantages that have an impact on project performance. This is relevant to the condition in Indonesia, where many organizations are still at the stage of "resource ownership" but have not fully reached the stage of "resource utilization excellence". Thus, the value of Financial Planning and Risk Management does not lie in their existence, but in the extent to which they are able to encourage innovation that is adaptive to changes in the business environment.

The strong influence of Budget Control on Project Performance shows that budget management is still a fundamental factor in improving performance, especially in the context of organizations in developing countries that are very sensitive to cost efficiency (Bhatti & Nazir, 2024; Ingle et al., 2023; Qadir et al., 2026). Budget Control has a direct impact because it is related to controlling the use of limited resources, so errors in budget management can have a direct impact on reducing project performance (Barros et al., 2023). Indirect influence through Technological Innovation shows that good budget control can also create space for innovation investment, which further strengthens performance (Khuluq & Rahmawati, 2025; Unegbu et al., 2022). In other words, Budget Control not only serves as a control tool, but also as an enabler for innovation.

Overall, the results of this study confirm that in the context of Indonesia and developing countries, it is not enough to improve project performance by relying on conventional managerial practices such as planning and risk management. Organizations need to be able to integrate these practices with the development of technological innovations in order to make a significant impact. This shows that the shift from an administrative approach to a capabilities-based strategic approach is key to increasing competitiveness. Thus, the main implication of these findings is the importance of building an organization's ability to transform internal resources into valuable innovations, so as to be able to create sustainable performance in the midst of increasingly complex business environment dynamics.

### **Theoretical Analysis and Integration**

The theoretical integration in this study shows that the relationship between Financial Planning, Budget Control, Risk Management, and Project Performance cannot be fully explained through just one theoretical approach. The Resource-Based View (RBV) provides the foundation that an organization's internal resources are an important factor in creating excellence, while Project Management Theory emphasizes how the process of planning, controlling, and managing risks is carried out systematically to achieve project success (Eisenhardt & Martin, 2000; Makhija, 2003). The findings of this study indicate that the existence of resources and managerial practices alone is not enough to produce optimal project performance, but rather requires integration between resource ownership and implementation effectiveness in project management (Ahn et al., 2022; Gerhart & Feng, 2021; Suoniemi et al., 2020).

From an RBV perspective, Financial Planning and Risk Management are strategic resources that have the potential to improve organizational performance. However, the results of the study show that neither has a direct influence on Project Performance (Barney et al., 2021; Eisenhardt &

Martin, 2000; Makhija, 2003). This can be explained through Project Management Theory, which asserts that the success of a project is not only determined by planning or risk mitigation, but by how the process is implemented in the project management cycle operationally (Project Management Institute, 2021; Turner, 2006). In other words, Financial Planning and Risk Management will only have a real impact when it can be translated into actions that support project efficiency, coordination, and adaptation through Technological Innovation.

Budget Control shows a significant direct influence on Project Performance, which reinforces the argument in Project Management Theory that cost control is one of the key dimensions of project success. In the context of RBV, Budget Control can be understood as a resource as well as an operational capability that has direct value because it is related to the efficiency of limited resource use. When combined with Technological Innovation, budget control not only maintains project stability but also allows organizations to allocate resources more strategically in support of innovation (A. J. Shenhar & Dvir, 1996). This shows that the integration of the two theories is able to explain both aspects of operational efficiency and capability development.

The role of Technological Innovation as a mediator shows the meeting point between RBV and Project Management Theory. In RBV, innovation is a form of transforming resources into competitive advantage, while in Project Management Theory, innovation functions as a tool to increase the effectiveness of project processes, such as improving coordination, accelerating work, and data-driven decision-making (Kerzner, 2009; Turner, 2006). The finding that Financial Planning and Risk Management only have an effect through technological innovation shows that the value of such managerial practices does not lie in its procedures, but in its ability to support project transformation through innovation. It emphasizes that the success of projects in the modern era relies heavily on the integration between resource management and the utilization of technology.

Overall, the marriage between RBV and Project Management Theory in this study results in a more comprehensive understanding of how project performance is formed. RBV describes what the organization has, while Project Management Theory explains how those resources are managed and implemented in the context of the project. The findings of this study confirm that excellence does not only come from the ownership of resources, but from the ability of organizations to manage, control, and integrate those resources through effective project management practices and supported by technological innovations. Thus, the integration of these two theories makes an important contribution in explaining the mechanism of improving project performance, especially in the context of organizations in developing countries that face limited resources but are required to remain adaptive and competitive.

### **Implications of Findings**

The findings of this study offer important implications for both theory and practice, particularly in the context of Indonesia and other developing countries where organizations often operate under resource constraints and dynamic market pressures. The results indicate that managerial practices such as financial planning and risk management do not directly enhance project performance unless they are effectively transformed into technological innovation, highlighting the critical need for organizations to shift from administrative orientation toward capability-driven strategies. In many developing economies, including Indonesia, firms still emphasize planning and control as compliance activities rather than strategic tools, which limit their impact on performance outcomes. This study implies that organizations should prioritize integrating financial and risk management practices with innovation initiatives to maximize their value. The

strong role of budget control underscores the importance of efficient resource allocation in environments where financial limitations are significant, making cost discipline a key driver of performance. These findings suggest that for organizations in developing countries to remain competitive, they must not only manage resources effectively but also continuously leverage them to support innovation, adaptability, and long-term value creation.

### **Research Strengths**

This study demonstrates several key strengths that enhance its academic and practical contributions, particularly within the context of Indonesia and other developing countries. (1) It offers a comprehensive analytical model that integrates financial planning, budget control, and risk management with technological innovation, enabling a more holistic understanding of how project performance is shaped. (2) The study captures both direct and indirect relationships, providing deeper insight into the underlying mechanisms that are often overlooked in conventional analyses. (3) The use of robust quantitative methods ensures the reliability and validity of the findings, strengthening the credibility of the conclusions drawn. Additionally, the study is contextually relevant, as it reflects real conditions faced by organizations in developing economies where resource constraints and innovation challenges coexist. (4) By linking Resource-Based View and Project Management perspectives, this research provides a more integrative and practical framework that can be applied to improve organizational performance in similar emerging market environments.

### **Research Limitations**

This study acknowledges several limitations that should be considered when interpreting the findings. These constraints provide opportunities for refinement in future research:

1. The study focuses on a limited set of variables, namely financial planning, budget control, risk management, technological innovation, and project performance. Other relevant factors such as leadership, organizational culture, or external environment were not included. This may limit the comprehensiveness of the model in explaining project performance.
2. The data were collected within a specific regional context, which may affect the generalizability of the findings. Conditions in Indonesia may differ from other developing or developed countries. As a result, caution is needed when applying these findings to different contexts.
3. This study uses a cross-sectional design, which captures data at a single point in time. It does not fully reflect dynamic changes in organizational processes or innovation over time. Future studies are encouraged to adopt longitudinal approaches for deeper analysis.

## **CONCLUSION**

Based on the overall findings of this study, it can be concluded that the performance of infrastructure construction projects is not solely determined by conventional managerial practices such as financial planning, budget control, and risk management, but is greatly influenced by the organization's ability to transform these practices into adaptive technological innovations. Empirically, budget control proved to be the most consistent and powerful factor in improving project performance both directly and through innovation, while financial planning and risk management did not show a direct influence, but had a strategic role through a full mediation mechanism by technological innovation. These findings confirm that in the context of

construction projects in Indonesia and developing countries, the value of managerial resources and practices does not lie in their existence, but rather in their ability to drive innovation that improves efficiency, responsiveness, and quality of project implementation. Thus, conceptually, this research reinforces the view that project performance excellence can only be achieved through the integration between disciplined resource management and the development of innovative capabilities, so that organizations are required to transform from an administrative approach to a strategic approach based on technological innovation to achieve sustainable performance.

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