

Exploring the relationship between social capital, knowledge management and lean construction ambidexterity in inter-organizational project networks

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Abstract

Purpose – The temporary nature and fragmented structure of inter-organizational project networks in construction foster inherent governance challenges, which lead to prevalent knowledge and experience loss, thereby undermining the development of essential organizational capabilities. To address these challenges, this study posits that informal governance mechanisms, specifically social capital, are critical for enabling effective knowledge management and fostering lean construction ambidextrous capabilities. This study thus investigates how social capital, through knowledge management practices, enables lean construction ambidexterity within project networks.

Design/methodology/approach – The survey questionnaire was distributed to construction project management personnel in China. The respondents, who were from inter-organizational networks and involved in implementing lean construction techniques, yielded 255 valid questionnaires. Partial least squares structural equation modeling was used for data analysis.

Findings – The findings indicate that both the relational and cognitive dimensions of internal and external social capital positively promote the exploitation dimension of lean construction capability. Moreover, the structural and relational dimensions of external social capital play a particularly significant role in promoting exploration. A noteworthy finding is that the cognitive dimension of social capital does not significantly affect exploration capabilities. Additionally, knowledge management is confirmed as an important mediator between social capital and lean construction ambidextrous capabilities.

Originality/value – This study provides a novel theoretical framework that advances the governance of inter-organizational project networks by explicating how social capital, through knowledge management, builds lean construction ambidexterity. The framework offers both a new theoretical lens for understanding capability building and a robust basis for improving project network governance while also serving as a strategic guide for practitioners.

Keywords Social capital, Knowledge management, Lean construction, Ambidexterity capabilities, Inter-organizational project networks, Governance

Paper type Research article

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Introduction

The governance of inter-organizational project networks in construction, often due to their temporary and dynamic nature, faces a fundamental governance dilemma: how to ensure the operational efficiency of current projects (*exploitation*) while simultaneously accumulating capabilities for future development and innovation (*exploration*)? This ambidextrous challenge can result in practical inefficiencies, loss of value and knowledge, and impediments to innovation (Formoso *et al.*, 2015; Ren *et al.*, 2018). For construction organizations that rely on temporary network collaboration, resolving this dilemma is key to achieving sustainable competitive advantage. The concept of Lean construction ambidexterity offers a useful framework for understanding and addressing this challenge.

Originating from production management, Lean Construction (LC) was introduced to the construction industry as a means to minimize waste and improve efficiency (Salem *et al.*, 2006). LC ambidexterity is a pair of contradictory yet interdependent capabilities, which focus on exploitation and exploration (Fang *et al.*, 2021). Organizations with ambidextrous capabilities are more likely to achieve short-term sustainable performance through exploitation and to improve long-term sustainable performance through exploration (Fang *et al.*, 2025). Nevertheless, a key question remains insufficiently addressed in the literature: how do organizations cultivate such seemingly contradictory LC ambidextrous capabilities within temporary project networks? In other words, the antecedents and formative pathways of LC ambidexterity, particularly within the unique context of the construction industry, remain unclear. As the governance networks among multiple organizations in construction projects grow increasingly complex, human factors, particularly social relationship attributes, play an increasingly important role in the success of construction projects (Daboun *et al.*, 2023). Existing research indicates that social capital, as a relational resource grounded in trust, norms, and networks, serves as a core mechanism for governing temporary networks and facilitating resource exchange (Di Vincenzo and Mascia, 2012). The accumulation of social capital through stable working relationships enhances network performance (Fonti and Maoret, 2016), with social relationships in the network ensuring sustained resource flows and increased partner interaction (af Hällström *et al.*, 2021). Social capital benefits project-based organizations while serving as a fundamental source of value creation within inter-organizational networks (Bresnen *et al.*, 2004). Exchange theory explains these governance benefits by recognizing social relationships that enable the exchange of vital information and resources as foundational elements of network structure (Wu and Lee, 2017). Social capital improves project delivery by enhancing collaboration and provides a crucial foundation for knowledge management (Radaelli *et al.*, 2024; Pinheiro *et al.*, 2016). This is particularly relevant in construction, where knowledge transfer often occurs informally through interpersonal relationships (Liu *et al.*, 2023). Social capital thus sustains industry know-how, with strengthened social ties improving knowledge management efficiency and mitigating knowledge loss in temporary projects environments (Bartsch *et al.*, 2013). However, existing research predominantly focuses on demonstrating the direct effects of social capital on performance or knowledge sharing. A deeper, yet often overlooked, question is: how does social capital, which acts as a “glue” (Turner *et al.*, 2015), specifically transform into and enhance an organization’s “ambidextrous” high-order dynamic capabilities? The mechanism underlying this transformation urgently requires exploration.

To address this gap, this study investigates the relationship and mechanism of action between social capital within and between construction project organizations and LC ambidexterity from the perspective of knowledge management of project organizations. Exploring social capital through its impact on LC ambidexterity capabilities is crucial as it provides a comprehensive understanding of how relational resources can enhance organizational capabilities for construction firms. Knowledge management is chosen as the mediating variable because it is a key process that enables the effective utilization of social capital in the construction industry (Peng, 2024). This study is expected to make three key contributions to project network governance: (1) propose an integrated theoretical framework

that integrates social capital, knowledge management, and LC ambidexterity capabilities; (2) deepens our understanding of how social capital strengthens organizational capabilities within inter-organizational project networks; and (3) highlight knowledge management as a mediating factor between social capital and LC ambidexterity capabilities, offering practical insights for enhancing project organizational capabilities.

Research background

Lean construction ambidexterity

In the course of lean construction implementation, various “tensions” arise, such as quality and efficiency, user requirements and cost (Fang *et al.*, 2021). To successfully manage these tensions, some form of ambidexterity is required as it allows the coexistence of seemingly inconsistent tendencies (Storey and Salaman, 2009). For instance, Just-in-Time (JIT) resolves the paradox of quality and efficiency (Storey and Salaman, 2009), and Total Quality Management (TQM) achieves customer-oriented and process-oriented demands (Koskela *et al.*, 2019). These studies have laid the foundation for the integration of LC with ambidexterity, which is a new concept that merges lean construction with ambidexterity. The new concept is based on the commonalities between LC and ambidexterity, which are grounded in paradox theory and ambidexterity theory. Paradox thinking is a “both/and” rather than an “either/or” mode of thought (Storey and Salaman, 2009). Potential tensions are the sources of paradoxes (Lewis, 2000). According to March (1991), exploration is related to experimentation and increased variability, while exploitation enhances productivity and efficiency by eliminating variability. The ambidexterity of LC in this context is a pair of contradictory yet interdependent capabilities, including LC exploitation and LC exploration (Fang *et al.*, 2021; Fang and Gao, 2024). The former capability is dedicated to eliminating all variability to achieve the ideal state of process continuity, standardization, modularization, and just-in-time inventory. Unlike tolerating variability, LC exploitation capability refers to the ability to maintain consistency and efficiency. It focuses on the effective utilization of the organization’s existing knowledge and technology. The latter, LC exploration capability, is the ability to manage variability (agility, flexibility, buffering, or resilience) to eliminate waste. This capability stems from having multi-skilled resources and providing a sufficient number of resources that can flow between different functions, absorb demand fluctuations, and ensure the continuity of system operation. Exploratory capabilities promote employee engagement, tolerance of variability, encourage trial and error by employees, and foster a culture of continuous improvement.

Social capital in construction project organization

The term “social capital” first emerged in community studies (Gibbs and Coleman, 1990). Bourdieu (1986) defines social capital as a set of actual or potential resources that arise from enduring networks of institutionalized relationships, primarily highlighting the relationships within a network of acquaintances, emphasizing its characteristic as a collective asset. Like other forms of capital, social capital is a productive long-term asset that can be invested in other resources (Gibbs and Coleman, 1990). Although social capital can be utilized and transformed, it differs from economic capital in that it has low mobility and high viscosity (Adler and Kwon, 2002). In addition, unlike physical capital, social capital increases with use rather than decreasing, and it can become depleted if not used (Putnam, 1993). Coleman (1988) believes that social capital includes not only social relations but also the norms and values associated with them, and also places more emphasis on the role of social structure. Putnam (1993) emphasizes that social capital also includes trust that can be transferred from one social environment to another.

Social capital can be classified in various ways. Nahapiet and Ghoshal (1998) proposed a widely recognized framework comprising structural, relational, and cognitive dimensions.

The structural dimension manifests as social interactions, while the relational dimension reflects mutual trust. Shared values, as a public goods characteristic, facilitate the development of the cognitive dimension, enhancing communication and benefiting the organization (Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998). Other studies distinguish between social capital: external social capital, often referred to as bridging social capital, and internal social capital, known as bonding social capital (Barroso-Castro *et al.*, 2016). The bridging perspective primarily emphasizes social capital as a resource that connects actors to others outside the organization, whereas the bonding perspective focuses on personal relationships cultivated through long-term interactions within the organization (Barroso-Castro *et al.*, 2016; Wiersema *et al.*, 2018). The distinction between internal and external social capital is relevant to construction project organizations. To effectively achieve project goals, internal social capital is crucial for improving efficiency and coordination. Meanwhile, organizational members must establish and maintain inter-organizational network relationships to access vital information resources, thereby enhancing project performance (Di Vincenzo and Mascia, 2012). Resources obtained through these networks typically include essential knowledge and information sets needed for the project. Based on this, this study divides the social capital of construction project organizations into internal and external social capital. The internal social capital of a construction project organization resides in the social network among its members. This network facilitates cooperation and collaboration through internal resource exchange, fosters trust and shared cognition, and thereby enables the reintegration, transformation, and application of internal resources. In contrast, external social capital is embedded in the network between the organization's members and its *external* stakeholders. It achieves the integration of necessary project resources across organizational boundaries through a shared language, frequent interaction, mutual trust, and active communication.

Knowledge management in construction project organization

The construction industry faces unique challenges in knowledge management due to the one-of-a-kind nature of its delivered products, the dynamic and complex environment of construction sites, making the management of knowledge particularly difficult. In today's rapidly changing and complex environment, the demand for knowledge in construction projects is increasing. The execution of knowledge documents and the sharing and transformation of experiential knowledge directly determine the speed of problem-solving in projects, as well as the quality and timely delivery of construction products, thereby affecting project success. Agbaxode *et al.* (2024), however point out that one of the constraints on the development of the construction industry is the lack of coordination and experience sharing among project participants, particularly during the design phase. This highlights the necessity of knowledge management in construction projects.

This study defines the knowledge of construction project organizations as a vast array of facts related to construction projects, collected through learning, observation, and experience, as well as the insights inferred from these facts (Fellows and Liu, 2021). *Explicit* knowledge includes documented, archived, and formalized information that can be directly learned and obtained through training and other dissemination methods. However, *tacit* knowledge may only exist in an individual's mind. Some particularly specialized experience and technical skills are considered a subset of tacit knowledge (Tahir *et al.*, 2021). The knowledge in construction project organizations includes not only explicit knowledge such as written standards, specifications, and technical documents but also a large amount of professional technical experience related to practice, which exists in the form of tacit knowledge. Knowledge management in construction project organizations is based on the project, with the hope that the results of knowledge management will be maximized in the current project to achieve project goals. This paper draws on the work of Reich *et al.* (2014) and Sung and Choi (2012) to define knowledge management in construction project organizations as the state of knowledge reserves within construction organizations during the project; the sharing of

knowledge, experience, and information; and the full and effective utilization of knowledge and related skills in the project. Specifically, knowledge management in construction project organizations includes three aspects: knowledge reserves, knowledge sharing, and knowledge utilization.

Research gaps and originality

The present research mainly addresses four gaps in the existing literature on inter-organizational construction project networks. *Firstly*, while some studies have examined the impact of social capital on organizational ambidexterity in construction firms (Duodu *et al.*, 2024; Duodu and Rowlinson, 2019), the relationship remains underexplored. Existing research exhibits noticeable limitations, as it often examines the overall association in isolation (Lee *et al.*, 2021) or focuses on a single dimension of social capital, such as relational (Benzidia *et al.*, 2021) or regional social capital (Kraus *et al.*, 2022), without systematically analyzing the differential impacts and synergistic effects of its structural, relational, and cognitive dimensions. Concurrently, research on the relationship between LC and social capital is still in its infancy. Although studies suggest that the trust dimension of social capital can promote knowledge sharing and the safe, collaborative environment that LC requires (Demirkesen *et al.*, 2021), challenges in understanding this implementation persist, and few studies have connected trust and information flow to project outcomes (Uusitalo *et al.*, 2021). Consequently, a significant gap exists in systematically revealing how the various dimensions of social capital influence LC ambidextrous capabilities through specific pathways.

Secondly, a research gap exists in understanding the comprehensive impact of knowledge management on LC ambidexterity. Although knowledge management is seen as a key factor for improving organizational ambidexterity (Rialti *et al.*, 2020; Restuputri *et al.*, 2024), its role in helping construction project organizations balance exploration and exploitation through knowledge sharing and application has not been deeply explored. The mechanism of how knowledge management respectively promotes the “exploitation” and “exploration” dimensions of LC ambidexterity remains insufficiently studied, despite its significance for project performance.

Thirdly, there is insufficient research on the integration of social capital and knowledge management in the context of construction project organizations. While studies in other contexts confirm their interdependence (Ozman and Parker, 2023; Peng, 2024; Nyame *et al.*, 2022), few have empirically examined how the structural, relational, and cognitive dimensions of social capital interact to shape knowledge management processes within the dynamic, temporary collaborative networks that characterize construction projects.

Finally, the existing literature has overlooked the mediating role of knowledge management. Most studies focus on the linear relationship between social capital and ambidextrous outcomes (e.g. Duodu and Rowlinson, 2019; Aslam *et al.*, 2024), without exploring whether and how the different dimensions of social capital affect organizational ambidexterity through the mediating channel of knowledge management practices. Understanding how knowledge storage, sharing, and utilization govern the social capital-ambidexterity relationship has profound implications for inter-organizational project networks and contributes to a more comprehensive model of innovation in construction.

To address these gaps, this study builds a comprehensive model that integrates social capital, knowledge management, and LC ambidexterity. It will provide empirical evidence on how these variables interact, explore how LC practices balance “exploration” and “exploitation,” and offer theoretical and practical insights for developing more effective innovation strategies in the construction industry.

Model development and hypotheses

Underpinning theories

This section integrates the Resource-Based View, the Knowledge-Based View, and Social Exchange Theory to clarify the theoretical logic of how social capital, by facilitating the

acquisition and sharing of knowledge resources, ultimately drives project organizations to enhance both exploration and exploitation capabilities.

The *Resource-Based View (RBV)* posits that resources, including both tangible and intangible assets, are the sources of an organization's competitive advantage (Madhani, 2010; Kamasak, 2017). Social capital is a quintessential example of an intangible asset. Furthermore, LC ambidexterity, which refers to the ability to balance exploration and exploitation in a learning context, represents a dynamic capability and serves as a core competence. This balance requires not only exploration of new possibilities but also the effective exploitation of existing knowledge, with the latter being crucial for refining operations and ensuring short-term efficiency. Such ambidexterity emphasizes the importance of responding to changes in the external environment through effective resource allocation and adjustment. Therefore, considering social capital as an intangible asset is a prerequisite for achieving LC ambidexterity.

Additionally, the *Knowledge-Based View* is an extension of the RBV (Kaur, 2022). The acquisition and sharing of knowledge resources is closely linked to the resources and support derived from social capital, including trust, reciprocal relationships, and cooperative networks. The fundamental principle of the Knowledge-Based View is that organizational capabilities develop through knowledge processes (Garcia-Perez et al., 2020); thus, effective knowledge management also fosters LC ambidexterity. Crucially, this involves not only exploratory innovation but also exploitation, as knowledge management enables the efficient application and refinement of existing knowledge to enhance process efficiency and reduce waste, which are the core goals of LC.

Building on this theoretical foundation, the present study proposes key hypotheses concerning the influence of both internal and external social capital on LC ambidexterity capabilities within construction project organizations. Additionally, it examines the role of knowledge management as a mediating factor. As Peng (2024) stated, social capital fosters an environment of trust and reciprocity, grounded in *Social Exchange Theory*. This environment facilitates effective knowledge sharing and transfer, which serves as a key mechanism through which organizations achieve ambidexterity (Mei et al., 2023; Peng, 2024) (see Figure 1).

Organizational social capital and knowledge management

Social capital acts as a precursor to organizational learning by facilitating knowledge exchange through its multidimensional nature (Bartsch et al., 2013; Thomson et al., 2017). Specifically, in its *structural* dimension, social capital provides channels for knowledge sharing (Ahuja, 2000; Wang et al., 2021), while in its *relational* and *cognitive* dimensions, particularly through trust, it shapes the effectiveness of knowledge management practices and the quality of information flow (Monavvarian et al., 2013; Phelps, 2012). Extensive research confirms that the accumulation of organizational social capital generally exerts a positive influence on knowledge management (Bharati et al., 2015; Wu et al., 2009).

To further clarify its mechanisms, scholars often analyze social capital by distinguishing between *internal* and *external* levels. *Internal* social capital focuses on trust, commitment, and shared understanding within an organization or team, serving as a key driver for internal knowledge integration and learning (Suseno and Ratten, 2007; Jiménez-Jiménez et al., 2014). *External* social capital, in contrast, involves linkages with external entities, providing essential network resources for acquiring and absorbing new knowledge and fostering innovation (Jiménez-Jiménez et al., 2014; Kokkaew et al., 2022). Together, they constitute core drivers of organizational knowledge development (Suseno and Ratten, 2007). Based on the conclusions of existing research, the following hypotheses are proposed for this paper:

- H1. The three dimensions (structure, relation, cognitive) of *external* social capital in construction project organizations (H1a, H1b, H1c) positively influence knowledge management.

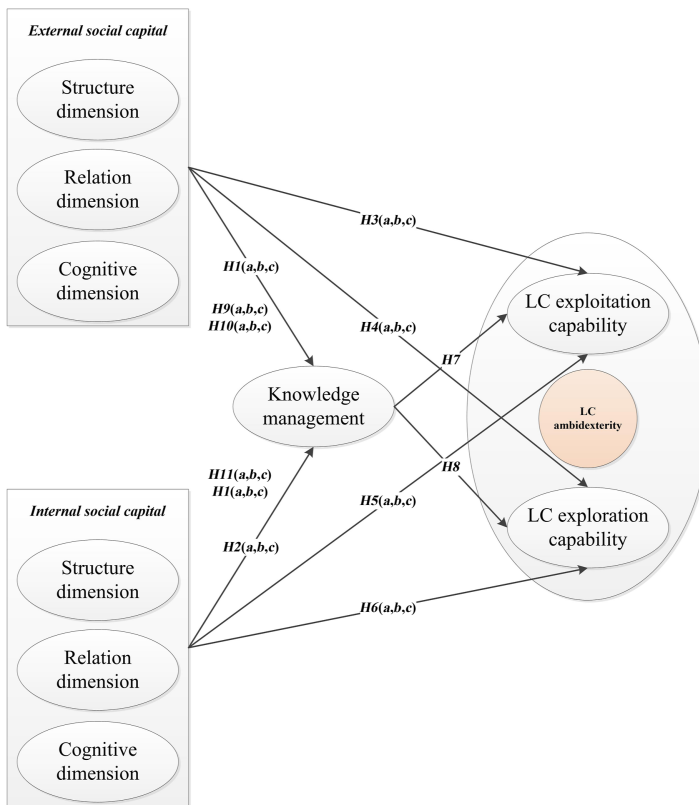


Figure 1. Conceptual model. Source: Authors' own work

- H2.** The three dimensions (structure, relation, cognitive) of *internal* social capital in construction project organizations (H2a, H2b, H2c) positively influence knowledge management.

External social capital and LC ambidextrous capabilities

Trust between organizations is considered the most critical success factor (Bhatti et al., 2021). Highly cohesive networks can foster trust and effective coordination among network members. Burt (1992) found that, all else being equal, a firm's ability to acquire information is directly proportional to the number of its connections. Therefore, actively managing relationships with external teams and members to access key information and resources becomes a core approach to enhancing efficiency (Bag et al., 2021).

Against this backdrop, the value of external social capital at both individual and organizational levels lies in its ability to simultaneously support an organization's exploitative and exploratory activities (Josserand et al., 2017). Specifically, nurturing social capital in external relationships can not only significantly improve a firm's innovation performance (i.e. *exploratory* capability) (Pansuwong et al., 2023), but also, as a form of bridging social capital, it facilitates collaboration with external entities, enabling the organization to more effectively integrate and utilize existing resources, thereby enhancing *exploitative* capability (Chen et al., 2025). This role is particularly pronounced in project contexts: the cognitive, affective, and relational dimensions of project members' social capital jointly promote knowledge integration, which in turn drives both

exploitative and exploratory learning processes (Prieto-Pastor *et al.*, 2018). In other words, social capital acts as “glue” that binds together the various temporary organizations within a project, strengthening inter-organizational relationships to facilitate project delivery and playing a key role in effective exploitation and exploration (Turner *et al.*, 2015). Based on these findings, the following hypotheses are proposed: Based on this, the following hypotheses are proposed:

- H3. The three dimensions (structure, relation, cognitive) of external social capital of construction project organizations (H3a, H3b, H3c) positively influence LC exploitation capabilities.
- H4. The three dimensions (structure, relation, cognitive) of external social capital of construction project organizations (H4a, H4b, H4c) positively influence LC exploration capabilities.

Internal social capital and LC ambidextrous capabilities

Within organizations, the internal social capital, characterized by shared norms, trust, and stable relationships (Coleman, 1988), provides a critical solution to balance exploitation and exploration in achieving LC ambidexterity. It enhances coordination and fosters identification with collective goals (Lengnick-Hall *et al.*, 2021), thereby creating a foundation for managing dualities, as evidenced by its impact on both creativity and efficiency. Specifically, Aslam *et al.* (2024) clarify the distinct mechanisms: structural and relational capital enhance efficiency and knowledge sharing to support exploitation, while in exploration, relational capital grants access to new knowledge and structural capital enables essential collaboration. This perspective is further supported empirically: internal social capital promotes both exploitative and exploratory innovation (Li *et al.*, 2014), while a higher degree of internal information sharing enhances a firm’s ability to integrate internal and external resources, thereby fostering the development of organizational ambidexterity (Mei *et al.*, 2023). Based on this, the following hypotheses are proposed:

- H5. The three dimensions (structure, relation, cognitive) of internal social capital in construction project teams (H5a, H5b, H5c) positively affect their LC exploitation capabilities.
- H6. The three dimensions (structure, relation, cognitive) of internal social capital in construction project teams (H6a, H6b, H6c) positively affect their LC exploration capabilities.

Knowledge management and LC ambidextrous capabilities in construction project organization

Research has shown a positive correlation between knowledge utilization and creativity (Sung and Choi, 2012), providing a basis for the role of knowledge management in promoting exploratory capability. In IT projects, Reich *et al.* (2014) found that team knowledge management significantly contributes to the achievement of project goals, reflecting its support for exploitative capabilities. Ahn *et al.* (2007) noted that knowledge management facilitates sharing best practices and enhances collaboration among project participants. The proposed system allows “pulling” prerequisite knowledge when participants are ready to act, thus supporting lean construction (Ahn *et al.*, 2007). Furthermore, knowledge management capabilities have been shown to positively influence ambidextrous innovation (Soto-Acosta *et al.*, 2018), while the integration of knowledge management with information and communication technologies can enhance ambidextrous alliances in multinational corporations (Bresciani *et al.*, 2018). Together, these studies reinforce the positive role of knowledge management in promoting both exploitation and exploration capabilities. Based on this, we propose the following hypotheses:

- H7. Knowledge management in construction project organization positively affects their LC exploitation capabilities.
- H8. Knowledge management in construction project organization positively affects their LC exploration capabilities.

The mediating role of knowledge management

Internal social capital, built among organizational members, facilitates the internal flow and integration of knowledge (Dahiyat *et al.*, 2023). It enhances the sharing of tacit and explicit knowledge (Gubbins and Dooley, 2021), thereby broadening the organization's knowledge base and improving ambidextrous capabilities. This process not only supports efficient improvements but also fosters the exploration of new solutions. Empirically, Cabeza-Pullés *et al.* (2020) demonstrated that knowledge absorption mediates the link between internal relational networks and innovative ambidexterity. Correspondingly, Berraies *et al.* (2024) proposed a model that clarifies a key internal mechanism: internal social capital, cultivated through empowerment and trust, enhances an organization's capability for both exploration and exploitation through the mediating mechanism of knowledge sharing. Further reinforcing this, Peng (2024) revealed that the structural and relational dimensions of internal social capital enhance the knowledge management process, which in turn promotes knowledge sharing and transfer.

External social capital, derived from relationships with external stakeholders, provides access to novel information and diverse perspectives. This influx of external knowledge is crucial for challenging internal assumptions and sparking innovation (David *et al.*, 2023; Zhang *et al.*, 2025). Parra-Requena *et al.* (2015) confirmed the mediating role of knowledge acquisition between external social capital and innovation. Likewise, Xie *et al.* (2021) verified that knowledge acquisition mediates the relationship between enterprise cooperation and dual innovation. However, merely acquiring external knowledge is insufficient. Dezi *et al.* (2019) empirically confirmed that knowledge management plays a vital mediating role between external relational ties and organizational ambidexterity, emphasizing that acquired knowledge must be effectively managed to be leveraged for performance. Therefore, we propose the following hypotheses:

- H9. Knowledge management mediates the relationship between the three dimensions (structure, relation, cognitive) of external social capital (H9a, H9b, H9c) and LC exploitation capabilities.
- H10. Knowledge management mediates the relationship between the three dimensions (structure, relation, cognitive) of external social capital (H10a, H10b, H10c) and LC exploration capabilities.
- H11. Knowledge management mediates the relationship between the three dimensions (structure, relation, cognitive) of internal social capital (H11a, H11b, H11c) and LC exploitation capabilities.
- H12. Knowledge management mediates the relationship between the three dimensions (structure, relation, cognitive) of internal social capital (H12a, H12b, H12c) and LC exploration capabilities.

Methodology

Sample and data collection

This study initially conducted a small-scale pilot test. The pilot surveys and interviews were conducted to refine the questionnaire and ensure that the language is easy to understand. Confidentiality policies were explained by designated personnel to ensure data security and improve the effectiveness of the questionnaire. The questionnaires collected in this study were

distributed through the following two main channels: First, with the help of construction project management personnel who have been cooperating with the first author for a long time, the questionnaires were distributed and completed (60 copies). Second, the questionnaire collection was carried out with the assistance of the professional research company (250 copies). By understanding the implementation of LC practices in the projects, this study selected team managers or workers of projects that have implemented LC practices to participate in the questionnaire survey. A total of 310 questionnaires were collected, of which 255 were valid, with an effective recovery rate of 82.3%. In this study, invalid questionnaires are defined as those with unanswered required options, or with identical or regular answers. Because a designated person checked the quality of the respondents' questionnaires during the answering process and tracked their completion, the effective recovery rate was relatively high.

Measures

The questionnaire consists of two parts: First, it includes project information and basic personal information. Second, it includes the main content of the questionnaire survey, including the measurement of the LC ambidexterity capabilities, divided into LC exploitation (6 items) and LC exploration (6 items); the three dimensions of the external social capital (9 items); the three dimensions of the internal social capital (9 items); and knowledge management (8 items). In total, there are 38 items. All variables are measured using a five-point Likert scale.

This paper adopts Nahapiet and Ghoshal's (1998) interpretation of social capital. The internal social capital of the construction project organization is divided into three dimensions: structural, relational, and cognitive. The structural dimension refers to the strength of connections and interactions among members within the construction project organization; the relational dimension refers to the trust, commitment, and mutual interest considerations among members within the organization; the cognitive dimension refers to the consistency of goals, shared values, norms, and operational processes among members within the organization. Similarly, the external social capital of the construction project organization is also divided into structural, relational, and cognitive dimensions: the structural dimension refers to the strength of connections and interactions between the construction party and external stakeholders such as the client, designer, supplier, and supervisor; the relational dimension refers to the trust, commitment, and mutual interest considerations between the construction party and project stakeholders; the cognitive dimension refers to the consistency of goals, values, common language, operational processes, and standard specifications between the construction party and project stakeholders. Although empirical research on the division of internal and external social capital is not very extensive, the method of dividing the dimensions of social capital by Nahapiet and Ghoshal (1998) has been widely adopted and recognized, which can clearly delineate the constituent elements of internal and external social capital. This paper does not divide the knowledge management of the construction project organization into dimensions, and based on existing research (Sung and Choi, 2012; Reich *et al.*, 2012, 2014), it designs the measurement items of this variable, mainly including the storage, sharing, and utilization of knowledge. The LC ambidexterity capabilities include two dimensions: exploitation capability and exploration capability. Here, LC ambidexterity capabilities are understood as a pair of contradictory and interdependent capabilities (Fang *et al.*, 2021). Based on the supportive literature on ambidexterity capability (March, 1991; Eriksson, 2013; Fang and Gao, 2024), combined with actual conditions, the LC exploitation capability (6 items, originally 7 items, Exploi_5 was excluded during the pilot survey), and LC exploration ability (6 items) scales were developed (See Table 1).

Profile of survey respondents

The project information survey in this study includes the project name, location, and type. A total of 89 construction projects were involved in this survey, with a higher concentration

in areas such as Shanghai, Beijing, Shandong, Jiangsu, Guangxi, Guangdong, and Tianjin. This distribution aligns with the social network characteristics of the survey personnel. Among the surveyed project types, civil engineering projects account for 50%, municipal and industrial construction projects account for 25%, and industrial construction engineering accounts for 19%, which generally conforms to the project characteristics of the research subjects in this study. Among the 255 surveyed individuals, 69% are male, which is consistent with the gender ratio characteristics of engineering projects in China. The age distribution of the surveyed individuals shows that 83% are between 18 and 40 years old, and 99% are under 50 years old. In terms of educational background, 95% of the surveyed individuals have a diploma or above, and the project management personnel in this study account for a larger proportion of the survey, which meets the research requirements. The distribution of the surveyed individuals' years of work experience shows that those with 6–10 years of experience account for the most, at 38%, followed by those with less than 5 years of experience, at 25%. The proportion of surveyors with 11–15 years of experience is 22%, indicating a relatively balanced distribution. This may be due to the temporary nature of the projects themselves and the high mobility of project-related personnel. The statistical description of the surveyed individuals covers two groups: construction project management personnel (86%) and construction workers (14%), which is in line with the research objectives of this study.

Data analysis method

Structural Equation Modeling (SEM) is a key statistical method in social science for quantitative research, which is typically divided into two main techniques: Covariance-based SEM (CB-SEM) and Variance-based SEM (PLS-SEM). CB-SEM relies on maximum likelihood estimation and requires normally distributed sample data, while PLS-SEM uses the Partial Least Squares method and does not impose strict normality requirements. This paper employs PLS-SEM for hypothesis testing for two main reasons: First, the study aims to analyze the relationships among social capital, knowledge management, and LC capabilities, focusing on causal relationships, which makes it suitable for exploratory model construction. Second, PLS-SEM aligns with the data distribution characteristics of the research sample, which do not adhere to strict normality. Thus, PLS-SEM is selected for hypothesis testing in this study.

Results

The analysis of results is presented in a structured manner. It begins with the validation of the *measurement model*, assessing the reliability and validity of the constructs. Subsequently, a comprehensive evaluation of the *structural model* is conducted, specifically encompassing assessments of overall model fit, explanatory power analysis, and robustness testing. Building on this foundation, *hypothesis testing* for the path coefficients is carried out. To ensure the reliability of the findings, *endogeneity issues* are further examined and the *mediating mechanisms* proposed in the theoretical framework are tested.

Measurement model assessment

(1) Reliability Test

Firstly, the reliability of the scale is examined. Reliability is an indicator that assesses the stability of measurement. Factor loadings of several items (e.g. Explor_1 = 0.719, Km_5 = 0.701, Km_6 = 0.703) were close to the recommended threshold of 0.7, yet all exceeded the minimum acceptable level of 0.7 (Hair *et al.*, 2019). These items were retained because removing them would compromise the construct validity, as they are theoretically essential for fully capturing the dimensions being measured. According to Table 2, the

Table 1. The measurable items of constructs

Construct/Dimension	Measurable items
<i>Internal social capital</i>	
Structure dimension	IsCs_1: Members within the construction project organization frequently maintain contact and communication outside of work IsCs_2: When facing work difficulties, members within the construction project organization support and help each other IsCs_3: Members within the construction project organization can often access the information needed for their work
Relation dimension	Iscr_1: Members within the construction project organization do not engage in actions that are detrimental to the interests of their colleagues Iscr_2: Members within the construction project organization do not take advantage of opportunities to deceive or exploit their colleagues Iscr_3: Members within the construction project organization keep commitments to one another
Cognitive dimension	Iscc_1: Members of the construction project organization share and accept team goals that are based on the project Iscc_2: The construction project organization has work processes and standard norms that are collectively accepted by its members Iscc_3: Members of the construction project organization share common values and team philosophies
<i>External social capital</i>	
Structure dimension	EsCs_1: Project stakeholders, such as suppliers, developers, designers, and supervisors, are frequently invited to participate in formal project exchange activities (e.g. new product demonstrations, seminars, training sessions, etc.) EsCs_2: Valuing and actively investing in the relationship building with stakeholders is considered very important EsCs_3: Stakeholders are regarded as important “members” of the project
Relation dimension	Escr_1: There is mutual trust between the construction project organization and stakeholders Escr_2: Stakeholders take the interests of the construction party into account when making significant decisions Escr_3: Stakeholders have made sacrifices or concessions for us in the past
Cognitive dimension	Escc_1: The goals of the construction project organization are aligned with the goals of the project stakeholders Escc_2: The construction project organization shares common values and culture with project stakeholders Escc_3: Communication between the construction project organization and project stakeholders is smooth, and mutual jargon is understood
<i>LC ambidexterity</i>	
LC exploitation capability	Exploi_1: The capability to ensure that actual construction progress aligns with the planned schedule Exploi_2: The capability to deliver construction materials in a timely and accurate manner Exploi_3: The capability to implement modular construction effectively Exploi_4: The capability to maintain a continuous workflow with minimal interruptions from changes Exploi_6: The capability to use standardization to eliminate variation Exploi_7: The capability to leverage mature knowledge and technology to achieve current benefits

(continued)

Table 1. Continued

Construct/Dimension	Measurable items
LC exploration capability	Explor_1: The capability to implement a contingency plan for unexpected situations, allowing for a quick resumption of construction Explor_2: The capability to ensure sufficient resources are available to address unforeseen circumstances Explor_3: The capability to pursue product diversity while attending to personalized product needs Explor_4: The capability to empower employees to view mistakes as learning opportunities, fostering a culture of improvement from variation Explor_5: The capability engages all members of the organization in continuous improvement efforts Explor_6: The capability to emphasize the establishment of long-term cooperative relationships that yield sustained benefits
Knowledge management	Km_1: Members of the construction project organization possess relevant knowledge in construction professionalism and project management Km_2: Communication and negotiation skills Km_3: Familiarity with and use of project management-related software (e.g. BIM) Km_4: Members of the construction project organization are aware of which team members have the knowledge and expertise related to specific tasks Km_5: Members of the construction project organization share knowledge, experience, and information with each other Km_6: The professional knowledge and skills of members within the construction project organization are often fully utilized in their work Km_7: The various knowledge and skills of the members of the construction project organization promote organizational learning Km_8: The knowledge and skills of the members of the construction project organization are effectively applied to solve practical problems encountered in work

Source(s): Authors' own work

Cronbach's α values for all dimensions of the variables are greater than 0.7, indicating good internal consistency. Composite reliability (CR) and average variance extracted (AVE) are two common indicators in reliability tests. According to [Bagozzi and Yi \(1988\)](#), the CR should be greater than or equal to 0.60, and the AVE should be greater than 0.50. This study meets all relevant indicators, indicating sample data has good reliability (see [Table 2](#)).

(2) Validity test

The validity test in this study includes content validity, structural validity, convergent validity, and discriminant validity.

Content validity – the scale of this study has been reviewed and revised by experts in the relevant research field and experienced project managers, which can be considered to have good content validity.

Structural validity – confirmatory factor analysis (CFA) is used to test the structural validity of the data, which is explained during the structural equation model test.

Convergent validity – this study uses the AVE and standardized factor loadings for the convergent validity test. The structural equation model stipulates that AVE should be greater than 0.5, and the standardized factor loadings should be greater than 0.4, indicating good convergent validity. The results showed that the standardized factor loadings of each question item were all greater than 0.7, and the AVE of each dimension was greater than 0.5, indicating that the convergent validity of each construct is good.

Common method bias test – this study uses the Harman's single-factor test to diagnose common method bias (CMB), as the data were collected through the same questionnaire and

Table 2. Reliability test

Construct dimension	Measures	Factor loadings	Cronbach's α	AVE	CR
External social capital cognitive dimension	Escc_1	0.872	0.780	0.694	0.872
	Escc_2	0.812			
	Escc_3	0.814			
External social capital relation dimension	Escr_1	0.863	0.814	0.728	0.889
	Escr_2	0.832			
	Escr_3	0.864			
External social capital structure dimension	Escs_1	0.820	0.721	0.642	0.843
	Escs_2	0.792			
	Escs_3	0.792			
Internal social capital cognitive dimension	Iscs_1	0.782	0.711	0.634	0.838
	Iscs_2	0.795			
	Iscs_3	0.810			
Internal social capital relation dimension	Iscr_1	0.867	0.748	0.673	0.860
	Iscr_2	0.818			
	Iscr_3	0.774			
Internal social capital structure dimension	Iscs_1	0.841	0.733	0.652	0.849
	Iscs_2	0.777			
	Iscs_3	0.803			
LC exploitation capabilities	Exploi_1	0.804	0.852	0.523	0.865
	Exploi_2	0.715			
	Exploi_3	0.805			
	Exploi_4	0.728			
	Exploi_6	0.756			
LC exploration capabilities	Exploi_7	0.742	0.840	0.546	0.878
	Explor_1	0.719			
	Explor_2	0.789			
	Explor_3	0.735			
	Explor_4	0.717			
	Explor_5	0.735			
Knowledge management	Explor_6	0.778	0.872	0.525	0.898
	Km_1	0.705			
	Km_2	0.707			
	Km_3	0.764			
	Km_4	0.753			
	Km_5	0.701			
	Km_6	0.703			
	Km_7	0.768			
	Km_8	0.709			

Source(s): Authors' own work

thus CMB could be a potential concern. The results of an unrotated exploratory factor analysis including all measurement items showed that the first factor accounted for 35.846% of the total variance, which is below the critical threshold of 50% (Podsakoff *et al.*, 2003). This indicates that CMB is not a serious problem in this study.

Discriminant validity – this study uses the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio to assess discriminant validity. The initial assessment using the Fornell-Larcker criterion showed that the square root of the AVE for each construct was greater than its correlations with all other constructs (see Table 3), indicating good discriminant validity. This finding was further validated by the HTMT ratio, as all HTMT values were below the conservative threshold of 0.85 (Henseler *et al.*, 2015), providing strong evidence for the excellent discriminant validity of the measurement model (see Table 4).

Table 3. Fornell-Larcker criterion method for discriminant validity test

	Escc	Escr	Escs	Exploit	Explor	Isc	Iscr	Iscs	Km
Escc	0.833								
Escr	0.649	0.853							
Escs	0.433	0.444	0.801						
Exploit	0.639	0.586	0.391	0.759					
Explor	0.571	0.636	0.605	0.541	0.746				
Isc	0.507	0.507	0.453	0.575	0.571	0.796			
Iscr	0.566	0.461	0.458	0.572	0.532	0.529	0.820		
Iscs	0.406	0.394	0.478	0.413	0.553	0.429	0.268	0.807	
Km	0.556	0.489	0.507	0.567	0.638	0.521	0.476	0.546	0.727

Source(s): Authors' own work**Table 4.** Heterotrait-monotrait ratio (HTMT) – Matrix

	Escc	Escr	Escs	Exploit	Explor	Isc	Iscr	Iscs	Km
Escc									
Escr	0.813								
Escs	0.572	0.578							
Exploit	0.777	0.703	0.495						
Explor	0.703	0.766	0.774	0.635					
Isc	0.670	0.660	0.633	0.735	0.732				
Iscr	0.736	0.583	0.617	0.723	0.687	0.751			
Iscs	0.536	0.505	0.655	0.517	0.701	0.592	0.381		
Km	0.666	0.568	0.638	0.653	0.738	0.656	0.593	0.681	

Source(s): Authors' own work

Structural model analysis

This section focuses on the assessment of the overall model and the inner model. The overall model's quality is evaluated through fit indices, which measure how well the model fits the data. The assessment of the inner model is comprehensive, encompassing explanatory power (R^2), the significance of path coefficients for hypothesis testing, effect sizes (f^2) for substantive impact, predictive relevance (q^2), and variance inflation factor (VIF) values to assess statistical robustness and check for multicollinearity concerns. The PLS-SEM results are shown in Figure 2.

(1) Assessment of Overall Model Quality

The model demonstrated a good fit to the data, as evidenced by a Standardized Root Mean Square Residual (SRMR) of 0.058, which falls below the recommended threshold of 0.08.

(2) Assessment of Structural Model Explanatory Power

The explanatory power of the structural model is assessed by R^2 , which can be used to evaluate the contribution of each latent variable and the explanatory power of the model. The research standard considers that a high level of explanatory power is indicated by an R^2 of ≥ 0.67 ; a medium level by R^2 of ≥ 0.33 ; and a low level by R^2 of ≤ 0.19 . The three dimensions of external social capital and the three dimensions of internal social capital in construction project organizations have an explanatory power of 56.4% for LC exploitation capability; 64.0% for LC exploration capability; and 49.7% for knowledge management. The results suggest explanatory power has reached a medium to high level, indicating that the model effectively explains the latent variables.

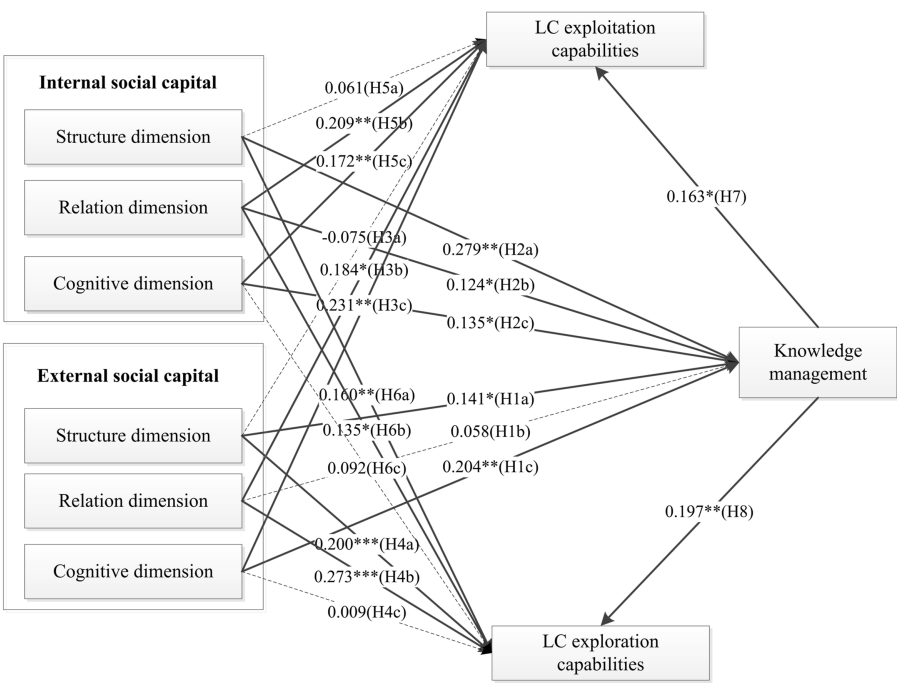


Figure 2. PLS-SEM modeling results. Notes: Dotted lines represent nonsignificant paths; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Source: Authors' own work

(3) Evaluation of the Structural Model and Robustness Tests

To evaluate the predictive power and robustness of the structural model, the following indices were calculated:

Variance Inflation Factor (VIF) – we evaluated multicollinearity in both the measurement model (outer model) and the structural model (inner model). All VIF values are well below the threshold of 5. The VIF values of all measurement indicators in the outer model range between 1.315 and 2.177. The VIF values of all constructs predicting the same endogenous variables in the inner model range between 1.463 and 2.230. This indicates that multicollinearity is not a concern in our model.

f^2 Effect size – The relative impact of the independent variables was assessed by calculating f^2 effect sizes for all structural paths. The results show that most paths exhibit small effects ($f^2 \geq 0.02$) according to Cohen (1988), which is common in models with multiple antecedents. Nevertheless, following the guidance of Hair et al. (2019) for a contextualized interpretation in social sciences, particular attention is paid to the two most influential paths: Escr $\rightarrow$ Explor ($f^2 = 0.107$) and Iscs $\rightarrow$ Km ($f^2 = 0.106$). Although conventionally classified as small effects (where $f^2 = 0.15$ indicates medium), their values are notably the highest in the model and approach this medium effect threshold. This highlights that the relational dimension of external social capital and the structural dimension of internal social capital have the strongest relative influence on exploration capability and knowledge management, respectively. All f^2 values are positive, confirming that each predictor contributes to the model, albeit to varying degrees. While the effect size of individual paths (e.g. Escr $\rightarrow$ Explor) is negligible, we have retained them in the model to maintain theoretical integrity, and their statistical significance has been verified through bootstrapping procedures (see the Hypothesis Testing section). The complete results, sorted by the magnitude of the effect, are presented in the Table 5 below.

Table 5. f^2 Effect Sizes

	<i>f</i> -square	Effect size
Escr → Explor	0.107	Small Effect (approaching medium)
Iscs → Km	0.106	Small Effect (approaching medium)
Escs → Explor	0.068	Small effect
Escs → Exploit	0.055	Small effect
Iscr → Exploit	0.055	Small effect
KM → Explor	0.054	Small effect
Iscs → Explor	0.044	Small effect
Escr → Exploit	0.04	Small effect
Escs → Km	0.039	Small effect
Iscs → Exploit	0.037	Small effect
KM → Exploit	0.031	Small effect
Iscr → Explor	0.028	Small effect
Escs → Km	0.025	Small effect
Iscs → Km	0.02	Small effect
Iscr → Km	0.017	Negligible effect
Iscs → Explor	0.013	Negligible effect
Escs → Exploit	0.008	Negligible effect
Iscs → Exploit	0.005	Negligible effect
Escr → Km	0.004	Negligible effect
Escs → Explor	0	Negligible effect

Source(s): Authors' own work

Predictive Relevance (q^2) – the PLSpredict procedure was performed to calculate the q^2 metric. The results demonstrate that the q^2 values for all endogenous variables substantially exceed the threshold of 0.35, indicating large predictive relevance (Henseler et al., 2009). Specifically, exploration capability (Explor, $q^2 = 0.588$) and exploitation capability (Exploit, $q^2 = 0.519$) exhibit strong predictive power, while knowledge management (Km, $q^2 = 0.461$) also demonstrates a large effect. This provides robust evidence for the model's substantive predictive validity.

(4) Test of Path Coefficients in Structural Equation Model

The path coefficients between each latent variable are calculated using the PLS-SEM, and the t-values of the path coefficients are calculated using the bootstrapping method. Generally, a t-value > 1.96 indicates significance at the 0.05 level, denoted by *; t-value > 2.58 indicates significance at the 0.01 level, denoted by **; and t-value > 3.29 indicates significance at the 0.001 level, denoted by ***. The path coefficients and their significance levels of the SEM are organized in Table 6 as shown below.

The results indicate that the social capital of construction project organizations has varying degrees of impact on knowledge management and LC ambidexterity across different dimensions. External social capital has a significant positive effect on knowledge management in the structural and cognitive dimensions, while the impact of the relational dimension is not significant. In terms of internal social capital, all three dimensions—structural, relational, and cognitive—have a significant positive impact on knowledge management. Furthermore, external social capital significantly enhances the LC exploitation capability in the relational and cognitive dimensions, while the impact of the structural dimension is not significant. All three dimensions of external social capital significantly improve the LC exploration capability, although the cognitive dimension's impact is numerically smaller. Internal social capital significantly enhances the LC exploitation capability in the relational and cognitive dimensions, but the impact of the structural dimension is not significant. The structural and relational dimensions of internal social capital also significantly improve the LC exploration capability, but the cognitive dimension's effect is not significant. Lastly, the knowledge

Table 6. Path coefficients results

Hypotheses	Path	Coefficient (β)	t-value	p-values (sig)	Bootstrap 95% confidence interval	Support
H1a	Escs → Km	0.141*	2.355	0.019	[0.017, 0.243]	Yes
H1b	Escr → Km	0.058	0.985	0.325	[−0.065, 0.175]	No
H1c	Escc → Km	0.204**	2.813	0.005	[0.060, 0.346]	Yes
H2a	Iscr → Km	0.124*	1.983	0.048	[−0.006, 0.241]	Yes
H2a	Iscs → Km	0.279**	4.432	0.000	[0.155, 0.399]	Yes
H2c	Iscs → Km	0.135*	2.104	0.036	[0.011, 0.268]	Yes
H3a	Escs → Exploit	−0.075	1.224	0.221	[−0.185, 0.049]	No
H3b	Escr → Exploit	0.184*	2.492	0.013	[0.032, 0.333]	Yes
H3c	Escs → Exploit	0.231**	3.129	0.002	[0.092, 0.370]	Yes
H4a	Escs → Explor	0.200***	3.466	0.001	[0.077, 0.307]	Yes
H4b	Escr → Explor	0.273***	4.229	0.000	[0.140, 0.410]	Yes
H4c	Escs → Explor	0.009	0.137	0.891	[−0.124, 0.139]	No
H5a	Iscs → Exploit	0.061	1.077	0.282	[−0.052, 0.168]	No
H5b	Iscr → Exploit	0.209**	3.285	0.001	[0.079, 0.320]	Yes
H5c	Iscs → Exploit	0.172**	2.791	0.005	[0.048, 0.284]	Yes
H6a	Iscs → Explor	0.160**	3.047	0.002	[0.051, 0.258]	Yes
H6b	Iscr → Explor	0.135*	2.019	0.044	[0.012, 0.262]	Yes
H6c	Iscs → Explor	0.092	1.441	0.150	[−0.035, 0.222]	No
H7	Km → Exploit	0.163*	2.223	0.026	[0.005, 0.296]	Yes
H8	Km → Explor	0.197**	2.985	0.003	[0.078, 0.333]	Yes

Note(s): * significant at *p*-value at the 0.05; ** significant at *p*-value at the 0.01; *** significant at *p*-value at the 0.001

Source(s): Authors' own work

management capability of construction project organizations has a significant positive impact on their LC exploitation and exploration capabilities, indicating that knowledge management is key to promoting organizational learning.

(5) Endogeneity Test

To rigorously address potential endogeneity, the Gaussian copula method was utilized. This technique tests for endogeneity by examining whether a significant correlation exists between the model's key predictors and the error term. The analysis failed to reject the null hypothesis of exogeneity for all constructs, as all Gaussian copula terms were statistically non-significant (*p* > 0.05). This provides evidence that endogeneity does not substantially bias the parameter estimates in our model.

(6) Mediation Effect Test

Lastly, the mediating role of knowledge management between social capital and LC ambidexterity was examined (see Table 7). According to the mediation effect test procedure by Zhao *et al.* (2010) and the results of the bootstrapping method, the mediating role of knowledge management is significant between the cognitive dimension of external social capital and LC exploration capability, between the structural dimension of internal social capital and both LC exploitation and exploration capabilities.

To further determine the type of mediating effect, following Zhao *et al.* (2010), in pathways where a mediating effect exists, if the direct effect is not significant, it is considered a full mediation, and in this case, the mediating variable should not be overlooked. If the direct effect is significant and the total effect is significant, it is a partial mediation. In the Escs → Km → Explor pathway, the direct effect is not significant, indicating that knowledge management plays a full mediating role between the cognitive dimension of external social capital and LC

Table 7. Direct, indirect and total effects

Hypotheses	Path	Direct effects	Indirect effects	Total effects	Support
H9a	Escs → Km → Exploit	−0.075 (1.224)	0.023 (1.558)	−0.052 (0.889)	No
H9b	Escr → Km → Exploit	0.184* (2.492)	0.010 (0.843)	0.194* (2.571)	No
H9c	Escs → Km → Exploit	0.231** (3.129)	0.033 (1.648)	0.264*** (3.739)	No
H10a	Escs → Km → Explor	0.200*** (3.466)	0.028 (1.808)	0.228*** (3.839)	No
H10b	Escr → Km → Explor	0.273*** (4.229)	0.012 (0.894)	0.285*** (4.379)	No
H10c	Escs → Km → Explor	0.009 (0.137)	0.040* (2.005)	0.049 (0.788)	Yes
H11a	Iscs → Km → Exploit	0.061 (1.077)	0.046* (2.076)	0.107* (2.111)	Yes
H11b	Iscr → Km → Exploit	0.209** (3.285)	0.020 (1.462)	0.229*** (3.661)	No
H11c	Iscs → Km → Exploit	0.172** (2.791)	0.022 (1.435)	0.194** (3.270)	No
H12a	Iscs → Km → Explor	0.160** (3.047)	0.055* (2.418)	0.215*** (4.199)	Yes
H12b	Iscr → Km → Explor	0.135* (2.019)	0.025 (1.491)	0.160* (2.287)	No
H12c	Iscs → Km → Explor	0.092 (1.441)	0.027 (1.650)	0.119 (1.858)	No

Note(s): *significant at p -value at the 0.05; **significant at p -value at the 0.01; ***significant at p -value at the 0.001

Source(s): Authors' own work

exploration capability. In the Iscs → Km → Exploit pathway, the direct effect is not significant, indicating that knowledge management fully mediates between the structural dimension of internal social capital and LC exploitation capability. In the Iscs → Km → Explor pathway, the direct effect is significant and the total effect is significant, indicating that knowledge management plays a partial mediating role between the structural dimension of internal social capital and LC exploration capability.

Discussion and conclusions

The impact of social capital on LC ambidexterity capabilities

The hypothesis test results indicate that the *relational* and *cognitive* dimensions of both internal and external social capital within construction project organizations have a positive effect on the dimension of LC *exploitation* capability. This is consistent with previous studies (Payne *et al.*, 2011; Ben-Hador and Yitshaki, 2025), where the researchers pointed out that social capital embedded in stable relationships helps enhance cohesion, increase employee identification with common goals, and improve their ability to coordinate activities, thereby improving organizational performance. However, the impact of the *structural* dimension of both internal and external social capital on exploitation capability is found insignificant in this study. This may be because excessive interaction also consumes more costs and disperses energy (Kaufmann and Kock, 2022), leading to project performance not meeting expectations.

The results of the impact of social capital in construction project organizations on LC *exploration* capability show that both the *structural* and *relational* dimensions of internal and external social capital have a promoting effect on LC exploration capability. Moreover, the impact of the structural and relational dimensions of external social capital on LC exploration ability is more significant than that of the internal dimensions. This indicates that the realization of LC exploration capability requires more interaction and trust between internal members and external stakeholders of the organization. It also confirms the view of Bhatti *et al.* (2021) that trust between project organizations is considered the most important key to success. However, the impact of the cognitive dimension of social capital on LC exploration capability is insignificant. This may be because in highly aggregated networks, information spreads rapidly, and individuals in the same network may share the same knowledge. This highly aggregated network promotes trust and effective coordination among network members to some extent. However, it also leads to a reduction in knowledge diversity, an increase in homogeneity and information redundancy, and hinders knowledge creation

(Ozkan and Parker, 2023). While social capital plays a crucial role in the governance of inter-organizational project networks, current research still falls short in integrating it with formal governance mechanisms (Wang *et al.*, 2023). To address the first gap, this study systematically reveals how the various dimensions of social capital influence LC ambidextrous capabilities—an area underexplored in the existing literature. Simultaneously, it enriches the underdeveloped body of research on social capital and LC.

The impact of knowledge management on LC ambidexterity capabilities

Knowledge management in construction project organizations has a significant positive impact on both LC exploitation and LC exploration capability. This confirms the empirical analysis conclusions of Sung and Choi (2012) and Reich *et al.* (2014) that temporary organizational knowledge management is of great significance to organizational creativity and the achievement of project goals. The test results show that the impact of knowledge management on LC exploration capability is more pronounced than on LC exploitation capability. This is because LC exploration capability comes from having multi-skilled resources and providing a sufficient number of resources to flow between different functions, absorb demand fluctuations, and ensure the continuity of system operation. The diversity, effective transformation, and application of knowledge are more important for exploration capability (Alkhubary and Gardiner, 2024). The findings of this study address the second research gap by clarifying how knowledge management respectively promotes the development of the “exploitation” and “exploration” dimensions in LC, while also extending the theoretical literature on knowledge management and organizational ambidexterity in the context of construction project networks.

The impact of social capital on knowledge management

The results show that all dimensions of *internal* social capital, as well as the structural and cognitive dimensions of *external* social capital, significantly enhance knowledge management in construction project organizations. As Bartsch *et al.* (2013) pointed out, social capital is a precursor to learning because it promotes knowledge exchange. This also confirms the conclusion of Nauman *et al.* (2024) and Wang *et al.* (2021) that the structural, cognitive, and relational dimensions of organizational social capital are inextricably linked to promoting knowledge transfer. According to Ahuja (2000), direct contact among network members makes knowledge sharing possible. However, the results indicate that the *relational* dimension of external social capital does not significantly affect knowledge management. While Ahuja (2000) suggests that all dimensions of social capital have meaningful relationships with knowledge management, with trust being the most influential factor in knowledge management practices, this may be because this paper further divides social capital into external and internal dimensions, and their impacts on knowledge management differ. Additionally, construction projects face different challenges compared to high-tech enterprises. This study effectively responds to the third research gap by systematically investigating how the three social capital dimensions shape knowledge management processes, an area that remains empirically unexplored within the complex inter-organizational project networks.

The mediating role of knowledge management

Knowledge management in construction project organizations fully mediates between the cognitive dimension of external social capital and LC exploration capability. This indicates that the common values and cognition of internal and external stakeholders of the construction project organization ought to be mediated by knowledge management to affect the LC exploration capability of the organization. This finding may be because, despite having common cognition and values, internal and external stakeholders of the construction organization cannot internalize these effectively into the resources used to solve practical

problems encountered in the project (Denicol and Davies, 2022). Therefore, it is necessary to further share, transform, create, and effectively apply the corresponding knowledge to enhance the team's exploration capability. As Wang *et al.* (2021) stated that knowledge transfer not only promotes knowledge sharing and integration within the organization, but also helps the organization combine external knowledge with its existing knowledge system, thus stimulating new innovative ideas and solutions.

Knowledge management fully mediates between the *structural* dimension of internal social capital and LC exploitation capability, indicating that member interactions and relationship maintenance should be channeled through knowledge management, which functions as a critical conduit for achieving greater efficiency in project task completion (Shahzadi *et al.*, 2021). This corroborates the perspective of Fanousse *et al.* (2021), highlighting the role of knowledge management in enabling internal collaboration to reduce project uncertainty and improve performance through the facilitation of organizational learning. The partial mediating role of knowledge between the structural dimension of internal social capital and LC exploration capability indicates that part of the interaction and relationship maintenance among members within the construction organization should be mediated by knowledge management. This mediation is necessary to enhance the organization's LC exploration capability. This is because, although these activities have obtained information resources, these resources cannot be effectively allocated for reasonable use. Therefore, knowledge transformation and creation are required to convert tacit knowledge into explicit knowledge, thereby achieving knowledge creation and enhancing the organization's continuous improvement (Ni *et al.*, 2022). This finding directly addresses the fourth research gap. It pinpoints the critical role of knowledge practices in mediating social capital and ambidexterity, ultimately enabling a more comprehensive innovation model for inter-organizational project networks.

Theoretical contribution

(1) Proposing a micro-governance framework and mechanism

This study contributes to the relevant literature by developing an integrated framework that incorporates social capital, knowledge management, and LC ambidextrous capabilities. This framework provides a new theoretical perspective for understanding how social capital shapes organizational capabilities in the construction industry, integrating social capital and knowledge management into the context of inter-organizational project networks. Unlike existing research, which primarily focuses on formal governance mechanisms such as contracts and authority, this study highlights how social capital, as a key informal governance mechanism, systematically influences organizational capability building through its different dimensions (structural, relational, cognitive) via knowledge management pathways. As corroborated by Aaltonen and Turkulainen (2022), cultivating trust and shared goals proves more consequential than merely refining contractual specifications during the industry's transition toward collaborative governance models.

(2) Distinguishing the differential mechanisms of internal and external social capital

The research highlights the importance of considering both internal and external social capital in the context of construction project organizations. We demonstrate that while both internal and external social capital positively influence LC exploitation and exploration capabilities, the specific dimensions of social capital have varying degrees of impact. This finding adds nuance to the existing literature and underscores the need for a more nuanced understanding of social capital in different organizational contexts.

(3) Revealing cross-contextual universal mechanisms

The "social capital → knowledge management → ambidexterity" mechanism proposed in this study demonstrates cross-context universality. Although empirically grounded in the

construction industry, which serves as a quintessential temporary project domain, this theoretical framework is equally applicable to dynamic project environments such as engineering, as well as non-temporary organizational settings like manufacturing. While the core driving mechanism remains consistent, the differences lie in its manifestations: temporary projects rely on rapidly established social ties and informal knowledge transfer, whereas stable organizations leverage pre-existing relational networks and formal management systems. This finding positions the framework as a versatile analytical tool applicable across diverse organizational contexts, offering a new theoretical perspective for understanding the mechanisms of dynamic capability building.

Practical implications

At the practical level, this study underscores that enhancing LC ambidextrous capabilities requires project managers to strategically balance exploitation and exploration. Managers should not limit themselves to optimizing internal resources but must proactively shape and manage external network relationships. To balance the deep exploitation and broad exploration of knowledge, organizations need to maintain long-term stable cooperative relationships to ensure operational efficiency while consciously embedding new network nodes to introduce cognitive diversity, thereby avoiding innovation inertia caused by excessively closed networks. Furthermore, attaching great importance to and investing in the development of knowledge management systems is a necessary pathway to transform loose social network resources into solid organizational capabilities. The managerial implications revealed in this study are not only applicable to construction projects but also hold significant promotional and reference value for other types of dynamic collaborative contexts and non-temporary project organizations.

(1) Practical implications for enhancing LC ambidexterity in construction organizations

The findings of this study offer actionable strategies for enhancing LC ambidexterity. Managers should first *leverage social capital strategically* by cultivating organizational culture and shared values to improve team cohesion and members' alignment with common goals. This can be achieved through regular team-building activities and clear communication of organizational values (Internal social capital); managers should also strengthen relationships with stakeholders by engaging in mutually beneficial activities and maintaining open communication channels. Treat stakeholders as integral members of the project network to build trust and foster long-term collaboration (External social capital).

Second, it is crucial to balance LC exploitation and exploration capabilities. While internal trust and consistency should be emphasized to ensure the smooth implementation of existing technologies and standards (exploitation), managers must also encourage interaction and trust between internal members and external stakeholders to boost flexibility and adaptability (exploration). To counter the potential negative effects of highly aggregated networks – such as reduced cognitive diversity and information redundancy – managers should maintain stable long-term partnerships while actively seeking new collaborations to inject diverse perspectives.

Third, implementing effective knowledge management practices is essential. This involves promoting knowledge sharing to convert tacit knowledge into explicit forms, consolidating fragmented explicit knowledge into standardized documents, and conducting regular training to enhance the knowledge base of members, thereby facilitating knowledge internalization and creating a virtuous cycle. It's crucial to further internalize cognition by sharing, transforming, and effectively applying knowledge. This process converts knowledge into team resources for addressing unexpected project situations, thereby enhancing LC exploration capability. Additionally, emphasis should be placed on the intermediary role of knowledge management between the structural dimension of internal social capital and LC exploitation capability. This is because knowledge management can better allocate resources obtained through

interactive activities, assisting in the effective completion of project tasks. Moreover, the intermediary role of knowledge management in the structural dimension of internal social capital and LC exploration capability within construction project organizations must be highlighted. The rational allocation and transformation of knowledge can help convert interaction-generated information into innovative ideas more effectively, thus strengthening LC exploration capability.

(2) Implication to managerial roles

For project managers, these findings translate into three core responsibilities. First, they must *strengthen trust and interaction* by building reliable relationships through consistent communication and collaborative activities, while carefully balancing the frequency of interactions to avoid excessive costs. As emphasized by Nauman *et al.* (2024), construction project organizations should actively invest in building internal social capital and fostering a culture of trust, shared vision, and collaboration. Second, managers should *promote a learning culture* by encouraging continuous improvement and recognizing innovative contributions, thereby empowering team members to share experiences and ideas. Finally, it is essential to *optimize resource allocation* by utilizing knowledge management tools to efficiently channel resources acquired through social capital toward enhancing both exploitation and exploration capabilities.

(3) Theoretical and Cross-Domain implications

The implications of this work extend well beyond the building construction sector. The developed model is highly relevant to other dynamic project domains, such as *engineering sites* and *large-scale infrastructure development*, where temporary inter-organizational networks, complex stakeholder interactions, and the need to balance routine operations (exploitation) with innovative problem-solving (exploration) are equally prevalent. For instance, in infrastructure projects, applying this model can help managers strategically leverage stakeholder relationships and knowledge processes to simultaneously ensure project compliance and adapt to unforeseen site challenges. Thus, this study provides a versatile framework for understanding and managing ambidexterity across a wide range of project-based environments.

Limitations and further research

Although this study reveals the mechanism through which social capital shapes LC ambidextrous capabilities via knowledge management, it still has several limitations that point to directions for future research.

First, this study primarily focuses on the inter-organizational level of analysis and does not fully explore the *cross-level dynamic interactions* between social capital and knowledge management. Specifically, while concentrating on organizational social capital, it fails to completely clarify its connection and transformation pathways with *individual social capital*. Furthermore, while emphasizing the importance of external social capital for cross-organizational knowledge acquisition, the study does not delve deeply into the unique mechanisms of these external relationships, such as how *trust* and reciprocity norms are specifically built and maintained across organizational boundaries. Future research could adopt a cross-level analytical framework to explore the interplay between individual and organizational social capital in construction projects, thereby more comprehensively uncovering the micro-level mechanisms of ambidextrous capability building.

Second, this study identifies that the *cognitive dimension* of social capital does not significantly affect exploration capabilities and proposes “cognitive homogenization” from a network governance perspective as a possible explanation. This finding itself suggests boundary conditions for the theoretical framework. To more universally test the “social capital-knowledge management-capability” model proposed here, future empirical work

could apply it to other types of project networks (such as R&D alliances, IT project clusters) for validation and comparison. This would effectively assess its cross-contextual universality and specificity.

Third, this study, based mainly on cross-sectional data, reveals associations between variables but lacks dynamic tracking of how social capital and knowledge management *co-evolve* throughout the project lifecycle. Employing *longitudinal case studies* to deeply trace the interaction and evolution of these elements within single or multiple project networks would significantly enhance the understanding of how these constructs develop together over time.

Finally, other important contextual variables, such as *organizational size*, might also exert a moderating effect on the construction of social capital, knowledge management, and LC ambidextrous capabilities, which this study did not explore in depth. Subsequent research could incorporate these as moderating variables into the analysis to enrich the model's detail. Simultaneously, the practical effectiveness of this theoretical model urgently requires validation and refinement through future empirical case studies.

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Further reading

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