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Technology application, risk management, and business performance in construction enterprises: Basis for enhanced project management framework

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Abstract

The aim of this study is to clarify the interrelationship between technology application, risk management, and business performance, and to propose the following research objectives: by using a descriptive correlation design, this study will empirically test the impact of technology application on business performance in construction projects in Guangdong Province, and evaluate the role of risk management in it. The study will collect data through structured questionnaires and analyze using statistical software to reveal trends, patterns, and significant correlations between technology use, risk control strategies, and corporate performance. The goal is to develop a data-driven comprehensive project management framework for Guangdong Construction Company, aimed at improving efficiency, reducing risks, and ultimately enhancing business performance. Through these research objectives, this study aims to provide in-depth insights into the construction industry and promote the understanding of the role of technology and risk management in enhancing the success of construction projects in both the practical and academic communities. The conclusion drawn from the study is: 1) The respondents unanimously agree that the technology application of construction companies is evident in information technology systems, building model software, project management software, as well as innovation and adoption. 2) These companies have good management practices in risk identification, risk assessment, risk response, and monitoring, which have been recognized by the respondents. 3) The respondents evaluated the company's performance in terms of project completion time, cost control, cost structure, and profit. 4) There is an important relationship between technological application, risk management practices, and business performance, which has developed a strengthened project management framework for construction companies.

Keywords: business performance, construction enterprises, risk management, technology application

Technology application, risk management, and business performance in construction enterprises: Basis for enhanced project management framework

1. Introduction

The construction industry, a vital component of the global economy, is undergoing rapid transformation, driven by technological advancements and evolving market dynamics. Guangdong Province, a pivotal economic region in China, is at the forefront of this evolution. The construction enterprises within this region are increasingly recognizing the imperative to integrate advanced technology and robust risk management strategies to enhance their business performance. Technology application, risk management, and business performance are all interconnected aspects of successful construction projects in Guangdong.

The construction industry is a significant contributor to China's economy, accounting for around 6.9% of the country's gross domestic product (GDP) in 2022. The sector itself expanded 5.1% annually in added value, accounting for over 6.9% of GDP in the 13th Five-Year Plan period (2016-2020). The construction industry value in China amounted to 1,049 billion U.S. dollars in 2020, expecting to grow by 8.5% to reach CNY 9,508 billion in 2022. The growth momentum is expected to continue over the forecast period, recording a CAGR of 7.3% during 2022-2026. The construction output in the country is expected to reach CNY 12,582.5 billion by 2026. China's construction industry has outperformed globally on schedule controls, cost controls, and supply chain management, resulting in some of the world's greatest engineering, procurement, and construction (EPC) projects. However, the industry now faces low productivity, labor shortages, and rising construction costs. Demographics are expected to continue spurring growth in residential construction in China. Now, Guangdong is a province in southern China that has long been known as the "world's factory" due to its manufacturing prowess. The construction industry in Guangdong is an important part of the province's economy, accounting for a significant share of the country's GDP. In 2021, regional officials in Guangdong announced plans to invest approximately US$100 billion in public medical facilities and other infrastructure construction activities. This investment is expected to boost the construction industry's growth in the region. However, Guangdong's advantage over other cities such as Suzhou and Chongqing is fading, and it's impossible to continue competing on land, price, and labor for continuous growth. The construction industry in China faces low productivity, labor shortages, and rising construction costs. Despite these challenges, the construction industry in Guangdong is expected to continue to grow and play a vital role in the overall success of the construction sector in China.

The Chinese government has been supporting the construction industry through various measures. In 2022, the Chinese government announced plans to pump $1 trillion into the construction of infrastructure megaprojects. The construction industry in China, already expected to grow to CNY 9,508 billion by 2022, is also given a growth momentum expectation which continues over the forecast period, a CAGR of 7.3% during 2022-2026. The construction output in the country is expected to reach CNY 12,582.5 billion by 2026. The Chinese government is also promoting the internationalization of Chinese construction companies. Premier Li Keqiang has been promoting Chinese transportation-equipment manufacturing in sectors including high-speed trains. The government is also planning for a smarter, greener, and safer construction industry over the next three to four years. To promote smarter, greener, and safer working in the Chinese construction industry, the government announced a five-year development in January 2022. The construction industry in China has recorded strong growth over the last few years on the back of low-interest rates and increasing government spending on the development of infrastructure projects. However, in 2022, the construction sector is facing ongoing pressure from the policies that are designed to deleverage property developers in the country and lead to more sustainable construction activity. Despite these challenges, the construction industry in China is expected to continue to grow and play a vital role in the overall success of the Chinese economy.

Project management is critically important in the construction industry sector in China, particularly in light

of the sector's rapid growth juxtaposed with emerging challenges such as low productivity, labor shortages, and rising costs. This importance is further underscored by the Chinese government's initiatives to promote the internationalization of construction companies and focus on sectors like high-speed train manufacturing, necessitating project management that aligns with these broader goals and international standards. Additionally, the government's push towards a smarter, greener, and safer construction industry, as highlighted in the five-year development plan announced in January 2022, places project management at the forefront of integrating these new standards into construction practices. In the face of economic and policy shifts, including low-interest rates, increased government spending on infrastructure, and policies aimed at sustainable construction activity, effective project management is essential to navigate these landscapes, ensuring financial viability and compliance with new regulations. Despite the pressures from policies designed to deleverage property developers, the construction industry in China is expected to continue its growth trajectory, making project management a key driver in not only steering individual projects to success but also in shaping the future trajectory of the construction industry in China.

This dissertation is pivotal for the construction industry in Guangdong, offering a targeted project management framework that enhances risk management and business performance through technology. It aims to elevate project success rates, bolstering the competitiveness of firms in the region. The research provides actionable insights for sustainable growth, guiding policy and strategic development for both companies and regulatory bodies. Moreover, it contributes to Guangdong's economic stability and advancement by harnessing technological innovation within the construction sector.

Objectives of the Study - This study aimed to explore technology application, risk management, and business performance of construction enterprises as a basis in developing enhanced project management framework. Specifically, to assess technology application in project management of construction enterprises in Guangdong Province, in terms of information technology system, building model software, Project management software, and innovation and adoption. To evaluate the strategies and practices of Guangdong construction enterprises in project risk management, including risk identification, risk assessment, risk response, and risk monitoring, To analyze business performance on project management of construction enterprises in Guangdong Province, in terms of project completion time, cost control, customer satisfaction, and corporate profits, To test the significant relationship between technology application, risk management, and business performance and to come up with enhanced project management framework for construction enterprises.

2. Methods

Research Design - For this study that examined the relationship among technology application, risk management, and business performance in Guangdong's construction enterprises, a descriptive correlational research design was employed. This section of the paper elaborates on the specifics of this design, its relevance to the study's objectives, and how it will be implemented to gather and analyze data. A descriptive correlational research design is chosen for its effectiveness in describing the characteristics of a specific population or phenomenon and examining the potential relationships between variables without manipulating them. This design is particularly suitable for studies aiming to assess the extent of relationships and patterns among variables in their natural settings. In the context of this study, the descriptive aspect will involve systematically recording, analyzing, and interpreting the current state of technology application, risk management practices, and business performance metrics within the construction industry in Guangdong. The correlational aspect will focus on exploring the relationships and interdependencies among these variables.

Participants of the Study - I have conducted a questionnaire survey on 20 engineering construction projects in Guangdong region, with 30 questionnaires distributed for each project. Finally, 400 valid questionnaires were collected and analyzed and tested. *Senior management of construction enterprises*: They have an overall understanding and decision-making power over the application of technology, risk management, and operational performance of the enterprise. They can provide data on the development strategy, management policies, and

project management strategies of the enterprise. *Project managers and project team members*: They directly participate in the implementation and management of the project, and have a deeper understanding of the specific situation of technology application and risk management. They can provide information on the technical application of the project, risk identification and response measures, project performance data, etc.

Technical application personnel: This includes information technology departments of enterprises, modeling software users, Project management software users, etc. They can provide specific tools, systems, and application data related to technology applications. *Risk management personnel:* This includes the risk management department or dedicated risk management personnel of the enterprise. They can provide data on enterprise risk management strategies, risk assessment reports, risk response measures, and other aspects. *Business performance personnel*: This includes the finance department, business development department, etc. of the enterprise. They can provide data on business performance, such as project completion time, cost control status, customer satisfaction survey results, corporate profits, etc.

Data Gathering Instrument - The research instrument for this study is a structured questionnaire designed to gather quantitative data on technology application, risk management strategies, and business performance in Guangdong construction enterprises. The questionnaire is divided into three parts, each focusing on one of the study's variables: technology application, risk management, and business performance. Respondents are asked to rate statements on a Likert scale ranging from 1 (Strongly Disagree) to 4 (Strongly Agree), providing a standardized method for capturing perceptions and practices within these enterprises.

The "Technology Application" category encompasses variables related to the use and implementation of technology within an organization. This includes Information Technology Systems (0.798), Building Model Software (0.755), Project Management Software (0.771), and Innovation and Adoption (0.761). All variables within this category exhibit an "Acceptable" level of reliability, suggesting that the items within each variable are sufficiently consistent in measuring aspects of technology application in an organization. The findings suggest that these aspects of technology application are reliable dimensions for assessing how technology is utilized and integrated into business practices.

Under "Risk Management Strategies and Practices," we have Risk Identification (0.882), which stands out with a "Good" reliability score, indicating a high level of internal consistency among the items used to measure this variable. This suggests that the items effectively capture various aspects of risk identification practices within an organization. On the other hand, Risk Assessment (0.715) and Risk Response and Monitoring (0.768) both fall into the "Acceptable" reliability range. These scores indicate that, while there is a reasonable level of consistency among the items measuring these variables, there may be room for improvement in ensuring that all items are as closely related as those in the Risk Identification variable.

The "Business Performance" category assesses variables related to the outcomes of business operations, including Project Completion Time (0.814), Cost Control (0.827), Customer Satisfaction (0.801), and Corporate Profits (0.738). Except for Corporate Profits, which is deemed "Acceptable," the rest are classified under "Good" reliability. These results imply that the measures used to assess these aspects of business performance are highly consistent and reliable. The measures for Project Completion Time, Cost Control, and Customer Satisfaction are particularly robust, suggesting they are effective indicators of business performance.

Overall, the table presents a mix of "Good" and "Acceptable" reliability scores across different variables within the categories of Technology Application, Risk Management Strategies and Practices, and Business Performance. This indicates a generally reliable set of measures, with certain areas—particularly in Risk Management Strategies and Practices—where the internal consistency could potentially be improved. For practitioners and researchers, these results underscore the importance of carefully selecting and refining the items used to measure various constructs to ensure high reliability and, consequently, the validity of any subsequent analyses based on these measures.

Data Gathering Procedure - When studying the technology application, risk management, and business performance of Guangdong construction enterprises, we adopted a phased data collection method. Firstly, we designed a questionnaire aimed at collecting information related to the research objectives. This questionnaire has undergone pre testing to ensure its clarity and relevance to the target audience. Subsequently, we identified a list of potential interviewees and obtained permission from the company to conduct surveys at their premises. The distribution of questionnaires marks the beginning of the data collection phase. We provide questionnaires in both electronic and paper formats to cater to the accessibility and preferences of the respondents. In order to promote electronic response, we have established a secure online platform and provided guidelines for accessing and completing questionnaires. We have also set a deadline for completing the questionnaire and sent reminders before the deadline to encourage participation and answer any questions that may arise during the filling process.

The second stage of the data collection process is to follow up on procedures to ensure high response rates and data quality. After the deadline, we contacted respondents who did not respond to understand the reasons for their non participation and provided assistance if necessary. Follow up is also used to verify received data and request any missing information. Throughout the entire data collection process, we closely monitor the quality of the data, including checking the consistency of responses, identifying potential outliers, and ensuring that the collected data represents the sample population. Through this gradual data collection method, we can obtain a high-quality dataset that accurately reflects the technical application, risk management practices, and commercial performance of Guangdong construction enterprises. This method ensures the reliability and effectiveness of research results, providing us with a deep insight into how enterprises can use technology to improve project management efficiency and business outcomes.

Ethical Considerations - Ethical considerations include ensuring the confidentiality and anonymity of the respondents. Participation in the survey will be voluntary, with respondents informed about the purpose of the study and assured that their responses will be used solely for research purposes. The data will be stored securely, and only aggregate results will be reported in the study, ensuring that individual responses cannot be traced back to specific participants. These measures are crucial to uphold the ethical standards of research and ensure the integrity of the study.

Data Analysis - The collected data were analyzed using statistical software, particularly SPSS 28. Descriptive statistics is used to summarize the responses, providing an overview of the general trends and patterns in the data. Correlation analysis using Spearman rho is done to examine the relationships between technology application, risk management, and business performance. Further, the study made use of the Shapiro-Wilk test to check on the significance of the relationships between the variables using an alpha of 0.05, in order to confirm the hypotheses of the study. The statistical analysis provides insights into how these variables interact and their impact on the construction industry in Guangdong. Weighted mean and rank were used to assess technology application in project management of construction enterprises in Guangdong Province, in terms of information technology system, building model software, Project management software, and innovation and adoption; to evaluate the strategies and practices of Guangdong construction enterprises in project risk management, including risk identification, risk assessment, risk response, and risk monitoring; and to assess business performance on project management of construction enterprises in Guangdong Province, in terms of project completion time, cost control, customer satisfaction, and corporate profits. The result of the Shapiro-Wilk Test showed that p-values of all variables were less than 0.05 which means that the data set was not normally distributed. Therefore, Spearman rho was used as part of the non-parametric tests to determine the significant relationship. All analyses were performed using SPSS version 28.

3. Results and discussions

Table 1 presents a concise overview of the utilization of technology in project management within the construction industry, consolidating multiple facets into fundamental outcome domains. There is a general consensus regarding the application of technology. The overall average of 2.64, classified as "Agree," suggests a

widespread agreement among construction companies in Guangdong on the beneficial use of technology in project management. All important result areas are encompassed within the scope of this agreement.

Table 1

Summary Table on Technology Application in Project Management of Construction Enterprises

Key Result Areas	Composite Mean	VI	Rank
1.Information Technology System	2.63	Agree	3.5
2.Building Model Software	2.63	Agree	3.5
3.Project Management Software	2.64	Agree	2
4.Innovation and Adoption	2.65	Agree	1
Grand Composite Mean	2.64	Agree	

Legend: 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree

The utmost priority is placed on fostering innovation and facilitating the widespread adoption of new ideas and practices. The domain of 'Innovation and Adoption' demonstrates the greatest composite mean score (2.65), positioning it at the top spot. This observation underscores the prioritization of construction firms in actively pursuing and embracing novel technology and methodologies in the realm of project management. The role of project management software is of great significance, as seen by its second ranking (Composite Mean = 2.64), highlighting its ability to improve project management processes. This implies that the utilization of such software is essential for enhancing the efficiency of project management operations.

Both the 'Information Technology System' and 'Building Model Software' are deemed equally important, as indicated by their composite mean of 2.63, resulting in a shared ranking of 3.5. This observation suggests a fair and impartial perspective on the contribution of these technologies in facilitating project management activities. Furthermore, there are a number of significant obstacles to the implementation of IR 5.0 in the construction sector, including a lack of technical expertise in IR 5.0, investor reluctance to make investments, security and cultural concerns regarding the integration of humans and machines, and a lack of data that would enable governments and stakeholders to make informed decisions. Based on the study of Musarat et.al (2023), demonstrate how IR 5.0 can be used to bring about reforms in the construction industry through the adoption of selective technology adoption, project teams embracing the concept for better coordination and collaboration.

Table 2

Summary Table on Risk Management Strategies and Practices of Construction Enterprises in Project Risk Management

Key Result Areas	Composite Mean	VI	Rank
1.Risk Identification	2.64	Agree	1.5
2.Risk Assessment	2.64	Agree	1.5
3.Risk Response and Monitoring	2.62	Agree	3
Grand Composite Mean	2.63	Agree	

Legend: 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree

Table 2 presents a comprehensive overview of the risk management methodologies and procedures employed in project risk management within construction firms, focusing on three primary areas of outcomes. A generally favorable perspective of risk management practices: The composite mean of 2.63, which represents the average score derived from multiple indicators, is situated within the "Agree" range. This suggests that there is a generally favorable impression of the risk management techniques currently employed by construction businesses.

Both the concepts of 'Risk Identification' and 'Risk Assessment' hold equal importance, as they both have a rank of 1.5. Their combined average score is calculated to be 2.64. This implies that firms assign comparable amounts of significance to the earliest stages of risk management, which involve the identification of prospective hazards and the assessment of their impact and possibility. Additionally, these stages are generally regarded favorably by the enterprises.

The category of 'Risk Response and Monitoring' has been assigned a significantly lower ranking, as indicated by a composite mean score of 2.62. Although the procedures concerning the response and monitoring of risks are still considered within the "Agree" range, there is a little perception that they are somewhat less effective when compared to the stages of identification and evaluation. The construction firms have a robust proficiency in the initial stages of risk management, specifically in the areas of risk identification and assessment. The aforementioned phases are of utmost importance as they establish the foundation for all following endeavors in risk management. There exists a possibility for enhancing the efficacy of response and monitoring processes. The marginally diminished score in the domain of 'Risk Response and Monitoring' implies that although these aspects are currently effectively managed, there may be potential for enhancement. Improving the efficacy of risk response and the monitoring of risk management could bolster the overall effectiveness of risk management methods. The observed close scores in all three domains suggest a balanced approach to risk management, wherein equal consideration is given to each phase. Nevertheless, the subtleties inherent in the rankings offer valuable insights into areas that may require further attention or allocation of resources. In addition, the construction sector is among the least digitized in the world, which has hindered its ability to address contemporary issues. Artificial Intelligence (AI), a cutting-edge digital technology, is now transforming sectors like telecommunications, retail, and manufacturing. Several sectors have effectively used AI subfields such as computer vision, robotics, knowledge-based systems, machine learning, and optimization to boost productivity, security, safety, and profitability. Even if the benefits of AI applications are acknowledged, the construction industry still faces a number of AI-related problems (Abioye et.al., 2021).

The consensus across the main domains indicates a broad efficacy in the risk management techniques and practices implemented by these construction companies. By further enhancing these practices, namely in the domain of risk response and monitoring, organization

Table 3

Summary Table on Business Performance on Project Management of Construction Enterprises

Key Result Areas	Composite Mean	VI	Rank
1.Project Completion Time	2.62	Agree	1.5
2.Cost Control	2.61	Agree	3.5
3.Customer Satisfaction	2.61	Agree	3.5
4.Corporate Profits	2.62	Agree	1.5
Grand Composite Mean	2.62	Agree	

Legend: 3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 3 presents a concise summary of the operational effectiveness of construction enterprises across different dimensions of project management. The general perception is predominantly positive across various significant domains. The calculated grand composite mean of 2.62, which falls under the category of "Agree," indicates a generally favorable perception across all major areas of project management. This implies that construction enterprises, as a whole, hold the belief that they are achieving satisfactory performance in these critical areas. According to the study of Khan et.al., (2022), the results imply that customer loyalty is positively and significantly impacted by customer relationship management and company reputation. Furthermore, the relationship between customer loyalty, company reputation, and customer relationship management is partially mediated by customer satisfaction.

The composite mean of 2.62 indicates that both 'Project Completion Time' and 'Corporate Profits' are ranked equally at 1.5 in terms of their importance. This observation suggests a perceived significant correlation between the timely completion of projects and the profitability of the organization, implying that the efficiency in project completion is directly associated with financial prosperity.

A balanced perspective on the relationship between cost control and customer satisfaction reveals that both factors are rated at 3.5, resulting in a composite mean of 2.61. Although project completion time and profits are given higher priority, these aspects are still considered favorably. This statement demonstrates an awareness that

managing expenses and guaranteeing customer contentment are crucial factors, albeit they may be perceived as having a slightly lesser direct influence on the overall organizational performance in comparison to timely project completion and attaining profitability.

In general, there is a positive business outlook as indicated by the overall consensus among the key result areas, indicating a high level of confidence in the current project management practices employed by these enterprises. Nevertheless, there is still ample opportunity for ongoing enhancement, particularly in the realm of effectively managing and optimizing all facets of project management in order to maintain and advance overall business efficacy.

Table 4 displays the statistical correlation between different dimensions of technology implementation and risk management strategies and practices within construction firms. The table exhibits a consistent pattern of strong correlation coefficients (rho) among the different technology applications (Information Technology System, Building Model Software, Project Management Software, Innovation and Adoption) and the various risk management strategies (Risk Identification, Risk Assessment, Risk Response and Monitoring).

Table 4

Relationship Between Technology Application and Risk Management Strategies and Practices

Variables	rho	p-value	Interpretation
Information Technology System			
Risk Identification	0.899**	<.001	Highly Significant
Risk Assessment	0.910**	<.001	Highly Significant
Risk Response and Monitoring	0.903**	<.001	Highly Significant
Building Model Software			
Risk Identification	0.885**	<.001	Highly Significant
Risk Assessment	0.895**	<.001	Highly Significant
Risk Response and Monitoring	0.900**	<.001	Highly Significant
Project Management Software			
Risk Identification	0.887**	<.001	Highly Significant
Risk Assessment	0.901**	<.001	Highly Significant
Risk Response and Monitoring	0.892**	<.001	Highly Significant
Innovation and Adoption			
Risk Identification	0.873**	<.001	Highly Significant
Risk Assessment	0.886**	<.001	Highly Significant
Risk Response and Monitoring	0.906**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

All of the correlations in the study exhibit a high level of statistical significance, as indicated by p-values below 0.001 (**p < .001). This finding demonstrates a high level of statistical significance, suggesting that the observed relationships are highly unlikely to be attributed to random chance.

For Information Technology System, the observed correlations exhibit values exceeding 0.89, indicating a robust association between the implementation of information technology systems and various facets of risk management. Moreover, in the study of Hegde et. al.,(2020) demonstrate that the use of machine learning algorithms for risk assessment is being driven by the automobile sector. The most popular machine learning technique for assisting in engineering risk assessment is artificial neural networks. For Building Model Software, the data reveals consistent and significant correlations, with coefficients ranging from 0.885 to 0.900, further affirming the robust association between risk management practices and the observed outcomes. On the other hand, based on the study of Othman et.al,(2021) findings revealed that only 13% of participants from the public and commercial sectors used Building Information Modelling (BIM) in their organizations, according to the results of the 268 replies that were received. This is a worrying indication that Malaysia is still far behind where it should be in terms of BIM implementation. The sluggish deployment of BIM was seen to be caused by a number of factors, including lack of knowledge, costs, slow adaptation, the absence of clear guidelines to support businesses and policymakers in altering their approach to BIM implementation, and the fact that BIM was not mandated in a timely manner. Meanwhile, for project management software, the correlation coefficients

observed in this study exhibit a range of values between 0.887 and 0.901. These findings consistently demonstrate the presence of robust and statistically significant associations between risk management components. For the concepts of innovation and adoption, this particular category exhibits moderately lower yet still robust correlations (ranging from 0.873 to 0.906) with risk management strategies.

The statistical association between different forms of technology application and key factors of business success in construction firms is presented in Table 5. Strong and statistically significant correlations were observed across all categories of technology application, including Information Technology Systems, Building Model Software, Project Management Software, and Innovation and Adoption. These correlations were found to be highly significant, with p-values less than .001. Furthermore, these technology applications were found to be associated with various aspects of business performance, such as Project Completion Time, Cost Control, Customer Satisfaction, and Corporate Profits. This finding demonstrates a robust and statistically significant correlation between the implementation of these technologies and enhanced business performance.

Table 5

Relationship Between Technology Application and Business Performance

Variables	rho	p-value	Interpretation
Information Technology System			
Project Completion Time	0.908**	<.001	Highly Significant
Cost Control	0.918**	<.001	Highly Significant
Customer Satisfaction	0.915**	<.001	Highly Significant
Corporate Profits	0.900**	<.001	Highly Significant
Building Model Software			
Project Completion Time	0.894**	<.001	Highly Significant
Cost Control	0.902**	<.001	Highly Significant
Customer Satisfaction	0.894**	<.001	Highly Significant
Corporate Profits	0.897**	<.001	Highly Significant
Project Management Software			
Project Completion Time	0.892**	<.001	Highly Significant
Cost Control	0.896**	<.001	Highly Significant
Customer Satisfaction	0.885**	<.001	Highly Significant
Corporate Profits	0.911**	<.001	Highly Significant
Innovation and Adoption			
Project Completion Time	0.903**	<.001	Highly Significant
Cost Control	0.890**	<.001	Highly Significant
Customer Satisfaction	0.884**	<.001	Highly Significant
Corporate Profits	0.896**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

Information Technology System: The observed correlation coefficients indicate a significant positive relationship between many dimensions of business performance and exhibit values above 0.9. Notably, the highest correlation coefficient of 0.918 is seen in the domain of Cost Control. This observation implies a significant correlation between information technology systems and the capacity to efficiently control project expenditures. Building Model Software: The correlation coefficients observed in this study vary from 0.894 to 0.902, suggesting a robust association between the measured characteristics of business performance and the utilization of this technology. These findings underscore the significance of using this technology in project management endeavors to achieve successful outcomes. Project Management Software: The data demonstrates a statistically significant correlation, albeit significantly lower, between the variables (range from 0.885 to 0.911) and business success indicators. This indicates the essential function of the variables in multiple aspects of project management. Innovation and Adoption: The findings indicate robust associations between company performance indicators, with Customer Satisfaction exhibiting the lowest correlation coefficient of 0.884, while Project Completion Time demonstrates the greatest correlation coefficient of 0.903. This underscores the significance of consistently embracing novel technology and methodologies.

Table 6 investigates the statistical relationship between risk management strategies and practices and various aspects of business performance in the construction sector. The table shows highly significant correlations

(p-value < .001) between each aspect of risk management (Risk Identification, Risk Assessment, Risk Response and Monitoring) and key business performance indicators (Project Completion Time, Cost Control, Customer Satisfaction, Corporate Profits). These strong correlations indicate a robust link between effective risk management and positive business outcomes.

The correlation coefficients with business performance indicators range from 0.875 to 0.891. This suggests a strong association between effective risk identification and improved project completion times, cost management, customer satisfaction, and profitability. For risk assessment, the data shows even higher correlation coefficients, particularly with Cost Control (0.911) and Corporate Profits (0.900), indicating that thorough risk assessment is crucial for financial aspects of project management. The same could be maintained for Risk Response and Monitoring, which maintains similarly high correlation values (around 0.89 to 0.895), highlighting the importance of responding to and monitoring risks effectively for achieving success in all measured business performance aspects.

Table 6

Relationship Between Risk Management Strategies and Practices and Business Performance

Variables	rho	p-value	Interpretation
Risk Identification			
Project Completion Time	0.884**	<.001	Highly Significant
Cost Control	0.885**	<.001	Highly Significant
Customer Satisfaction	0.875**	<.001	Highly Significant
Corporate Profits	0.891**	<.001	Highly Significant
Risk Assessment			
Project Completion Time	0.890**	<.001	Highly Significant
Cost Control	0.911**	<.001	Highly Significant
Customer Satisfaction	0.896**	<.001	Highly Significant
Corporate Profits	0.900**	<.001	Highly Significant
Risk Response and Monitoring			
Project Completion Time	0.891**	<.001	Highly Significant
Cost Control	0.895**	<.001	Highly Significant
Customer Satisfaction	0.889**	<.001	Highly Significant
Corporate Profits	0.892**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

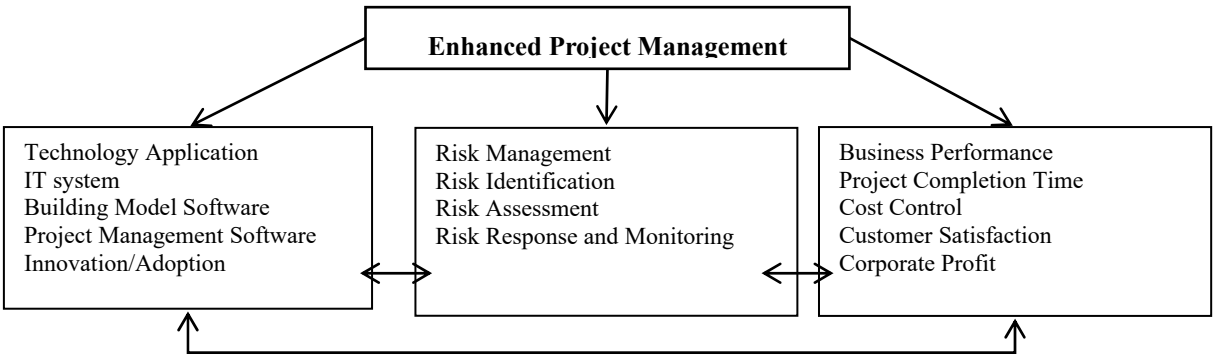

Figure 1. Enhance Project Management Framework

4. Conclusions and recommendations

Based on the findings of the study, the researcher came up with the following conclusions. Respondents agreed that the technology application in construction companies is evident in terms of information technology system, building model software, project management software, and innovation and adoption. These companies have good management practices in terms of risk identification, risk assessment and risk response and monitoring as agreed by the respondents. Business performance is assessed by the respondents as good in terms of project completion time, cost control, cost structure and corporate profit. There are highly significant relationships among technology applications, risk management practices and business performance. An enhanced

project management framework for construction companies has been developed.

Construction enterprises may establish a dedicated technology innovation department or task force. To refine risk response and monitoring strategies, top management of construction enterprises may invest in specialized training programs for their project management teams. Construction enterprises may establish a strategic investment fund specifically allocated for technological innovation and risk management tools. Top management may develop an integrated risk management system that is embedded into the core project management software used by the enterprise. Construction companies may consider the application of the enhanced project management framework. Future researchers may conduct further studies in project management using other variables such as HR management, operations management and cost management.

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