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The impact of inter-stakeholder knowledge sharing on project performance in the construction industry

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Abstract

Purpose – Due to the characteristics of modern construction projects, such as large scale, long construction period, huge investment and complicated technology involved, project success relies heavily on close cooperation among various stakeholders. Particularly, knowledge sharing among these stakeholders can determine the performance of construction projects. However, few studies explored the impact of inter-stakeholder knowledge sharing on project performance in the construction industry. This research, therefore, aims to explore the impact of inter-stakeholder explicit and tacit knowledge sharing on project's overall performance (i.e. project management performance and project cooperation performance) in construction projects.

Design/methodology/approach – Using the questionnaire survey method, a total of 191 valid samples were collected from Chinese construction professionals with various backgrounds, followed by descriptive and structural equation modeling analyses.

Findings – The results indicate that inter-stakeholder knowledge sharing in Chinese construction projects is at a relatively high level, with the level of tacit knowledge sharing exceeding that of explicit knowledge sharing. The project's overall performance was also perceived as relatively high by the Chinese professionals. Inter-stakeholder explicit knowledge sharing and tacit knowledge sharing are strongly correlated, and they have a strong and positive impact on project's overall performance in construction projects. Specifically, inter-stakeholder tacit knowledge sharing can improve project management performance more significantly, while inter-stakeholder explicit knowledge sharing is more conducive to achieving a higher level of project cooperation performance.

Originality/value – This research is unique in revealing the impact of inter-stakeholder knowledge sharing on construction project performance. The results can help various stakeholders in construction projects share their knowledge more effectively to further improve project performance.

Keywords Inter-stakeholder, Knowledge sharing, Project performance, Construction industry, China

Paper type Research article

1. Introduction

Modern construction projects have the characteristics of large scale, long delivery time, huge investment and complicated technology involved, making it impossible for a single stakeholder to achieve project objectives successfully. As a result, collaborative efforts, such as knowledge sharing among various stakeholders, including clients, designers, contractors, engineering consultants, subcontractors and suppliers, play a critical role in

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determining construction project performance (Ishdorj *et al*., 2024). Inter-stakeholder knowledge sharing in construction projects refers to the process in which different stakeholders share various information and experience to solve problems encountered in construction projects and facilitate successful project implementation (Demirkesen and Ozorhon, 2017).

In the current era of the knowledge-based economy, knowledge has progressively replaced traditional production factors such as land, labor and capital, emerging as the most critical economic resource and an important competitive advantage for organizations (Ni *et al*., 2018; Hartono *et al*., 2019). Inter-stakeholder knowledge sharing plays a pivotal role in the successful delivery of construction projects. Through knowledge sharing, understanding and trust can be strengthened among all stakeholders involved in a construction project, fostering closer collaboration and avoiding various problems caused by poor coordination. For instance, in large-scale construction projects, knowledge sharing between designers and contractors can help contractors better understand design intent, avoid design errors from the designers, and provide effective guidance for decision-making from clients. In addition, knowledge sharing promotes effective project integration, strengthening project team cohesion, which in turn enhances problem-solving abilities and facilitates technological advancement and innovation within construction projects (Demirkesen and Ozorhon, 2017). Faraji *et al*. (2021) observed that previous project experience endows construction professionals with enhanced decision-making and problem-solving skills, which in turn facilitates the effective selection of suitable alternative dispute resolution techniques. With the application of new technologies and delivery methods in the construction industry, such as Building Information Modeling (BIM) and Integrated Project Delivery (IPD), knowledge sharing among various stakeholders has a more profound impact on project performance. However, knowledge sharing among different stakeholders meets some challenges due to various reasons, which might negatively influence project performance. Most importantly, the interests of various stakeholders are not aligned since knowledge sharing may damage their individual interests. Hence, stakeholders in a construction project tend to hide knowledge, that is, attempt deliberately to withhold or conceal knowledge that other stakeholders have requested (Connelly *et al*., 2012). In fact, knowledge hiding has become a critical barrier for successful knowledge management in construction since it hinders the transfer and sharing of important expertise and information among stakeholders (Anbar *et al*., 2024). In addition, Fong and Chu (2006) revealed that knowledge is normally dispersed across scattered individuals and locations. Hence, knowledge sharing occurs more frequently at individual levels while it is more difficult to achieve knowledge sharing at organizational levels in a sense of continuity. Researchers have also found that the diffusion of explicit knowledge is easier than sharing tacit knowledge (e.g. Leonard and Sensiper, 1998). Furthermore, Haldin-Herrgard (2000) identified four major challenges of sharing tacit knowledge: perception and language, time available, value difference and distance. Sparkling and Dogra (2021) further found that field staff and management have contrasting viewpoints regarding the challenges of knowledge sharing for trade contractors; that is, management prioritized lack of formal processes as the key barrier to knowledge sharing, while the field team emphasized the lack of socialization and encouragement.

Project performance, which is used interchangeably with project overall performance in this paper, is defined as the attainment of project goals, which is employed to evaluate project success through key indicators such as time, cost, and quality (Zaman *et al*., 2019). As modern projects become increasingly complex, a broader set of indicators is used to achieve a more comprehensive assessment of project's overall performance, including customer requirements, team satisfaction and market share (Lu *et al*., 2019). Bjorvatn and Wald (2018) further differentiated project management performance from project performance, with the latter encompassing a broader scope that includes the objectives of all stakeholders throughout the project lifecycle. On the other hand, project cooperation

performance, which assesses the effectiveness of collaboration among stakeholders, has also become an important indicator measuring project overall performance (Ma *et al*., 2024).

Despite the importance of inter-stakeholder knowledge sharing, research on this topic is insufficient. First, existing research mainly focused on knowledge sharing within an organization and overlooked the important influence of inter-stakeholder knowledge sharing on the project's overall performance. For instance, in an early study, Fong and Chu (2006) identified the main barriers and the primary benefits of effective knowledge sharing at tendering department levels in contracting companies. Javernick-Will (2012) explored the reasons why employees share their knowledge in various types of firms in the construction industry, and the results revealed four main factors affecting knowledge sharing: resources, intrinsic motivations, global incentives and social motivations. Wanberg *et al*. (2017) examined the mechanisms to initiate knowledge-sharing connections in communities of practice within organizations. Second, the impact of knowledge-sharing on project performance is also not well explored. More specifically, in this area, either the direct association between knowledge-sharing and project performance is not adequately investigated, or the measurement indicators for knowledge-sharing and project performance are limited. For instance, Kiomjian *et al*. (2020) only analyzed the association between knowledge sharing and productivity improvement, and their findings indicated that more diverse crews facilitate knowledge sharing and productivity improvement. Although Li *et al*. (2024) evaluated the impact of explicit and tacit knowledge sharing on improving project management performance, they used only six indicators assessing knowledge sharing and four indicators measuring project management performance. These are not sufficient to present the overall profile of explicit and tacit knowledge sharing across different stakeholders, as well as project management performance and project cooperation performance. Therefore, it is necessary to develop well-structured and comprehensive indicators that can adequately measure the inter-stakeholder explicit and tacit knowledge sharing, as well as project management performance and project cooperation performance in construction projects. Third, another two main research streams in the field are analyzing factors influencing or facilitating knowledge sharing (e.g. Sparkling and Dogra, 2021; Ju and Ning, 2022; Hsu *et al*., 2023; Huang *et al*., 2024; Jia *et al*., 2025) and knowledge-sharing behavior (e.g. Etemadi *et al*., 2019; Cheng and Yin, 2024; Ishdorj *et al*., 2024), which are not the focus of this study. Fourth, the remaining studies tend to use knowledge-sharing as a mediating factor in exploring its influence between two or more sets of variables (e.g. Qiao *et al*., 2021; Imam, 2021; Shi *et al*., 2022). Last but not least, knowledge-sharing level in construction remains underexplored in existing research outcomes.

In fact, it is important to examine the impact of knowledge sharing on a project's overall performance from an inter-stakeholder perspective, because knowledge sharing, especially across different stakeholders, has critical impacts on construction project performance, including quality, cost, time, safety and risk management (Anbar *et al*., 2024). To address the knowledge gap, this research employed literature review and questionnaire survey methods, and aimed to: (1) evaluate the level of inter-stakeholder knowledge sharing in construction projects; (2) assess the level of project overall performance in construction projects; and (3) explore the impact of inter-stakeholder knowledge sharing on project overall performance in construction projects. The structure of this paper is organized as follows: Firstly, an extensive literature review was conducted to identify the factors measuring the types of inter-stakeholder knowledge sharing and the indicators evaluating a project's overall performance in construction projects, followed by the development of research hypotheses. Secondly, the research methodology was presented, including the research process, data collection and data analysis. Thirdly, data were analyzed using descriptive and Structural Equation Modelling (SEM) methods, and the results were discussed comprehensively. Finally, the conclusion was drawn, and limitations and future research directions were summarized.

2. Literature review and hypothesis development

2.1 Types of knowledge sharing

Knowledge is defined as a fluid combination of experience, values, contextual information and expertise that is rooted in individuals and serves as a framework for interpreting and integrating new information (Zhang and Ng, 2013). In the construction industry, knowledge is commonly categorized into explicit knowledge and tacit knowledge (Ishdorj *et al*., 2024). Explicit knowledge refers to information that can be articulated in words and numbers, easily communicated and shared in tangible forms such as documents, scientific reports, codified procedures and universal principles (Ma *et al*., 2008). Conversely, tacit knowledge resides in individuals' minds, which is acquired over time through experience, learning, perception, analysis and observation in the physical world (Saini *et al*., 2018). Both forms emphasize that knowledge is inherently personal and not easily accessible by others, which underscores the importance of effective knowledge sharing in construction projects (Zhang and Ng, 2013).

Based on extensive literature review results, Table 1 presents the types of explicit knowledge sharing and tacit knowledge sharing.

2.2 Project overall performance in construction projects

Project performance has been extensively examined to evaluate the extent of intended objectives achieved in a construction project (Ma *et al*., 2021). These objectives span from the traditional iron triangle of project management to encompass the interests of all project participants, including team satisfaction, safety requirements, sustainability, effective communication and efficient resolution of claims and disputes throughout the project lifecycle (Lin *et al*., 2024; Imam, 2021; Jia *et al*., 2021; Demirkesen and Ozorhon, 2017; Samee and Pongpeng, 2016). Through an extensive literature review, the project's overall performance indicators were identified and grouped into two dimensions, namely project management performance and project cooperation performance (Samee and Pongpeng, 2016). Project management performance is to assess the effectiveness of resource management and process execution within construction projects, emphasizing the overall success of project delivery related to established project objectives and stakeholder expectations (Ma *et al*., 2021). Conversely, project cooperation performance is used to evaluate the status and results of the cooperation among project stakeholders (Ma *et al*., 2024). The evaluation indicators are presented in Table 2.

2.3 Hypotheses development

2.3.1 The impact of inter-stakeholder knowledge sharing on project management performance. Existing research demonstrates a positive correlation between knowledge sharing and project management performance (Han and Hovav, 2013; Huang *et al*., 2020). Inter-stakeholder knowledge sharing significantly reduces repetitive work and errors resulting from poor communication and information asymmetry, which can improve the time, cost and quality performance (Zhang and Ng, 2013). Furthermore, knowledge sharing among team members is reported to significantly improve the efficiency and quality of decision-making and ensure the accuracy and adaptability of project plans in dynamic environments, which in turn enhances project efficiency (Li *et al*., 2024). Other studies emphasize the critical role of explicit and tacit knowledge sharing in construction project management, indicating that effective inter-stakeholder knowledge sharing can not only improve the three triangle project objectives but also optimize HSE (Health, Safety and Environment) results, reduce risks and meet users' requirements, thereby enhancing project management performance. Based on these literature review results, the following two hypotheses are proposed:

H1a. Inter-stakeholder explicit knowledge sharing has a positive impact on project management performance in construction projects.

Table 1. Types of knowledge-sharing

Type	Literature source	Description
Explicit knowledge sharing		
(1) Planning and design-related document (EKS1)	O'Connor and Koo (2021), Qi *et al.* (2021), Wang *et al.* (2016), Xia *et al.* (2012)	It includes specifications, technical drawings and other relevant documents, which guide construction processes and inform the selection of materials
(2) Construction technical document (EKS2)	Faraji *et al.* (2021), Qiao *et al.* (2021), Qady and Kandil (2013)	It specifies the construction methods, process and technology used in projects, which are used as common references for all stakeholders
(3) Quality-related document (EKS3)	Hong *et al.* (2019), Yung and Yip (2010)	It includes quality management plans, quality standards and manuals, which are important to ensure the client's requirements for quality being met
(4) Cost-related document (EKS4)	Faraji *et al.* (2021), Duzkale and Lucko (2016)	It includes bill of quantities, cost control reports and cost management plans, which are important to ensure project costs being efficiently managed
(5) Progress-related document (EKS5)	Shi *et al.* (2022), Assaf *et al.* (2019), Kang *et al.* (2018)	It specifies schedules, detailed timelines and work sequences, which can explicitly communicate the progress and coordinate project activities among all stakeholders
(6) Safety-related document (EKS6)	Ashraf *et al.* (2023), Le *et al.* (2014), Hallowell (2012)	It includes safety risk checklists, safety management plan and accident reports, which are critical to disseminate safety knowledge and take proactive interventions across project teams
(7) Change-related document (EKS7)	Qi *et al.* (2021), Wang *et al.* (2016)	It includes change orders and cost variation report because of change orders, which are used as formal records in change management process
(8) Procurement-related document (EKS8)	Assaf *et al.* (2019), Xia *et al.* (2012)	It includes tendering documents, procurement strategy and product brochure, which can enhance stakeholders' understanding of the project's overall requirements
(9) Equipment and material-related document (EKS9)	Qiao *et al.* (2021), Kang *et al.* (2018)	It includes all the technical information for equipment and material to be used in construction projects, which can ensure that materials and equipment are correctly procured, delivered, and used onsite
(10) Regulation and policy-related document (EKS10)	Deng *et al.* (2014)	It establishes standardized frameworks, procedures and requirements from governments that ensure stakeholders comply with design specifications, safety protocols and environmental assessments throughout the project lifecycle

(*continued*)

Table 1. Continued

Type	Literature source	Description
Tacit knowledge sharing		
(1) Construction-related experience and understanding (TKS1)	Qi *et al*. (2021), Assaf *et al*. (2019), Kang *et al*. (2018)	They encompass practical and hands-on expertise and insights that are typically acquired through working experience of managing or implementing construction activities
(2) Quality management-related experience and understanding (TKS2)	Ye *et al*. (2015)	They refer to the skills, understanding, and experience that enable individuals to apply quality techniques or methods to ensure consistent adherence to quality standards
(3) Cost management-related experience and understanding (TKS3)	Assaf *et al*. (2019), Kang *et al*. (2018)	They include experience and understanding of market conditions, material costs and cost estimations, which are precondition for enhancing cost management performance
(4) Progress management-related experience and understanding (TKS4)	Osei-Kyei *et al*. (2019), Kang *et al*. (2018), Ye *et al*. (2015)	They help project managers and stakeholders to determine a reasonable project schedule, sequence of activities and acceleration plan
(5) Safety management-related experience and understanding (TKS5)	Ashraf *et al*. (2023), Zhang *et al*. (2022), Hallowell (2012)	They include experience and understanding in proactive hazard identification and development of effective safety management solutions, contributing to the improvement of safety management performance
(6) Risk management-related experience and understanding (TKS6)	Osei-Kyei *et al*. (2019), Kang *et al*. (2018), Deng *et al*. (2014)	They enable proactive and effective identification, evaluation, control and management of project risks for stakeholders
(7) Previous project experience and lessons (TKS7)	Faraji *et al*. (2021), Deng *et al*. (2014)	They are valuable for stakeholders to develop a practical project management plan and avoid management failures
(8) Experience and understanding learnt from training and education (TKS8)	Qi *et al*. (2021), Ye *et al*. (2015)	Participants involved in construction projects may share their experience and understanding from training and education to improve their management performance or solve project problems

Source(s): Authors' own work

H1b. Inter-stakeholder tacit knowledge sharing has a positive impact on project management performance in construction projects.

2.3.2 The impact of inter-stakeholder knowledge sharing on project cooperation performance. Zhang and Wang (2016) explored the impact of knowledge sharing on project cooperation performance in IPD projects and found a high correlation between knowledge sharing behavior and cooperation performance. They also found that through promoting effective communication and enhancing mutual trust among team members, knowledge sharing effectively improves the stability and coordination of team cooperation, which are closely related to the satisfaction of relationships between teams. Ma (2017) also found that knowledge sharing has a positive impact on cooperation performance in EPC (Engineering Procurement and Construction) projects. Similarly, Ghazwani and Alzahrani (2024) found that

Table 2. Evaluation indicators of project overall performance

Indicator	Literature source	Description
Project management performance		
Time requirements (PMP1)	Huang *et al*. (2020), Bjorvatn and Wald (2018), Wang *et al*. (2016), Lu and Liu (2014)	The achievement of progress/time requirements is one of the important indicators to evaluate project management performance
Quality requirements (e.g. technical and functional requirements) (PMP2)	Qi *et al*. (2021), Hussain *et al*. (2019), Bjorvatn and Wald (2018), Lu and Liu (2014), Wang *et al*. (2016), Yung and Yip (2010)	These requirements are related to the degree to which the functions and characteristics of the project meet relevant quality-related standards and consumer requirements
Cost requirements (PMP3)	Huang *et al*. (2020), Bjorvatn and Wald (2018), Li *et al*. (2018), Wang *et al*. (2016)	These requirements are related to the expenses necessary to complete a project, including materials, labor, equipment, management and other related expenses
User's requirements (PMP4)	Jia *et al*. (2021), Huang *et al*. (2020), Hussain *et al*. (2019), Kang *et al*. (2018)	User may have special requirements for construction projects, such as façade, light, green space and energy efficiency for operation
Safety requirements (PMP5)	Ashraf *et al*. (2023), Le *et al*. (2014), Wanberg *et al*. (2013), Wang *et al*. (2013)	They are used to evaluate the performance of construction projects in ensuring workplace safety and avoiding safety accidents
Occupational health requirements (PMP6)	Wang *et al*. (2013, 2017)	They are used to evaluate the performance of projects in protecting the health of participants involved in the delivery and operation processes
Environmental requirements (PMP7)	Lin *et al*. (2024), Liu *et al*. (2022), Wang *et al*. (2013)	They are used to assess the performance of projects in protecting the surrounding environment and reducing environmental negative impacts in the delivery and operation processes
Project cooperation performance		
Cooperation satisfaction (PCP1)	Jia *et al*. (2021), Han and Hovav (2013)	It refers to the positive emotional state related to overall satisfaction of the cooperation relationship among the stakeholders involved in the delivery of construction projects
Future cooperation willingness (PCP2)	Lu and Liu (2014), Zhang and Ng (2013)	After completing the project, stakeholders may have enthusiasm and intention to cooperate again in the future
Technical competitiveness (PCP3)	Anbar *et al*. (2024), Huang *et al*. (2024)	It refers to the overall capability of an enterprise's technical ability, production methods and related technical qualifications
Innovation ability (PCP4)	Shi *et al*. (2022), Qiao *et al*. (2021), Hong *et al*. (2019)	It includes product innovation, process innovation, market innovation, organizational innovation and business model innovation
Profitability ability (PCP5)	Ghazwani and Alzahrani (2024), Xue and Zhang (2018), Samee and Pongpeng (2016), Zollo *et al*. (2002)	It refers to an enterprise's ability to generate profits and create economic value through its business activities
Market share/business volume (PCP6)	Anbar *et al*. (2024), Xue and Zhang (2018), Samee and Pongpeng (2016)	It refers to the percentage of an enterprise's sales in a specific market, reflecting its competitive position and market influence

Source(s): Authors' own work

knowledge sharing promotes employees' collaboration and product innovation, leading to improved profitability performance. Ali *et al*. (2018) also found that both knowledge governance and knowledge sharing are critical antecedents for improving knowledge

integration and innovation capabilities. In addition, effective knowledge sharing can promote trust and mutual understanding among partners, enhance the efficiency of collaborative work and create more value for stakeholders (Anbar *et al*., 2024; Qiao *et al*., 2021). Based on the above literature review results, the following two hypotheses are proposed:

H2a. Inter-stakeholder explicit knowledge sharing has a positive impact on project cooperation performance in construction projects.

H2b. Inter-stakeholder tacit knowledge sharing has a positive impact on project cooperation performance in construction projects.

2.3.3 The correlation between inter-stakeholder explicit and tacit knowledge sharing. According to Nonaka and Takeuchi's (1995) knowledge spiral theory, explicit and tacit knowledge are in a continuous process of transformation, facilitating the creation of both team and organizational knowledge. Internalization refers to the process by which explicit knowledge is transformed into tacit knowledge when individuals internalize explicit knowledge into their own experiences and know-how through reading, learning and other practices. Conversely, externalization involves the transformation of tacit knowledge into explicit knowledge, where individuals employ interactive methods such as imitation, observation and practice to summarize and refine tacit knowledge into explicit forms that can be communicated through various media (Ni *et al*., 2022). Hansen (1999) found that sharing tacit knowledge needs strong ties or connections that have frequent interactions, while sharing explicit knowledge can occur among individuals or between organizations with weak ties or connections that have less frequent interactions. Hallowell (2012) further suggested that both explicit and tacit knowledge are equally critical for effective knowledge management, and that achieving a balance and integration of the two facilitates organizational performance improvement. Qiao *et al*. (2021) found that tacit knowledge sharing had a mediating role between BIM application and innovation capability, while explicit knowledge sharing had a mediating role between BIM application and tacit knowledge sharing. Shi *et al*. (2022) indicated that explicit knowledge sharing significantly affects tacit knowledge sharing in the construction supply chain. Hsu *et al*. (2023) also revealed that collaboration improves when employees in an organization can transform their tacit knowledge into explicit knowledge. Therefore, it can be inferred that explicit and tacit knowledge sharing are interdependent processes rather than independent ones. Based on the above literature review results, the following hypothesis is proposed:

H3. There is a positive correlation between inter-stakeholder explicit knowledge sharing and inter-stakeholder tacit knowledge sharing in construction projects.

The conceptual model showing the hypothesized relationships among the variables is depicted in Figure 1.

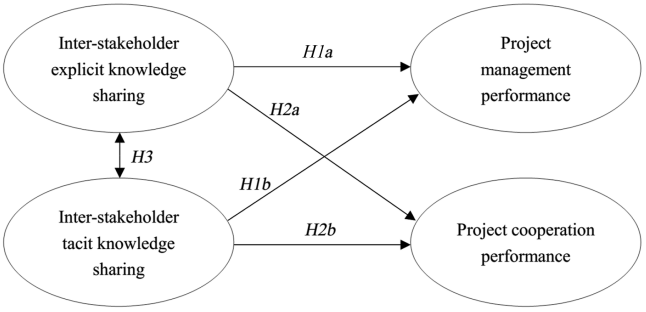

Figure 1. Conceptual model showing the hypothesized relationships among the variables. Authors' own work

3. Research methodology

3.1 Data collection

A questionnaire survey was used to solicit viewpoints from professionals regarding the inter-stakeholder knowledge sharing and the project's overall performance. Referring to Conner *et al*. (2025), Jia *et al*. (2025), Li *et al*. (2024) and Kim *et al*. (2021), a standard scale development procedure was followed to develop and validate the proposed scales in the questionnaire. The procedure mainly includes an extensive literature review, as introduced above, which was further validated through a pilot survey, as well as reliability and validity tests of the survey data and Confirmatory Factor Analysis (CFA) of the variables as presented in the following sections.

The questionnaire comprised three main sections. The first section collected the demographic information of the surveyed construction professionals, including gender, age, type of stakeholder, years of working experience and job position. The second section aimed to investigate the levels of inter-stakeholder knowledge sharing in a construction project they have recently participated in or are currently participating. Built on the literature review results identifying the types of knowledge-sharing as shown in Table 1, this section employed ten and eight statements to capture the professionals' perspectives on explicit and tacit knowledge sharing among different stakeholders, respectively. The third section sought to investigate the project's overall performance of the construction project in which they have been recently involved or are currently participating. Similar to section two of the questionnaire, according to the literature review results, identifying the indicators measuring the project's overall performance as indicated in Table 2, in this section, seven and six questions were used to evaluate project management performance and project cooperation performance, respectively. A five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) was used in sections two and three. The full questionnaire is attached as an appendix to this paper.

A pilot survey was conducted with five experienced professionals with diverse backgrounds and with at least five years of working experience (two construction project managers, one design professional, one technical manager and one academic who is familiar with survey design in the construction management field), to validate and improve the questionnaire. In this process, the full questionnaire was presented to them for comments and suggestions. In total, sixteen comments were obtained, which were mainly related to the wording and clarity of the questionnaire. For instance, one construction project manager recommended adding an explanation of the meaning of explicit and tacit knowledge sharing in the investigation background note of the questionnaire to better inform the respondents. Based on their comments, the questionnaire was refined to improve clarity. The final questionnaire was then administered online to construction professionals working for various types of stakeholders to obtain a representative sample with balanced views. The survey participants were approached using the research team's networks, employing the purposive sampling technique. This technique has been frequently used in construction management research, such as Zhang *et al*. (2022), who evaluated the safety risk management performance in subway construction projects in China. Purposive sampling was adopted in this research because it has several advantages, such as obtaining qualified respondents more effectively, controlling the quality of data, reaching respondents quickly and selecting informative samples (Crossman, 2020; Talebi *et al*., 2021). In the survey administration process, different types of stakeholders were identified through the research team's networks, including client, general contractor, subcontractor/supplier, geological survey/design company, supervision company (*Jianli* in Chinese) and consulting company. The managers working for these stakeholders were contacted and fully informed of the details of the investigation. After obtaining their approval for the survey, the managers got the survey link and administered the survey within their department or company. In order to gather representative samples from professionals with different demographic characteristics, the managers were requested to distribute the survey to their colleagues, considering the balance of their gender, age, years of working experience, and job position.

Similar to other construction management research using the questionnaire survey method, potential nonresponse bias may exist in this study because of the busy work schedules of the construction professionals, worry about releasing personal or company information or having no interest in the research topic. Following Vogel and Jacobsen (2021), several measures were undertaken to address the potential problem of nonresponse bias. First, special attention was paid to reducing the length of the questionnaire and improving the clarity of questions so as to minimize the time needed for the respondents to complete the survey. Second, the respondents were fully informed that the investigation was anonymous and their personal information would not be disclosed. Third, as the research team has excellent networks with the managers of the surveyed company, full support for the investigation was obtained from them. Fourth, the respondents were reminded two times during the process to complete the survey. All these measures can improve the response rate and, in turn, minimize problems related to potential nonresponse bias.

Data underwent a two-step screening process to ensure the validity. Firstly, the responses were examined for completeness. Secondly, Standard Deviation (SD) values for the Likert scale sections were calculated to determine whether all the answers to the questions were the same. If the SD value was zero, the response was considered as repeated answers for the questions and thus invalid (Zheng *et al*., 2023). In total, 214 responses were collected, of which 191 samples are valid (see Table 3). Existing research argues that an SEM analysis requires a minimum of between 100 and 400 responses (Iacobucci, 2009; Tripathi and Jha, 2018). In addition, the sample-to-variable ratio in this study was 6.16:1, exceeding the recommended minimum ratio of 5:1 (Hair *et al*., 2010).

Table 3. Demographic information of the respondents

Category	Profile	Number of respondents	Percentage (%)
Gender	Male	147	76.96
	Female	44	23.04
Age	Less than 25 years old	13	6.81
	26–30 years old	29	15.18
	31–35 years old	43	22.51
	36–40 years old	53	27.75
	41–45 years old	27	14.14
	46–50 years old	10	5.24
	Over 51 years old	16	8.38
Type of stakeholders	Client	25	13.09
	General contractor	63	32.98
	Subcontractor/supplier	36	18.85
	Geological survey/design company	23	12.04
	Supervision company (*Jianli* in Chinese)	26	13.61
	Consulting company	18	9.42
Years of working experience	1–5 years	17	8.90
	6–10 years	31	16.23
	11–15 years	44	23.04
	16–20 years	54	28.27
	21–25 years	25	13.09
	Over 26 years	20	10.48
Job position	Senior manager	3	1.57
	Middle-level manager	32	16.75
	Project responsible person	27	14.14
	Management staff	85	44.50
	Non-management employee	44	23.04

Source(s): Authors' own work

3.2 Data analysis methods

The collected data were analyzed using the following methods. Firstly, Cronbach's alpha coefficient, Bartlett's test of sphericity and Kaiser–Meyer–Olkin (KMO) were calculated to assess the reliability and internal consistency of the survey data, and ascertain their suitability for subsequent analyses. A Kolmogorov–Smirnov (KS) test was also conducted to determine whether the data were normally distributed (Zhang *et al*., 2022). Secondly, descriptive analyses were performed to obtain the mean values of inter-stakeholder knowledge sharing and project overall performance levels. Third, SEM was employed to examine the relationships among the factors measuring inter-stakeholder knowledge sharing and project's overall performance. SEM is considered the most powerful technique to determine the significance and relationships among the observed and latent variables in a model (Zahoor *et al*., 2017). Although four indices are sufficient to determine the degree of fit for a structural equation model (Kline, 1998), six indices were employed in this study, including χ^2 (Chi-square), df (degrees of freedom), RMSEA (Root Mean Square Error of Approximation), GFI (Goodness-of-fit Index), TLI (Tucker–Lewis index) and IFI (Incremental Fit Index).

4. Data analysis results and discussions

4.1 Reliability and validity test results

Statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) 23.0. The Cronbach's alpha coefficients for inter-stakeholder knowledge sharing and project overall performance are 0.929 and 0.923, respectively, which are beyond the 0.7 threshold, demonstrating a good internal consistency (Jia *et al*., 2021). Furthermore, the KMO values for the inter-stakeholder knowledge sharing and project overall performance are 0.939 and 0.944, respectively. Both are well above the acceptable threshold of 0.5. The Bartlett's test of sphericity results for the inter-stakeholder knowledge sharing and project overall performance ($p = 0.00$) are lower than 0.05, indicating strong relationships among the variables. These results suggest that the validity of the survey is acceptable and suitable for further analysis (Wang *et al*., 2016).

4.2 Inter-stakeholder knowledge sharing analysis results

The mean values for each variable of inter-stakeholder explicit and tacit knowledge sharing were calculated. In addition, as the data were normally distributed, one-way Analysis of Variance (ANOVA) was used to compare the mean values between the viewpoints among the respondents from different stakeholders. The results are shown in Table 4.

At the dimension level, the mean value of inter-stakeholder tacit knowledge sharing is slightly higher than that of inter-stakeholder explicit knowledge sharing, indicating that professionals in the Chinese construction industry are more willing to exchange experience and expertise among stakeholders than to disseminate formal construction information and documentation. Fang (2013) also obtained similar results, indicating that the level of tacit knowledge sharing is slightly higher than that of explicit knowledge sharing in construction projects. Explicit knowledge is more frequently disseminated in written form, such as work reports, official documents and manuals (Bock *et al*., 2005). Compared to tacit knowledge, although explicit knowledge is easier to standardize, the sharing process is more formal, which is not sufficient to promote deep communication and understanding among different stakeholders (Qiao *et al*., 2021). Although tacit knowledge is difficult to express clearly in some cases (Hooff and Ridder, 2004), communicating tacit knowledge is more flexible, such as face-to-face interaction and informal communication methods (Willem and Buelens, 2007).

At the factor level, among the factors of inter-stakeholder explicit knowledge sharing in construction projects, the mean value of safety-related documents (EKS6) is the highest (4.000), while that of cost-related documents (EKS4) is the lowest (3.403). This indicates that stakeholders tend to share safety-related documents more frequently, while they are not willing

Table 4. Analysis results of inter-stakeholder knowledge sharing

Dimension	Type of knowledge sharing	Mean value	Rank	ANOVA *F*	*p*
EKS	EKS1	3.880	8	1.842	0.107
	EKS2	3.733	15	2.288	*0.048**
	EKS3	3.827	13	0.593	0.705
	EKS4	3.403	18	1.129	0.346
	EKS5	3.869	10	1.06	0.384
	EKS6	4.000	1	1.927	0.092
	EKS7	3.796	14	1.447	0.209
	EKS8	3.450	17	1.588	0.166
	EKS9	3.518	16	1.055	0.387
	EKS10	3.890	7	1.291	0.269
	Total	*3.737*	-	*0.776*	*0.568*
TKS	TKS1	3.963	5	1.582	0.167
	TKS2	3.969	3	1.98	0.084
	TKS3	3.942	6	1.213	0.305
	TKS4	3.969	4	1.105	0.359
	TKS5	3.974	2	0.638	0.671
	TKS6	3.859	11	2.424	*0.037**
	TKS7	3.859	11	0.811	0.543
	TKS8	3.880	9	0.366	0.871
	Total	*3.927*	-	*1.675*	*0.143*

Note(s): *means that significantly different perceptions exist among different types of stakeholders at 95% confidence levels

Source(s): Authors' own work

to share cost-related documents with others. If a safety accident occurs during the implementation of a construction project, it will have a serious negative impact on the performance (Ashraf *et al*., 2023), meaning that all the stakeholders will be affected by a safety accident. Therefore, achieving high levels of safety performance through knowledge sharing is the common goal for all the stakeholders involved in a construction project. In addition, there are strict safety-related laws and regulations in China that require stakeholders to comply with in the project management process. For instance, the Ministry of Housing and Urban-Rural Development stipulated that project managers, safety managers, designers and clients who fail to fulfill their safety responsibilities and cause safety accidents will face severe penalties, including revocation of professional certificates and prohibition from participating in construction activities (MHURD, 2019). Therefore, stakeholders tend to attach the highest level of importance to safety-related knowledge sharing in construction projects. However, cost-related information is the least commonly shared explicit knowledge in construction projects. This is understandable because if cost information is known by other stakeholders, they may use it to lower the quotation in the tendering stage or cut the cost compensation in a claim. In fact, the majority of the stakeholders have a conflict of cost interest in a construction project. For instance, clients typically aim to minimize investments, while contractors seek to maximize profits, making the disclosure of cost information potentially detrimental to each other's interests (Lin *et al*., 2024).

Among the factors of inter-stakeholder tacit knowledge sharing in construction projects, the mean value of safety management-related experience and understanding (TKS5) is the highest (3.974), while that of previous project experience and lessons (EKS6) is the lowest (3.859). But the differences between the highest and lowest mean values of the factors of inter-stakeholder tacit knowledge sharing are minor, which is also lower than the differences between those of the inter-stakeholder explicit knowledge sharing. Similar to the sharing of safety-related documents in inter-stakeholder explicit knowledge sharing, different

stakeholders can learn how to more effectively prevent and manage safety risks by exchanging their experiences and understanding in safety management, which can help to promote a favorable safety climate in a construction project, ensure regulatory compliance and facilitate the adoption of best practices for mitigating safety risks (Ashraf *et al*., 2023). On the contrary, the experience and lessons learned from previous construction projects are critical intellectual assets for a stakeholder that can enhance innovation and provide a competitive advantage in achieving project success (Carrillo *et al*., 2013). In fact, tacit knowledge has been regarded as a valuable resource for organizations (Wu, 2012), as they usually include unique experiences and capabilities accumulated by organizations in a long-term practice, which can develop the core competitiveness of organizations and help them obtain a favorable position in the construction market. Davenport and Prusak (1998) interpreted knowledge sharing as a process of knowledge trading from the perspective of transaction costs. They believed that knowledge sharing depends on whether the buyer and seller are willing to engage in the transaction process when the transaction interests meet their needs. The results of this research also demonstrate this phenomenon. Only when knowledge-sharing behavior aligns with the common interests of all the stakeholders involved in construction projects and can effectively manage the risks and costs in the sharing process, will the level of knowledge sharing be significantly improved.

At the dimension level, no significant differences were found in inter-stakeholder explicit and tacit knowledge sharing levels among respondents from different types of stakeholders. However, significant differences were observed in the perceptions among different groups of respondents in terms of the construction technical document (EKS2) and risk management-related experience (TKS6). In addition, the mean values suggest that general contractors tend to be more willing to share their explicit knowledge (3.82) and tacit knowledge (4.01) compared with other stakeholders, while geological survey/design companies tend to be less likely to share their explicit knowledge (3.49) and tacit knowledge (3.49) compared with other stakeholders.

4.3 Project overall performance analysis results

The mean values for each variable of project management performance and project cooperation performance were calculated. In addition, ANOVA was used to compare the mean values among respondents from different stakeholders. The results are shown in Table 5.

Table 5. Analysis results of project overall performance

Dimension	Performance indicator	Mean value	Rank	ANOVA *F*	*p*
PMP	PMP1	3.812	10	0.879	0.496
	PMP2	3.911	1	1.769	0.121
	PMP3	3.890	3	0.77	0.572
	PMP4	3.869	5	0.672	0.645
	PMP5	3.890	4	1.819	0.111
	PMP6	3.848	8	1.271	0.278
	PMP7	3.906	2	1.893	0.098
	Total	*3.875*	-	*1.581*	*0.167*
PCP	PCP1	3.785	12	1.056	0.386
	PCP2	3.843	9	0.366	0.871
	PCP3	3.759	13	0.563	0.728
	PCP4	3.859	7	0.841	0.522
	PCP5	3.812	10	1.622	0.156
	PCP6	3.864	6	0.927	0.464
	Total	*3.820*	-	*0.727*	*0.604*

Source(s): Authors' own work

At the dimension level, the overall performance of Chinese construction projects is at a relatively high level, with project management performance (3.875) slightly exceeding project cooperation performance (3.820). Zollo *et al*. (2002) used direct and indirect performance to evaluate the cooperation performance among stakeholders, where direct performance refers to the achievement of project goals, while indirect performance relates to the competitive advantage gained through stakeholder cooperation. They found that compared to indicators such as quality and cost in project management performance that can achieve measurable improvements in a short term, the competitiveness (such as technical competitiveness, innovation ability and profitability ability) in project cooperation performance is difficult to measure and improve in a short period of time. This is because the improvement of competitiveness is a long-term process that needs to be developed and consolidated in future construction projects (Eriksson *et al.*, 2014). Shi *et al*. (2022) further noted that cooperation performance improvement is an iterative and long-term process, where construction enterprises must constantly engage in collaborative activities to enhance knowledge sharing and project overall performance. In construction projects, the competitiveness enhancement brought by inter-stakeholder cooperation has a profound impact on project management performance and cooperation behavior among stakeholders (Zollo *et al*., 2002).

At the indicator level, the average values of quality-related requirements (PMP2) (3.911) and environmental requirements (PMP7) (3.906) in project management performance are relatively higher compared with other indicators. In addition, the average values of market share/business volume (PCP6) (3.864) and innovation ability (PCP4) (3.859) in the project cooperation performance are relatively higher. These results demonstrate that stakeholders have paid special attention to these aspects and achieved higher levels of performance in Chinese construction projects.

Quality is an important indicator for evaluating the performance of construction projects (Songer *et al*., 1996), which directly influences safety, functionality, durability and users' satisfaction (Qi *et al*., 2021). In construction projects, the level of quality not only affects the economic benefits but also has an impact on the reputation and competitiveness of enterprises (Pinto *et al*., 2009). Although high-quality standards may require more initial investments in early stages, such as using high-quality materials, high quality can effectively reduce the costs related to rework, repair and maintenance, which in turn can save the overall lifecycle cost of construction projects (Zhang *et al*., 2022). Environmental impact has emerged as a critical performance indicator in evaluating the success of construction projects, encompassing social, economic and sustainable dimensions of construction activities throughout project implementation (Rajabi *et al*., 2022). A high level of environmental performance of construction projects can increase the support and trust from the government and public, enhance the corporate social responsibility image and help to obtain market recognition.

Market share represents the competitive position of construction enterprises and their ability to secure contracts in a highly competitive construction market. Samee and Pongpeng (2016) also highlighted the importance of sustainable business for construction enterprises, as collaboration fosters resource sharing, exchange of market information and access to clients' networks, which together enhance market influence and business growth (Anderson and Faff, 2008). In addition, with the advancements in construction management methods and technology, innovation has become a core ability for enterprises to sustain a competitive advantage (Qiao *et al*., 2021). Liao and Li (2019) found that collaboration facilitates knowledge sharing, resource pooling and expertise exchange, which have a positive impact on innovation. The integrated knowledge obtained through inter-stakeholder sharing helps to generate innovative thinking and solutions, which in turn enhances the innovation capability of the project team.

The analysis results also indicate that there is no significant difference in the perception of project management performance level and project cooperation performance level among the respondents from different types of stakeholders.

4.4 SEM analysis results of the impact of inter-stakeholder knowledge sharing on project performance

AMOS 22.0 was employed to conduct first-order CFA on the four latent variables and thirty-one observed variables, comprising eighteen variables for inter-stakeholder knowledge sharing and thirteen variables for project overall performance. The preliminary first-order CFA results indicated that factor loadings for all thirty-one variables exceeded the threshold of 0.5, they were all included for further analysis (Awang, 2012; Xiong *et al*., 2015). Then the second-order CFA was conducted, and the results met the threshold of developing a valid model (χ^2/df = 1.181 < 3, RMSEA = 0.031 < 0.08, TLI = 0.974 > 0.9, CFI = 0.976 > 0.8 and IFI = 0.976 > 0.8) (Hu and Bentler, 1999; Xiong *et al*., 2015; Naji *et al*., 2022). The results for the model are shown in Figure 2.

Figure 2 shows that at the dimension level, the strongest path coefficient (i.e. standardized factor loadings) is between inter-stakeholder explicit and tacit knowledge sharing (0.712, $p < 0.001$), which indicates that one type of inter-stakeholder knowledge sharing can most effectively facilitate the other type of knowledge sharing. For instance, the sharing of safety-related documents (explicit knowledge) among various stakeholders might become an effective way to facilitate the sharing of safety or other management-related experience and understanding (tacit knowledge), and vice versa. The path coefficients between inter-stakeholder explicit knowledge sharing and project management performance, as well as project cooperation performance, are 0.269 ($p < 0.001$) and 0.479 ($p < 0.001$), respectively. While the path coefficients between inter-stakeholder tacit knowledge sharing and project management performance, as well as project cooperation performance, are 0.582 ($p < 0.001$) and 0.474 ($p < 0.001$), respectively. This means that inter-stakeholder explicit knowledge sharing is more effective to improve project cooperation performance, while inter-stakeholder tacit knowledge sharing is more effective to improve project management performance.

The findings are similar to those of Li *et al*. (2024), who demonstrated that the two types of knowledge sharing have significantly positive effects on project management performance.

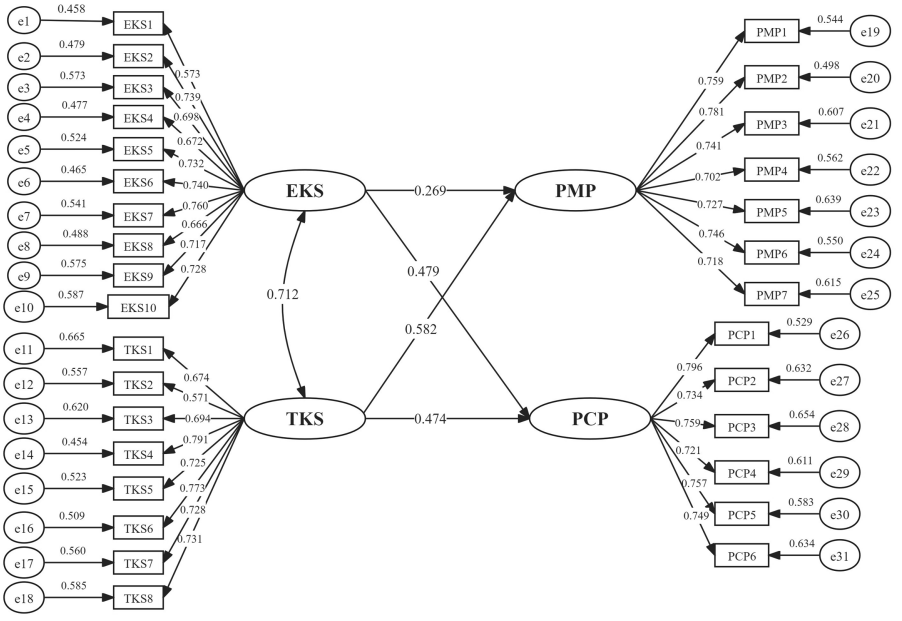

Figure 2. SEM model. Authors' own work

More specifically, their research found that tacit knowledge sharing has a stronger impact on project management performance, which is aligned with the findings of this research. On the contrary, Rudawska *et al*. (2025) indicated that while proactive knowledge-sharing helps to improve performance, reactive knowledge-sharing doesn't have performance implications for employees. Additionally, Dzenopoljac *et al*. (2023) found that explicit knowledge sharing has no significant impact on knowledge quality and only affects the exploitative extent of ambidexterity. Olan *et al*. (2022) further revealed that if knowledge sharing and artificial intelligence are not integrated, a more sustainable organizational performance cannot be achieved in a constantly changing digital society. These results highlight the complicated relationships between knowledge sharing and performance at individual and organizational levels.

4.4.1 The impact of inter-stakeholder explicit knowledge sharing on project management performance. In construction projects, explicit knowledge sharing involves the exchange of codified information among various stakeholders through contracts, planning documents and safety requirements (Alashwal *et al*., 2016). By sharing explicit knowledge, it can ensure that all stakeholders have a clear and aligned understanding of the ultimate goals and scope of the construction project. The sharing of explicit knowledge, such as progress arrangements and quality standards, helps all stakeholders involved to clarify their responsibilities and communicate their respective expectations, reducing project potential delays caused by information asymmetry or misunderstandings. Zhu *et al*. (2016) revealed that construction project organizations are typical temporary organizations that involve many interest-conflicted stakeholders. Promoting inter-stakeholder explicit knowledge sharing can further expand the project knowledge base, ensure smooth implementation of projects, and, in turn, improve project management performance. Jia *et al*. (2021) also noted that given that stakeholders have diverse interests, the efficient sharing of explicit knowledge facilitates clear communication and reduces the likelihood of conflicts or misinterpretations, which also enhances project management performance.

4.4.2 The impact of inter-stakeholder tacit knowledge sharing on project management performance. In construction projects, tacit knowledge primarily encompasses personal experiences, skills and practical know-how that cannot be explicitly described, providing more practical insights for enhancing project management performance (Li *et al*., 2024). Tacit knowledge sharing among different stakeholders can help them to socialize abstract knowledge into their personal knowledge base (Nonaka and Takeuchi, 1995). Project team members can directly access relevant experiences and know-how from their personal knowledge base when dealing with specific situations and complex problems in construction projects, which can help them to improve work efficiency and promote the successful implementation of construction projects.

In terms of HSE performance of construction projects, the sharing of tacit knowledge among different stakeholders can transmit safety management best practices, emergency response experience and health protection measures, which are not easily documented in writing. The sharing of these experiences is extremely important for preventing accidents and improving the overall HSE performance of construction projects. Ni *et al*. (2020) also found that tacit safety knowledge sharing has a significant impact on safety compliance behavior and safety participation behavior in construction projects.

Tacit knowledge sharing helps to enhance collaboration and communication efficiency among team members. Through face-to-face communication, discussion and interaction, team members from different stakeholders can better understand each other's working methods, experiences, and intuition, which is effective in forming a tacit common understanding in project implementation. For instance, in complex construction scenarios, experienced project managers can quickly impart some intuitive implementation skills and coping strategies to colleagues through informal sharing, which can greatly improve the overall work efficiency and collaboration of the entire project team, and in turn enhance project management performance.

4.4.3 The impact of inter-stakeholder explicit knowledge sharing on project cooperation performance. Explicit knowledge sharing promotes communication and understanding among stakeholders through clear documentation and standardized processes, which is helpful to reduce misunderstandings and conflicts (Wang *et al*., 2014). When different stakeholders can access and understand the same project information, the level of trust between them will be improved, which can effectively promote mutual understanding and enhance cooperation satisfaction (Han and Hovav, 2013). In addition, explicit knowledge is easy to disseminate and share (Willem and Buelens, 2007), which can provide rich information resources for different teams in construction projects. This facilitates the improvement of the technical competence and problem-solving abilities of stakeholders. Huang *et al*. (2024) also found that team members with similar expertise are more likely to exhibit creative behavior when the team is engaged in higher levels of explicit knowledge sharing, which in turn fosters team innovation and competitiveness, leading to enhanced project cooperation performance. In contrast, Qiao *et al*. (2021) and Shi *et al*. (2022) found that explicit knowledge sharing doesn't have positive effects on innovation performance in the construction supply chain. Truong *et al*. (2023) also revealed that knowledge sharing has no influence on firm innovation.

4.4.4 The impact of inter-stakeholder tacit knowledge sharing on project cooperation performance. Tacit knowledge sharing deepens trust and understanding among stakeholders through informal communication and collaboration, which can improve team cooperation satisfaction (Ding *et al*., 2014). Tacit knowledge is usually transmitted through face-to-face communication, shared work practices, and team development activities. This process not only disseminates useful knowledge but also enhances mutual understanding and trust among team members, which are critical for efficient cooperation (Qiao *et al*., 2021). Tacit knowledge, especially personal experience and intuition, is essential in addressing complex and uncertain issues in construction projects, as well as proposing innovative solutions. For instance, when unexpected problems arise in a construction project, experienced team members can quickly provide effective solutions through sharing tacit knowledge, which can reduce delays and minimize losses, as well as improve the project's adaptability and implementation efficiency (Li *et al*., 2024). As a result, tacit knowledge sharing is highly effective in facilitating project collaboration (Ishdorj *et al*., 2024).

4.4.5 The relationship between inter-stakeholder explicit and tacit knowledge sharing. According to Nonaka and Takeuchi (1995), explicit and tacit knowledge can be transformed into each other through socialization, externalization, combination and internalization processes. In fact, an increase in the sharing of one type of knowledge across stakeholders stimulates the sharing of the other. For instance, explicit knowledge sharing creates a common knowledge foundation and transparent information exchange environment for different stakeholders, which can create a favorable climate for developing trust and fostering communication for the transmission of tacit knowledge. On the other hand, the transformation of tacit knowledge into explicit knowledge can broaden the knowledge base and enhance collaboration among stakeholders in construction projects (Alashwal *et al*., 2016). Guo *et al*. (2022) analyzed correlations between unsafe behaviors and historical accident records in construction projects by investigating the transformation of tacit knowledge into explicit knowledge using data mining techniques. Their approach enhanced safety knowledge sharing and provided deeper insights into how multiple unsafe behaviors contribute to the occurrence of safety accidents. Ashraf *et al*. (2023) also revealed that externalization of tacit knowledge into explicit knowledge enables individuals to identify and address the root causes of nonconformities in safety management systems, which is critical to improve safety management outcomes. In addition, Ni *et al*. (2022) found that converting valuable tacit knowledge into explicit forms is essential for enhancing knowledge management and preventing knowledge loss, thereby improving organizational performance.

The hypothesis test results are summarized in Table 6.

Table 6. Hypothesis test results

Hypothesis	Test result	
H1a: Inter-stakeholder explicit knowledge sharing has a positive impact on project management performance in construction projects	Path coefficient = 0.269 $p < 0.001$	Accept
H1b: Inter-stakeholder tacit knowledge sharing has a positive impact on project management performance in construction projects	Path coefficient = 0.479 $p < 0.001$	Accept
H2a: Inter-stakeholder explicit knowledge sharing has a positive impact on project cooperation performance in construction projects	Path coefficient = 0.582 $p < 0.001$	Accept
H2b: Inter-stakeholder tacit knowledge sharing has a positive impact on project cooperation performance in construction projects	Path coefficient = 0.474 $p < 0.001$	Accept
H3: There is a positive correlation between inter-stakeholder explicit knowledge sharing and inter-stakeholder tacit knowledge sharing in construction projects	Path coefficient = 0.712 $p < 0.001$	Accept

Source(s): Authors' own work

4.5 Theoretical and practical implications

The research findings advance theory on knowledge sharing and project performance in the following three main aspects. First, through an extensive literature review, this paper developed a detailed set of indicators measuring the inter-stakeholder explicit and tacit knowledge sharing. The actual inter-stakeholder knowledge sharing level was also evaluated in the Chinese construction industry. In addition, using empirical analysis methods, the strong relationship between inter-stakeholder explicit and tacit knowledge sharing was quantified, which is critical for improving our understanding of the complex relationship between them. Second, a broader perspective was employed to assess the project's overall performance, including project management performance and project cooperation performance. The actual performance levels were also measured in the Chinese construction industry, which provides a reference point for future comparative studies. Third, the impact of both inter-stakeholder explicit and tacit knowledge sharing and the project's overall performance was determined through SEM analysis results, which offer empirical evidence of how each type contributes to project outcomes. These findings provide new insights for improving performance through more effective knowledge sharing across stakeholders in the construction industry.

Practically, the findings are valuable for project stakeholders to develop targeted measures to further improve the project's overall performance from the perspective of inter-stakeholder knowledge sharing. First, although converting explicit knowledge into tacit knowledge (and vice versa) can be challenging, project stakeholders should still take practical steps to foster this process, as one type of inter-stakeholder knowledge sharing can strongly facilitate the other type of knowledge sharing. In practice, it is advocated that stakeholders can promote the easier implementation of inter-stakeholder explicit knowledge sharing in construction projects, such as sharing project management reports or construction methods. This can effectively help to create the conditions for more informal exchanges of experience and judgement, which is also conducive to building a stronger understanding and cooperation across different stakeholders. Second, stakeholders may use different types of knowledge sharing depending on the performance outcome they aim to improve. For instance, clients who want to strengthen cooperation with other stakeholders might focus on encouraging open sharing of formal documents and information. On the other hand, contractors aiming to improve project management performance might invest more effort in improving tacit knowledge sharing through direct communication and informal coordination with other stakeholders. Third, existing research has demonstrated that design outcomes have significant influences on project management performance, including quality, time, cost and safety. However, this research found that design companies have the lowest level of willingness to share their knowledge with other stakeholders. This situation might be due to the popular utilization of the traditional fragmented project delivery method in China, where design and

construction are undertaken by design companies and contractors through independent contracts with the clients, respectively. Therefore, the design-build general contracting model, where design and construction are undertaken by a design-builder with a single-point responsibility to the client, is highly advocated to be used in the Chinese construction industry. This can more effectively facilitate the active tacit and explicit knowledge sharing between designers and construction professionals, which is a pragmatic way to improve both the project management performance and project cooperation performance.

5. Conclusion

Inter-stakeholder knowledge sharing has become increasingly critical for enhancing the performance of modern construction projects. However, limited research has examined the impact of knowledge sharing among various stakeholders on project performance in the construction industry. This research, therefore, was conducted to evaluate the status of inter-stakeholder knowledge sharing and project overall performance in the construction industry, and explore the impact of inter-stakeholder explicit and tacit knowledge sharing on both project management performance and project cooperation performance.

The results indicate that a relatively high level of knowledge sharing exists among various stakeholders in Chinese construction projects. Notably, stakeholders are more willing to share tacit knowledge than explicit knowledge. Within explicit knowledge, the stakeholders are more likely to share safety-related documents, while they are less likely to share cost-related documents. For tacit knowledge, the stakeholders are more willing to share safety management-related experience and understanding, but they are less willing to share previous project experience and lessons. The project's overall performance is also perceived at a relatively high level in Chinese construction projects, and the project management performance is slightly outperforming the project cooperation performance. Generally, the respondents from different stakeholders share a common understanding of the levels of inter-stakeholder knowledge sharing and the project's overall performance. However, general contractors exhibit the highest level of willingness to share their knowledge with other stakeholders, while geological survey/design companies are at the lowest level. Furthermore, a strong relationship exists between inter-stakeholder explicit and tacit knowledge sharing in construction projects. The two types of knowledge sharing also have strong and positive impacts on both project management performance and project cooperation performance. Specifically, inter-stakeholder tacit knowledge sharing exerts a stronger influence on project management performance, while explicit knowledge sharing has a greater impact on project cooperation performance.

6. Limitations and future research directions

There are four main limitations in this research. Firstly, knowledge was categorized as explicit and tacit types, without considering the knowledge in different stages in the overall lifecycle of construction projects. Future studies could analyze knowledge sharing across these stages to identify which types are more frequently shared among various stakeholders and which one has the most significant impact on the project's overall performance. Secondly, inter-stakeholder knowledge sharing can be examined at the individual, team and organizational levels. The results can also reveal the knowledge sharing status at the different levels of organizations in construction projects, and determine which types of knowledge sharing are more effective to improve the project's overall performance. Thirdly, although previous research indicated that knowledge sharing has direct impacts on project performance, it is also important to explore their relationship with the effects of other potential mediating factors, which could further deepen our understanding of the complicated relationship between them. Fourthly, questionnaire survey was the primary data collection method in this study. Other data collection methods, such as interviews and

case studies, can be employed to further complement the quantitative results and obtain in-vdepth insights of the impact of inter-stakeholder knowledge sharing on project overall performance.

Supplementary material

The supplementary material for this article can be found online.

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