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Impact of Project Manager Competencies and Risk Management on Project Success in China's IT Industry: Mediating Role of Knowledge Management

(*Kesan Kecekapan Pengurus Projek dan Pengurusan Risiko terhadap Kejayaan Projek dalam Industri IT China: Peranan Pengantara Pengurusan Pengetahuan*)

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ABSTRACT

With the increasing reliance on project-based structures, project success (PS) is crucial in organizational growth, especially in IT industry. This study seeks to explore the impact of Project Manager Competencies (PMCs) and Risk Management (RM) on PS, with Knowledge Management (KM) as a mediating factor. The theoretical framework is grounding in Project Management theory and Critical Success Factors (CSF) theory, forming the basis for nine hypotheses. A self-administered questionnaire utilizing a five-point Likert scale was distributed to project managers of medium and large IT projects in China, and data were analyzed using CB-SEM in AMOS 24 for model estimation and hypothesis testing, while SPSS was employed for preliminary data processing and regression analysis. Findings reveal that PMCs and RM demonstrate a significant positive effect on PS, with KM playing a partial mediating role, and all hypotheses were supported. This study contributes empirical insights to project management research, demonstrating the importance on the relationships among PMC, RM, and KM on PS. The findings offer practical guidance for top management and policymakers to enhance project outcomes by strengthening these key factors.

Keywords: Project manager competencies; risk management; knowledge management; project success; IT

ABSTRAK

Dengan peningkatan pergantungan pada struktur berasaskan projek, kejayaan projek (PS) telah menjadi faktor penting dalam pertumbuhan organisasi, terutamanya dalam industri IT. Kajian ini bertujuan untuk meneroka kesan Kecekapan Pengurus Projek (PMC) dan Pengurusan Risiko (RM) terhadap PS, dengan Pengurusan Pengetahuan (KM) sebagai faktor pengantara. Rangka kerja teori adalah berasaskan teori Pengurusan Projek dan teori Faktor Kejayaan Kritikal (CSF), membentuk asas kepada sembilan hipotesis. Soal selidik yang ditadbir sendiri menggunakan skala Likert lima mata telah diedarkan kepada pengurus projek projek IT sederhana dan besar di China, dan data dianalisis menggunakan CB-SEM dalam AMOS 24 untuk anggaran model dan ujian hipotesis, manakala SPSS digunakan untuk pemprosesan data awal dan analisis regresi. Penemuan mendedahkan bahawa PMC dan RM mempunyai kesan positif yang ketara ke atas PS, dengan KM memainkan peranan pengantara separa, dan semua hipotesis telah disokong. Kajian ini menyumbangkan pandangan empirikal kepada penyelidikan pengurusan projek, menunjukkan kepentingan hubungan antara PMC, RM, dan KM pada PS. Penemuan ini menawarkan panduan praktikal untuk pengurusan atasan dan penggubal dasar untuk meningkatkan hasil projek dengan mengukuhkan faktor utama ini.

Kata kunci: Kecekapan pengurus projek; pengurusan risiko; pengurusan pengetahuan; kejayaan projek; IT

INTRODUCTION

Global IT investment continues to rise, with spending projected to reach $5.26 trillion by 2024 (Gartner Inc. 2024). In China, IT spending hit $547.12 billion in 2023, accounting for 3.07% of GDP, signaling growth potential compared to its 17% share of the global economy (TradingEconomics 2023). However, IT project failure rates remain high. Only 2.5% of companies successfully complete all projects as planned, while 43% of IT projects fail or are abandoned (Alexander Eser 2024). In China, just 0.5% of IT projects achieve full success, with over 70% facing delays, budget overruns, or unmet requirements (NetEase 2024). Given these challenges, identifying key success factors is crucial to improving IT project outcomes.

IT projects are more prone to risks and project failures than those in other industries (Alexander Eser 2024; NetEase 2024) and these failures are attributed to deficiencies in project manager competencies (PMCs) rather

than technical shortcomings (Parker 2021; PMI 2021). As the team leader, project managers play a crucial role in determining project success (PS). Therefore, rigorous assessment of their competencies, especially in the IT project, is essential (Mansourimoayyed et al. 2020). Some scholars believe that hard competencies (such as technical knowledge, experience, and project management skills) are important for PS (Luţaş et al. 2020; Ribeiro et al. 2021), while other studies point to the importance role of soft competencies (such as communication, relationship building, and leadership) to achieving PS (Alvarenga et al. 2020; Castro et al. 2022). To navigate the complexity and uncertainty of IT projects, project managers with comprehensive project skills is essential, requiring both management skills and technical expertise, along with soft skills such as leadership, commitment, and adaptability (Lei et al. 2022; Sampaio et al. 2022).

Projects rely on team execution, and ensuring PS requires both strong leadership which provides vision and problem-solving capabilities (Anantatmula 2020) and effective risk management (RM) to navigate the complex, multidisciplinary challenges of project execution and product development (Oliva 2016). According to Hubbard (2020), project failure rates drop from 70% to 20% with effective RM. While improper RM application can lead to higher failure rates and increased resource costs (Willumsen et al. 2019). Therefore, RM must be integrated into project planning to identify issues early inorder to enhance PS. Once risk factors are identified, they should be contextualized and prioritized based on their significance (Emerald 2020). However, in the IT industry, the importance of RM is often overlooked in IT projects, particularly in agile software development projects, which even do not have a mature RM method (Tavares et al. 2019; Trzeciak 2021).

Effective project management rely on both PMCs and RM to enhance success rates, which requires the efficient use of organizational knowledge throughout the project lifecycle (PMI 2021). Organizational knowledge has become a significant resource for companies and organizations, with the transition from industry-based to knowledge and information driven economy (Akram et al. 2022; Clemente & Domingues 2023). This has led to the growing importance of knowledge management (KM), which facilitates the utilization of existing knowledge while also fostering the creating of new knowledge through interaction and collaboration with individuals and systems. Effectively acquisition, sharing, and exploitation knowledge throughout the project lifecycle can influence decision-making, enhance innovation, and form the foundation for transforming and leveraging knowledge to achieve successful project outcomes (Alves et al. 2022; Clemente & Domingues 2023). However, the uniqueness and temporary nature of projects can pose challenges for organizations, necessitating a well-planned KM strategy, especially in IT projects (Alves et al. 2022).

While previous studies have investigated the individual effect of PMCs, RM and KM on PS, few have explored how these factors interact in a unified model. Moreover, most research lacks a clear knowledge-based perspective that integrates tacit (PMCs) and explicit (RM) knowledge in project contexts. To fill the gaps, the study aims to analyze the impact of PMCs and RM on PS and the mediating role of KM between them. It seeks to answer the following research questions:

1. To what extent do the PMCs and RM affect PS in China's IT projects?
2. To what extent do the PMCs and RM affect KM in China's IT projects?
3. To what extent do the KM affect PS in China's IT projects?
4. Does KM mediate the relationship between PMCs and PS, as well as the relationship between RM and PS in China's IT projects?

This study highlights the significance and contributes of identifying several factors that are significantly related to the PS. A theoretical framework is developed grounded by the project management theory and the critical success factors (CSF) theory. The study also extends to the role of KM as mediation variable between independent variables (PMCs and RM) and dependent variable (PS) and provides new insights for future studies by examining how knowledge-driven PS can be achieved across diverse IT projects through the effective use of tacit knowledge (PMCs) and explicit knowledge (RM). Meanwhile this study contributes to a better understanding for firms or organizations when conducting project management activities in reality.

LITERATURE REVIEW

PROJECT SUCCESS

PS has traditionally been evaluated based on cost, time, and quality (Iron Triangle) (Atkinson 1999). However, this narrow criterion has been chanllenged as IT projects become more complex. Scholars now highlight broader criteria: Gomes et al. (2021) pointed that PS can be defined through multiple approaches. Gheni et al. (2017) emphasized PS criteria that include project management, product quality, stakeholder's satisfaction, and the overall benefits derived from the project. Radhakrishnan et al. (2022) added risk and resource management to PS based on Iron Triangle, whereas Garousi et al. (2019) emphasized stakeholder satisfaction as the primary measure of success. Iriarte and Bayona (2020) identified critical success factors for IT projects through a systematic

literature review, and fitted these factors into this grouping, project management, along with time & budget form the component of project management success, while user satisfaction and economic value constitute elements of project product success.

Luţaş et al. (2020) found technical project management skills, including tools, practices, and senior management support, categorized as hard competencies by Ribeiro et al. (2021), positively correlate with IT PS. In contrast, Alvarenga et al. (2020) and Castro et al. (2022) highlighted the significance of soft competencies like communication, relationship building, and leadership for achieving IT PS. Beyond competencies, effective RM is also essential. Ferreira de Araújo Lima et al. (2021) pointed that project managers can incorporate lessons learned from previous projects during the planning phase, treating RM as a structural analysis process focused on identifying and assessing potential risk factors. De Bakker et al. (2010) referred to this method as the evaluation approach, which emphasized identifying and understanding risks in the specific context of each project. Similarly, Green and Dikmen (2022) advocated for moving beyond rigid, quantitative frameworks toward more reflective, adaptive, and context-sensitive RM. In addition, KM plays a crutial role throughout the project lifecycle. Latif et al. (2020) examined the positive relationship between KM practices and PS from a knowledge-based view. Shahzadi et al. (2021) also confirmed the growing importance of KM in software project environments, where systematic KM can enhance the the success rates of projects.

PROJECT MANAGER COMPETENCIES

PMCs encompass the essential skills and knowledge needed for project managers to achieve project objectives. According to Project Management Body of Knowledge (PMBOK), interpersonal skills are no longer separate but are integrated into team and stakeholder management within the twelve management principles and eight performance domains. This aligns with modern project management, which emphasizes collaboration, leadership, and stakeholder engagement in complex environments (PMI 2021). The relationship between Project Management Professional (PMP) certification and core competencies for IT project managers was examined, identifying key traits valued by IT recruiters in successful project manager hires (Starkweather & Stevenson 2011). The positive relationship between them has also been confirmed by subsequent scholars confirmed that PMP-certified project managers are perceived to have stronger competencies (Altahtooh 2020; Aslam & Bilal 2021; Robertson & Stock 2023). Salvador et al. (2021), highlighted that PMCs include specialized management experience which, in certain sectors, is more influential than general management experience. Compared to the broad classification of soft and hard competencies (Alvarenga et al. 2020; Ribeiro et al. 2021), intellectual competencies, managerial competencies, and emotional competencies (Müller & Turner 2010) provide a clearer definition of the core skills needed by project managers in different dimensions. Intellectual competencies enable project managers to grasp complex issues, plan effectively, and make effective decisions, managerial competencies ensure efficient resource utilization, emotional competencies help lead teams, resolve conflicts, and foster collaboration (Ahmed & Lodhi 2021; Podgórska & Pichlak 2019; Rana & Shuja 2022).

RISK MANAGEMENT

One view of risk is that it involves the full spectrum of uncertainties in the project, so RM strategies cannot be standardized for all projects of a certain type (Trzeciak 2021). De Bakker et al. (2010) summarized two approached for RM: management approach and evaluation approach. The management approach views RM as a decision-support tool, emphasizing a structured framework for identifying, mitigating, and monitoring risks throughout the project lifecycle. The evaluation approach assumes that understanding risks and their causes allows for effective management, relying on the idea that projects are comparable, and risk knowledge can be generalized for future use. Green and Dikmen (2022) contended that traditional RM practices often relies on established frameworks focused on standard practices, which can fail to capture the complexities of project environments, especially in IT projects using agile methodologies which adopt an iterative and incremental approach to project management, focusing on rapid and continuous delivery while enabling flexibility to evolving requirements and customer demands (Singh et al. 2023). Therefore, to identify the critical factors for RM is better suited to IT projects. It can be integrated at each stage of the IT project lifecycle, allowing for continuous evaluation and updating of potential risks based on evolving project circumstances (Kalia & Gill 2023; Smith & Merritt 2020). Liu et al. (2010) established seven risk factor classifications which found in the literature from the perspective of senior executive and project manager, used a brain-storm round to produce as many risk factors as possible, then 57 risk factors were identified. The most important 14 risk factors from six classifications (organization, requirement, user, technology, team and planning and control) were selected by a majority of project managers within IT projects in China through ranking and rating. As internal risks are inherent to the organization and can be managed by the project team or organization itself, external risks come from outside the organization and include factors like user interactions and changing requirements, which are not entirely within the project team's control (Matuszak-Flejszman & Paliwod 2022). Therefore, these 14 risk factors identified by Liu et al. (2010) can be divided into

two dimensions: Internal risk factors (organization, team, technology, planning and control) and External risk factors (requirement, user).

KNOWLEDGE MANAGEMENT

KM treats knowledge as an organization's key resource, focusing on its collection, management, and continuous utilization (Pereira et al. 2021). Unlike temporary projects, KM programs are long-term investments, but the temporary nature of projects poses challenges for effective KM (Pereira et al. 2021). KM leverages individual and project knowledge to enhance outcomes. Project managers must recognize project constraints on KM and implement effective strategies for creating, transferring, sharing, and utilizing knowledge to ensure PS and client benefits (Egbu 2001). As organizational knowledge contributes to enhanced competitiveness and enables more effective decision-making, the acquisition, sharing, maintenance, and reuse of knowledge have become critical for many organizations (Costa & Monteiro 2016; Sadeghi & Rad 2018). Wang and Hu (2020) noted that KM relies on individual initiative and organizational commitment to be effective. It facilitates knowledge creation, sharing, and transfer among project teams, influenced by trust, social interactions, and management support. People are more willing to share knowledge when they feel safe from negative consequences. Blak Bernat et al. (2023) suggested that robust KM practices ensure valuable insights and lessons are captured, shared, and applied. Even within virtual teams, which present unique challenges, these practices can support ongoing improvement. Similarly, Amoako-Gyampah et al. (2021) demonstrated the importance of KM in project management by examining its three dimensions: knowledge acquisition, knowledge sharing, and knowledge exploitation.

THEORETICAL FOUNDATIONS

Project management theory aims to establish a standard body of knowledge and best practices for managing various types of projects, and help organizations achieve their objectives by guiding projects to successful completion with the defined constrains of time, cost and quality (Cicmil & Hodgson 2006). The Project Management Institute (PMI) has compiled project management theory into standards and frameworks known as the PMBOK, which is widely used by project management practitioners. It defines the term 'project management' refers to the application of specific knowledge, skills, and techniques to meet the project requirements (PMI 2021).

CSF Theory, first introduced by Daniel (1961), refers to the limited number of key areas that must be effectively managed to ensure organizational or project success. In the context of IT projects, CSF Theory helps identify and prioritize the most critical elements that influence project outcomes (Pinto & Slevin 1987). This theory supports the selection of PMCs, RM, and KM as the core variables in this study.

This study is grounded in these two theories which provide a foundation for establishing the theoretical framework, highlighting the interrelationship among PMCs, RM, and KM in driving PS.

FRAMEWORK

HYPOTHESES DEVELOPMENT

THE RELATIONSHIPS AMONG PMCS, RM, KM AND PS

An effective project manager is a key factor in ensuring PS. Project managers need to possess adequate skills to ensure PS in environments that are highly complex and uncertain (Li et al. 2020). Bashir et al. (2021) examined the competencies of project managers across various stages of the project life cycle and identified the essential competencies required which not only help to enhance the performance of individual project managers but also increase the likelihood of successful implementation of the projects. Sampaio et al. (2022) performed a systematic literature review on 27 studies that identified 179 competencies within information systems projects. They concluded a significant positive relationship between behavioral competencies and IS PS. Among them, emotional intelligence, creativity, and ethics emerge as the most influential factors. Building on the above analysis, this study proposes the following hypothesis:

H_1 Project manager competencies have a positive influence on project success.

The vital importance of RM in the success of IT projects is now widely recognized, RM within IT projects is officially considered essential and is recognized as one of the key factors contributing to PS (Sajid et al. 2023). Rodríguez-Rivero et al. (2020) identified economic, cultural, and political factors as the most critical risk factors and found a direct positive relationship between effective RM and PS. Alves et al. (2023) conduct a statistical analysis to verify if there is a difference between the theoretical knowledge and the practice of RM and concluded that there was a significant and positive impact of RM factors on IT PS. Building on the above analysis, this study proposes the following hypothesis:

H_2 Risk management has a positive influence on project success.

Managerial level employees who engage in KM activities can influence and encourage other employees to practice KM as well (Hussinki et al. 2017). The project manager is responsible for the integrated management of knowledge and for facilitating the transfer of body of knowledge that is easy to use within the organization culture context (Srisuksa et al. 2021). Project managers need to recognize the critical role of leadership during the process of project management and this will encourage team members to share their knowledge with each other which can ensure smooth operations and effectively managing uncertainties throughout the project (Imam & Zaheer 2021). As a key component of PMCs, leadership plays a crucial role in KM, influencing how an organization defines its activities and allocates resources for knowledge acquisition, sharing, and exploitation (Latif et al. 2020). Building on the above analysis, this study proposes the following hypothesis:

H_3 Project manager competencies have a positive influence on knowledge management.

Normally, much of the knowledge is still in the realm of tacit knowledge (experience), RM can complement this weak point and be treated as the explicit aspect of knowledge. Chin et al. (2020) have built a mediation model which include three variables: RM, KM and project performance, and proved there was a positive and significant relationship between RM and KM. RM plays a crucial role in shaping KM practices, influencing how organizations manage, prioritize, and utilize knowledge. Companies with a higher tolerance for risk-taking are more likely to foster KM behaviors, promoting organizational creativity and innovation (Hock-Doepgen et al. 2021). Organizations must enhance knowledge-related risk management as an integral part of their KM strategy (Kamaruddin & Isa 2023). Building on the above analysis, this study proposes the following hypothesis:

H_4 Risk management has a positive influence on knowledge management.

Projects are highly knowledge-driven initiatives, bringing together temporary, cross-functional teams with diverse expertise and perspectives. To address challenges and resolve technical issues effectively, these teams need to continually integrate new information into their existing knowledge base (Blak Bernat et al. 2023). Yang et al. (2017) have found a significant influence of KM practices on PS. The relationship between the processes of KM and PS becomes clearer when examined from a knowledge-based perspective, revealing a significantly positive impact (Latif et al. 2020). Meanwhile, there is an increased importance of KM in the software industry, Shahzadi et al. (2021) have investigated the relationship between KM processes and PS and concluded that in software industry, project-based organizations can enhance their likelihood of PS by using KM processes. Building on the above analysis, this study proposes the following hypothesis:

H_5 Knowledge management has a positive influence on project success.

Latif et al. (2020) investigated the influence of entrepreneurial leadership (EL) on KM processes and examined how KM servers as a mediator in the relationship between EL and PS in software projects. The findings revealed that KM processes significantly affect PS, and that EL indirectly influences PS through its impact on KM processes. Imam and Zaheer (2021) investigated the influence of shared leadership on PS within the context of IT projects. Additionally, he examined the role of knowledge sharing as a mediator and concluded that shared leadership amplified PS directly via the facilitation of knowledge sharing. Nakash and Bouhnik (2022) discovered that the risks associated with knowledge significantly drive the initiation and investment in efforts to manage organizational knowledge, which in turn influences organizational performance. Chin et al. (2020) have examined the KM as the mediator in the relationship between RM and project performance. The results indicated that KM can partially influence the relationship between RM and project performance. Building on the above analysis, this study proposes the following hypothesis:

H_6 Knowledge management mediates the relationship between project manager competencies and project success.

H_7 Knowledge management mediates the relationship between risk management and project success.

Based on project management theory and CSF theory, this study identifies four key variables: PMCs, RM, KM, and PS. The proposed theoretical framework (Figure 1) illustrates that PMCs, RM, and KM influence PS, with KM mediating the relationships between PMCs and PS, as well as RM and PS.

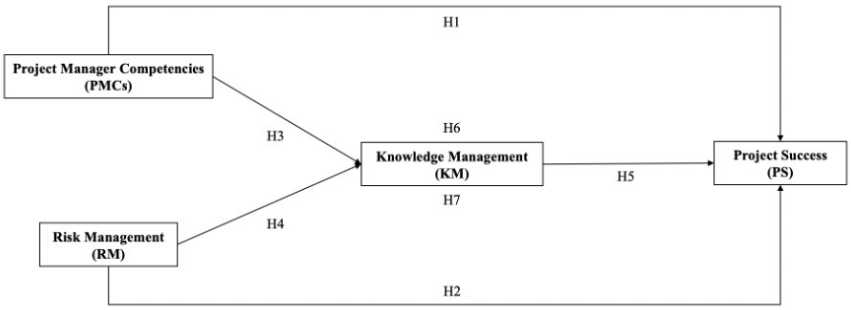

FIGURE 1. Theoretical framework

METHODOLOGY

QUESTIONNAIRE DESIGN AND DATA COLLECTION

This study follows a positivism research philosophy to examine the relationships among PMCs, RM, KM, and PS. Hypothesis testing explores PMCs and RM as independent variables, KM as a mediator, and PS as the dependent variable. A quantitative approach was used, collecting primary data through online questionnaires distributed to IT project managers in China. Ethical approval was obtained from The Research Ethics Committee, The National University of Malaysia (RECUKM) (Approval No: JEP-2024-816, Date: 18 November 2024). For the measurement of scales for all variables are provided in Appendix 1.

The questionnaire consists of five sections: demographics, PMCs, RM, KM, and PS. A five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) measures responses for PMCs, RM, KM, and PS. The survey was conducted through online platform called Credamo which is a widely used in China and its database includes over 3 million samples, covering all provinces and regions of China. It offers the capability to filter samples based on attributes such as region, gender, profession, industry, family, children, income, marital status, and more. By targeting IT project managers in China, of 886 distributed questionnaires, 413 valid responses were collected (46.6% response rate), forming the basis for analysis. Respondent profiles are shown in Table 1.

TABLE 1. Profile of respondents

Demographic profile		Number of respondents (n=413)	Percentage
Gender	Male	276	66.8%
	Female	137	33.2%
Age	18-24 years old	32	7.7%
	24-34 years old	190	46.0%
	35-44 years old	118	28.6%
	45-50 years old	53	12.8%
	51 years old and above	20	4.8%
Highest level of education	Secondary School or equivalent	0	0
	Diploma	68	16.5%
	Bachelor's degree	197	47.7%
	Master's degree	136	32.9%
	Doctoral degree	12	2.9%
Working experience	1-3 years	108	26.2%
	4-6 years	229	55.4%
	7-10 years	47	11.4%
	11-15 years	20	4.8%
	16 years and above	9	2.2%
Team members	10-30	317	76.8%
	31 and above	96	23.2%

The respondent profile in this study closely matches findings from (Segmentfault Research Institute 2023), which surveyed 900 IT professionals in China. That study reported a 7:3 male-to-female ratio, a similar gender distribution to this research. It also found that 63.64% of respondents were aged 26-40, aligning with this study's age distribution. Additionally, 95.29% held a bachelor's degree or higher, including 2.13% with doctorates, consistent with this research. Lastly, 50.51% had around five years of experience, reflecting the work experience of participants in this study.

DATA ANALYSIS AND RESULTS

RELIABILITY ANALYSIS

Reliability testing assessed the consistency of the survey questionnaire results using Cronbach's alpha coefficient. Typically, a Cronbach's alpha above 0.8 indicates highly reliability, values between 0.7 and 0.8 suggest good reliability, values between 0.6 and 0.7 reflect moderate reliability, and values below 0.6 indicate low reliability

(Cronbach 1951). As shown in Table 2, all Cronbach's alpha values are above 0.8, indicating a high level of reliability.

TABLE 2. Results of the reliability test

Variables	Cronbach's Alpha
Project manager competencies (PMCs)	0.910
Risk management (RM)	0.940
Knowledge management (KM)	0.915
Project success (PS)	0.929

VALIDITY ANALYSIS

To ensure measurement validity, several criteria must be met. First, standardized loadings for each item should be 0.50 or higher to confirm strong factor representation (Hair et al. 2019). Second, correlations between factors should not exceed 0.85 to ensure adequate discriminant validity (Kline 2015). Third, the CR (Composite Reliability) should be 0.70 or above, and the AVE (Average Variance Extracted) should exceed 0.50 (Hair et al. 2019). Lastly, the measurement model must demonstrate an adequate fit across multiple fit indices. Based on Table 3, all factor loadings exceed 0.70, confirming that each item strongly contributes to its respective latent variable. Additionally, the AVE values for all constructs exceed 0.50, indicating that each construct accounts for more than 50% of the variance in its respective observed indicators. Furthermore, the CR values exceed 0.90 across all variables, demonstrating high internal consistency and reliability. These results collectively confirm that the measurement model exhibits strong convergent validity, ensuring that the selected indicators effectively represent their corresponding constructs.

TABLE 3. Results of the convergent validity

Variables	Items	Factor loadings	AVE	CR
PMCs	IC3	.733	0.614	0.960
	IC2	.721		
	IC1	.814		
	MC5	.731		
	MC4	.826		
	MC3	.817		
	MC2	.750		
	MC1	.758		
	EC7	.860		
	EC6	.774		
	EC5	.869		
	EC4	.804		
	EC3	.770		
	EC2	.745		
	EC1	.758		
RM	IRM6	.811	0.638	0.958
	IRM5	.806		
	IRM4	.818		
	IRM3	.844		
	IRM2	.807		
	IRM1	.791		
	ERM8	.775		
	ERM7	.725		
	ERM6	.781		
	ERM5	.804		
	ERM4	.826		
	ERM3	.799		
	ERM2	.793		
	ERM1	.847		
KM	KA3	.866	0.666	0.956
	KA2	.754		
	KA1	.767		
	KS4	.746		
	KS3	.771		
	KS2	.821		
	KS1	.854		
	KE4	.820		
	KE3	.778		
	KE2	.896		
	KE1	.888		
PS	PMS8	.859	0.673	0.961
	PMS7	.858		
	PMS6	.828		
	PMS5	.824		
	PMS4	.868		
	PMS3	.838		
	PMS2	.838		
	PMS1	.769		

PPS4	.787
PPS3	.799
PPS2	.789
PPS1	.783

Note: PMCs = project manager competencies; RM = risk management; KM = knowledge management; PS = project success; IC = intellectual competencies; MC = managerial competencies; EC = emotional competencies; IRM = internal risk management; ERM = external risk management; KA = knowledge acquisition; KS = knowledge sharing; KE = knowledge exploitation; PMS = project management success; PPS = project product success.

Table 4 demonstrates that PMCs, RM, KM, and PS are significantly correlated at the 0.01 level (2-tailed). In the SEM research, discriminant validity can be assessed via several approaches including the Fornell–Larcker criterion, cross-loadings, and the Heterotrait–Monotrait (HTMT) ratio, but this study adopts the widely recognized Fornell–Larcker method Fornell and Larcker (1981). The absolute values of the correlation coefficients are all below the square root of the respective AVE values, which are displayed along the diagonal. This result aligns with the Fornell and Larcker (1981) criterion, confirming that while the latent variables exhibit a certain degree of correlation, they remain sufficiently distinct from one another. Therefore, the scale data meets the requirements for discriminant validity.

TABLE 4. Results of the Results of the discriminant validity

	PMCs	RM	KM	PS
PMCs	**0.783**			
RM	0.270**	**0.638**		
KM	0.450**	0.417**	**0.666**	
PS	0.385**	0.334**	0.465**	**0.673**

** indicates the significant at 0.01 level (2-tailed) and the diagonal is the AVE square root of each variable

HYPOTHESES TESTING

Various goodness-of-fit indices assess model adequacy, with Hair et al. (2019) recommending at least three types: absolute, incremental, and parsimonious fit indices. As shown in Table 5, most indices meet or exceed recommended thresholds, indicating a strong model fit. The CMIN/DF (1.301) is well below the ≤ 3 threshold, confirming parsimonious fit. IFI (0.974), TLI (0.973), and CFI (0.974) all surpass the ≥ 0.90 standard, supporting incremental fit. RMSEA (0.027) remains within the ≤ 0.08 threshold, confirming absolute fit (Hair et al. 2019; Hu & Bentler 1999). Although the GFI (0.873) and NFI (0.898) are marginally below the 0.90 cut-off for "good" fit, prior guidelines suggest that values ≥ 0.85 are still acceptable when other fit indices exceed recommended thresholds (Hair et al. 2019; Hu & Bentler 1999; Kline 2015). Given that CFI, TLI, IFI (> 0.97) and RMSEA (< 0.03) all indicate excellent fit, the overall model adequacy remains strongly supported.

TABLE 5. Model fit

Model Fit indices	CMIN/DF	GFI	NFI	IFI	TLI	CFI	RMSEA
Standard Values	≤3	≥0.9	≥0.9	≥0.9	≥0.9	≥0.9	≤0.08
Statistical Values	1.301	0.873	0.898	0.974	0.973	0.974	0.027
Fit Assessment	Good	Adequate	Adequate	Good	Good	Good	Good

A structural equation model (SEM) was employed to examine the relationships among the independent variable, mediating variable, and dependent variable. Meanwhile, in SEM, error terms (e) are included because observed variables cannot fully represent latent constructs. This follows CFA assumptions and helps improve the accuracy and validity of the model (Hair et al. 2019; Kline 2015). Figure 2 illustrates the standardized path coefficients, factor loadings, and error terms. The model evaluates the direct effects of PMCs and RM on PS, as well as the mediating role of KM.

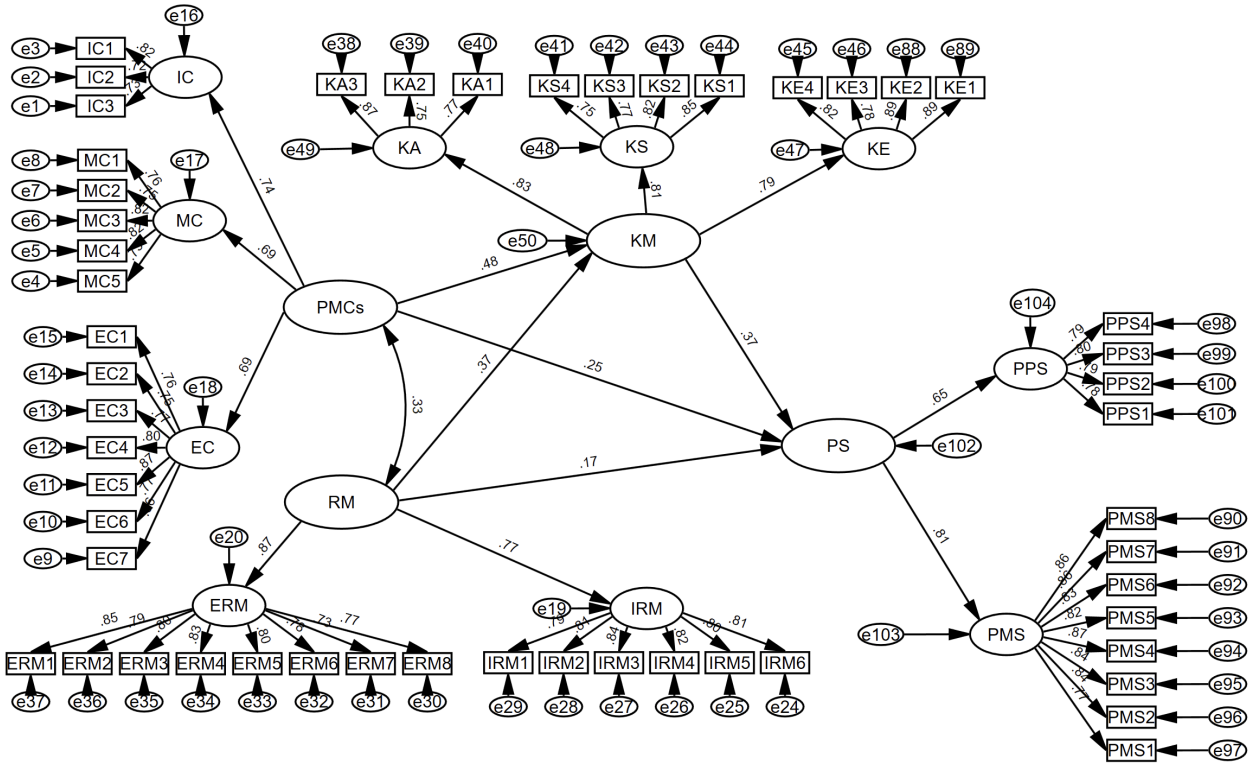

FIGURE 2. Model diagram

The results of path analysis as shown in Table 6. This table summarizes the SEM results, highlighting the significant relationships between constructs. PMCs ($\beta = 0.253, \rho = 0.005$) and RM ($\beta = 0.174, \rho = 0.022$) both positively impact PS, supporting Hypotheses H_1 and H_2. These findings are in line with prior studies such as Bashir et al. (2021) and Rodríguez-Rivero et al. (2020), which emphasize the critical roles of PMCs and effective RM in achieving PS. Additionally, both PMCs and RM have significant positive effects on KM, with PMCs showing a stronger influence ($\beta = 0.476, \rho < 0.001$) compared to RM ($\beta = 0.375, \rho < 0.001$), supporting Hypotheses H_3 and H_4. This results consistent with Imam and Zaheer (2021) who argued that leadership—an essential element of PMCs—plays a central role in shaping KM behaviors and Hock-Doepgen et al. (2021) who emphasized that proactive RM encourages knowledge creation and innovation, particularly in high-risk environments. While KM ($\beta = 0.371, \rho < 0.001$) also significantly contributes to PS, proving support for Hypothesis H_5. This confirms earlier findings by Shahzadi et al. (2021) and Yang et al. (2017), who demonstrated the positive role of KM in enhancing project performance. These results indicate that KM mediates the relationship between the independent variables (PMCs and RM) and the dependent variable (PS).

TABLE 6. Independent-mediating-dependent variable path coefficients

			Estimate	S.E.	C.R.	P	Standardized Estimate
PMCs	--->	KM	.736	.118	6.258	***	.476
RM	--->	KM	.422	.076	5.528	***	.375
RM	--->	PS	.173	.075	2.292	.022	.174
PMCs	--->	PS	.345	.122	2.826	.005	.253
KM	--->	PS	.327	.086	3.791	***	.371
PMCs	--->	IC	1.000				.742
PMCs	--->	MC	.999	.125	8.002	***	.692
PMCs	--->	EC	1.201	.143	8.418	***	.684
KM	--->	KA	1.000				.828
KM	--->	KS	.845	.073	11.550	***	.814
KM	--->	KE	.910	.075	12.141	***	.788
PS	--->	PMS	1.000				.806
PS	--->	PPS	.692	.091	7.616	***	.647
RM	--->	IRM	.925	.111	8.317	***	.764
RM	--->	ERM	1.000				.866

To rigorously confirm mediation effects, bootstrapping is used to estimate indirect effects and test their statistical significance. This resampling technique generates confidence intervals (CI), making it ideal for mediation analysis in CB-SEM. Although AMOS can estimate mediation effects, this study instead used the PROCESS macro for SPSS 29 with 5,000 bootstrap samples and bias-corrected 95% CI, a widely accepted and robust approach that not only generates bias-corrected CI for direct and indirect effects but also classifies mediation as full, partial, or absent by comparing the magnitude of the indirect effect to the total effect (Hayes

2012). To determine the type of mediation effect, the proportion of the indirect effect relative to the total effect should be calculated using the mediation ratio:

$$\text{Mediation Ratio} = \frac{Indirect\ Effect}{Total\ Effect}$$

If the mediation ratio exceeds 80% and the direct effect is not significant ($p > 0.05$), the model demonstrates full mediation, meaning the mediator fully explains the relationship. If the mediation ratio falls between 20% and 80%, with both indirect and direct effects significant, it indicates partial mediation, where the mediator explains part of the effect, but a direct relationship remains. If the mediation ratio is below 20% and the indirect effect is not significant ($p > 0.05$), no mediation is present, suggesting the independent variable primarily influences the dependent variable through direct effects (Hayes 2022).

In this study, Model 4 of Process macro which is a foundational mediation model that includes one independent variable, one dependent variable, and one or more mediating variables, was utilized to analyze the mediating effects. Additionnally, this model allows for the inclusion of multiple control variables (Hayes 2012).

As showed in Table 7, the total effect of PMCs on PS was significant ($\beta = 0.425$, 95% CI [0.301, 0.542] exclude 0). The indirect effect of PMCs on PS via KM was also significant ($\beta = 0.179$, 95% CI [0.124, 0.239], excluding 0), indicating a mediating pathway. Importantly, the direct effect of PMCs on PS remained significant after including the mediator ($\beta = 0.245$, 95% CI [0.132, 0.356] exclude 0), confirming that both direct and indirect paths contribute to the outcome. Additionally, the mediation ratio (indirect effect / total effect) was 42.26%, falling between the 20%–80% range typically interpreted as partial mediation. This pattern supports a conclusion of partial mediation, consistent with (Hayes 2022). Therefore, Hypothesis H_6 is supported. Similarly, Table 8 shows that the total effect of RM on PS was significant ($\beta = 0.321$, 95 % CI [0.229, 0.414]). The indirect effect of RM on PS via KM was significant as well ($\beta = 0.149$, 95 % CI [0.099, 0.209]), while the direct effect remained significant ($\beta = 0.172$, 95 % CI [0.072, 0.272]). The resulting mediation ratio was 46.43 %, again falling within the partial-mediation range. Accordingly, Hypothesis H_7 is supported.

TABLE 7. Mediating effect of KM between PMCs and PS

Path	Effect size	SE	t value	P value	Boot LLCI	Boot ULCI	Effect Percentage(%)
PMCs→KM→PS(Indirect)	0.179	0.030	/	/	0.124	0.239	42.26
PMCs→PS(Direct)	0.245	0.059	4.619	<0.001	0.132	0.365	57.74
PMCs→PS(Total)	0.425	0.061	8.404	<0.001	0.301	0.542	100

TABLE 8. Mediating effect of KM between RM and PS

Path	Effect size	SE	t value	P value	LLCI	ULCI	Effect Percentage(%)
RM→KM→PS(Indirect)	0.149	0.028	/	/	0.099	0.209	46.43
RM→PS(Direct)	0.172	0.051	3.880	0.001	0.072	0.272	53.57
RM→PS(Total)	0.321	0.047	7.401	<0.001	0.229	0.414	100

HYPOTHESES SUMMARY

A total of seven hypothesized relationships were examined in this research, with the results summarized in Table 9.

TABLE 9. Summary of results of hypotheses testing

	Hypotheses	Result	Comment
H_1	PMCs have a positive influence on PS	Supported	
H_2	RM has a positive influence on PS	Supported	
H_3	PMCs have a positive influence on KM	Supported	
H_4	RM has a positive influence on KM	Supported	
H_5	KM has a positive influence on PS	Supported	
H_6	KM mediates the relationship between PMCs and PS	Supported	Partial mediating effect
H_7	KM mediates the relationship between RM and PS	Supported	Partial mediating effect

IMPLICATIONS

The findings of this study provide valuable theoretical and managerial insights, aiming to enhance the success rate of project, especially in the IT industry.

THEORETICAL IMPLICATIONS

From the perspective of theoretical view, this study integrates Project Management Theory and CSF Theory to identify and analyze the critical determinants of IT PS. Unlike traditional models that primarily focus on the “Iron

Triangle" (cost, time, and quality) (Atkinson 1999), highlights the roles of PMCs, RM, and KM in shaping PS. Meanwhile, this research introduces KM as a critical bridging mechanism. By bridging tacit (PMCs) and explicit (KM) knowledge, demonstrating how PMCs and RM collectively enhance KM, ultimately improving IT PS, extending the theoretical understanding of knowledge-driven PS, reinforcing the idea that knowledge plays an indispensable role in project execution and in enhancing the effectiveness of PMCs and RM.

MANAGERIAL IMPLICATIONS

For the managerial implication, organizations, particularly project-based ones, should prioritize the comprehensive development of project managers as their competencies are closely tied to PS. To improve project outcomes, organizations should implement training programs that enhance both technical expertise and leadership capabilities (Rana & Shuja 2022). Strengthening both hard and soft competencies ensures that project managers are not only technically proficient but also effective leaders, capable of steering teams successfully in dynamic IT project environments (Sampaio et al. 2022). Meanwhile, effective RM in IT projects requires addressing both internal and external risk factors to enhance project resilience and success (Menezes et al. 2019). By implementing proactive risk identification, real-time monitoring, and adaptive mitigation strategies, organizations can minimize uncertainties, improve decision-making, and optimize project performance (Pimchangthong & Boonjing 2017). Lastly, the firms in the IT industry should establish systematic KM practices to ensure that lessons learned from past projects are effectively captured and reused (PMI 2021). Organizations should establish structured processes for capturing project insights and retaining critical expertise (knowledge acquisition) (Al Shatti et al. 2018), foster a collaborative culture through digital platforms and mentoring programs to enhance knowledge sharing (Imam & Zaheer 2021), and ensure that acquired knowledge is effectively applied to decision-making, risk management, and project execution (knowledge exploitation) (Gonzalez & de Melo 2018).

CONCLUSION

This study investigates the factors influencing PS in China's IT projects, focusing on the roles of PMCs, RM, and KM. The findings confirm that PMCs and RM both have a positive influence on PS, emphasizing the necessity of developing competencies for project managers (Bashir et al. 2021; Sampaio et al. 2022) and implementing robust risk management strategies in IT projects (Alves et al. 2023; Trzeciak 2021). Additionally, the results demonstrate that PMCs and RM positively influence KM, indicating that organizations with well-equipped project managers and structured risk management practices are more effective in managing and utilizing knowledge (Hock-Doepgen et al. 2021; Srisuksa et al. 2021). Furthermore, KM has been shown to have a significant positive impact on PS, underscoring its role as a key success factor in IT project environments (Shahzadi et al. 2021). The mediation analysis further reveals that KM partially mediates the relationships between PMCs and PS, as well as RM and PS, suggesting that KM enhances the impact of PMCs and RM on PS but does not entirely replace their direct effects. These findings enrich project management literature by offering insights into the interrelationships among PMCs, RM, KM, and PS in IT projects.

Several limitations still exist in this study and offer directions for future research. First, the cross-sectional nature of the study captures only a single-point-in-time perspective, whereas IT projects evolve dynamically. Future studies could adopt a longitudinal approach to track changes across different project phases. Secondly, this study is centered on China's IT industry, which may limit generalizability due to cultural, organizational, and industry-specific differences. Future research could explore cross-country and cross-industry comparisons to assess how regional and sectoral variations influence project success factors. Lastly, the study's reliance on self-administered questionnaires introduces potential response and common method bias, which could be mitigated by triangulating multiple data sources such as expert evaluations or case studies. Addressing these limitations would strengthen the theoretical foundation of project management research and provide more actionable insights for organizations navigating complex IT project environments.

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APPENDIX 1

MEASUREMENT SUMMARY OF VARIABLES

Variables	Role of Variable	Dimensions	Numbers of Items	Sources
Project Management Competencies (PMCs)	Independent	Intellectual competencies	3	Dulewicz and Higgs (2005) Müller and Turner (2010)
		Managerial competencies	5	
		Emotional competencies	7	
Risk Management (RM)	Independent	Internal RM	6	Schmidt et al. (2001) Liu et al. (2010) Matuszak-Flejszman and Paliwod (2022)
		External RM	8	
Knowledge Management (KM)	Mediating	Knowledge acquisition	3	Yang et al. (2012) Amoako-Gyampah et al. (2021)
		Knowledge sharing	4	
		Knowledge exploitation	4	
Project Success (PS)	Dependent	Project management success	8	Brandon (2005) Iriarte and Bayona (2020)
		Project product success	4	