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Coordination and Knowledge Sharing in Construction Project-Based Organization: A Longitudinal Structural Equation Model Analysis

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ABSTRACT

With increasingly advanced construction technology and complex project demand, the construction industry is becoming more and more knowledge-intensive. Effectively coordinating the collective efforts of organization members and sharing knowledge among them are two pivotal and interrelated enablers of organization competitiveness. This study aims to investigate the relationship between individuals' coordination and knowledge sharing behaviors in construction project-based organizations (PBOs). Social network analysis (SNA) with Enron e-mail dataset identified the knowledge sharing network in the Enron Corporation. The e-mail texts were mined to reveal the members' coordination behaviors. Longitudinal structural equation model (SEM) was utilized to analyze the reciprocal relationship between coordination and knowledge sharing. The results suggest that coordination behaviors enable knowledge sharing, while knowledge sharing in turn does not significantly contribute to coordination. Theoretically, it supports the sociology perspective of knowledge sharing in the current empirical analysis. Future studies can replicate the analysis procedure and test the generalizability of the findings in other organization settings. In practice, managers can adopt the proposed approach to identify members' roles in knowledge sharing and coordination, and align their roles with abilities to achieve effective knowledge sharing and coordination.

1. Introduction

Faced with increasingly complex demand and fierce market competition, more and more construction companies adopt the project-based organization form to improve project delivery efficiency [5]. Delivering projects as the building blocks of business strategy requires the integration of multidisciplinary expertise [5,20]. Construction PBOs need to tackle the challenges of coordinating and sharing knowledge in interdisciplinary project teams [65]. With the rapid construction technology development, the construction industry is becoming more and more knowledge- and information-intensive. A survey of construction company CEOs suggests that knowledge is deemed as the most critical strategic asset [56]. As a result, knowledge sharing in construction PBOs has become an emerging topic attracting growing research attention [2].

First, knowledge sharing is a core organization capability essential for team integration. From the knowledged-based view (KBV), organizations are networks of members with diverse knowledge backgrounds, and the core capability of organizations is to effectively accumulate, share and utilize the knowledge asssets [22]. This view is especially applicable in construction PBOs, where knowledge sharing acts as the basis of integrating multidisciplinary expertise [33,65]. Second, knowledge sharing enables organization learning and experience transfer [48]. In construction PBOs, sharing lessons learned across projects encourages members to follow best practices and avoid the repetition of mistakes in subsequent projects [49]. It facilitates continuous improvements in project and organizational business performance [20,36]. Third, knowledge sharing acts as an important vehicle for innovation. Various modern communication systems (such as e-mail systems and enterprise management information systems) provide convenient access to unprecedentedly abundant information [17,62]. Knowledge sharing through these communication channels stimulates innovative ideas, incorporates individual innovators into joint efforts and promotes a knowledge spillover effect [62].

Despite the growing awareness of knowledge sharing and the increasing investment on it, organization knowledge sharing practices in the construction industry remain largely poor [31,33,64]. Experience from previous projects cannot be fully utilized in subsequent projects, especially in terms of safety management [61] and contract management [7]. Individual members are the knowledge holders in temporary project teams. They are highly mobile across projects, and may take away precious knowledge often without the awareness to share it. Even with the intention to share, it is difficult for them to determine whether the knowledge is valuable to other projects from the

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standpoint of the individual project [36]. Moreover, different projects may be competing for mutual organization resources, and there is even less incentive to share knowledge with competitors [59].

The above obstacles to knowledge sharing in construction PBOs originate from the various dependencies among projects and project members [59]. As pointed out by Malone and Crowston [42], to coordinate is to manage dependencies. Coordination processes are closely related to the effectiveness of knowledge sharing [51]. The coordination theory conceptualizes coordination as four processes [42], i.e. managing shared resources, managing task dependencies, managing consumer/producer relationships and managing simultaneity constraints. These processes are deeply embodied in classical construction project management techniques such as PERT (Program Evaluation and Review Technique) and line of balance. At the organization level, construction PBO managers coordinate the dependencies among projects to realize the benefits not available by managing them separately [68]. At the project level, project managers coordinate the task dependencies and resource constraints among members [46]. Taken together, the importance of coordination is increasing in the project-based setting where organizations become more reliant on interdisciplinary teams of specialists [19].

Members' coordination performance affects their ability to approach others, obtain information, refine knowledge and become active in knowledge sharing [33]. Active members in the knowledge sharing network, in turn, are able to process timely information and valuable knowledge, which is the basis of effective coordination [17]. Many previous studies examined the relationship between knowledge sharing and coordination [12,29,50], whereas the empirical findings are mixed in terms of causality. This limitation induces the confusion on whether organization managers can improve knowledge sharing by enhancing coordination, or they can improve coordination by motivating knowledge sharing.

This study aims to bridge this research gap by empirical analysis on real-world data from the Enron Corporation, which is a giant engineering company specialized in power and electricity. Social Network Analysis (SNA), text mining technique and Latent Variable Cross-Lagged Panel model (LCLP, a kind of longitudinal SEM) are incorporated to extract data and analyze the causal relationship between knowledge sharing and coordination. The theoretical implication of the findings is that coordination acts as the antecedent of knowledge sharing, while knowledge sharing in turn does not significantly contribute to coordination. Practically, organization managers can improve members' coordination behaviors as an important enabler for knowledge sharing.

Subsequent sections focus on the relationship between knowledge sharing and coordination, and are organized as follows. Section 2 reviews literature on knowledge sharing and coordination in PBOs, and identifies implications and limitations in previous studies. Section 3 elaborates on the empirical analysis procedure and methods, including SNA, text mining and LCLP. Section 4 summarizes the empirical results, and based on these, discussion and conclusions are presented in Sections 5 and 6 respectively.

2. Literature review

2.1. Knowledge sharing in PBOs

Knowledge management in PBOs involves knowledge obtaining, sharing, storing, applying, integration and renovation processes, in which knowledge sharing is a critical process [48]. Without adequate knowledge sharing, knowledge leakage will lead to repeated mistakes, duplicated work, lack of innovation and ultimately organization inefficiency. This is supported by Zhang and El-Diraby [63], who underlined the importance of knowledge sharing in complex project enviroment. Reich, et al. [48] further pointed out that growth in knowledge stock does not necessarily contribute to competitive advantage, and knowledge sharing acts as the essential mediator.

2.1.1. A social network perspective of knowledge sharing

In order to motivate knowledge sharing, many researchers identified critical enablers such as team cohesion [3] and organization culture [3,20]; constructed information systems to build a collaborative knowledge sharing environment [51]. Despite the abundant research efforts, numerous organizations are struggling with problems in knowledge sharing [31,36]. It has been widely reported that the benefits obtained from knowledge sharing do not match the investment on it, and approximately half of the knowledge management systems failed their original goals [25,33]. The reasons are twofold. First, the traditional realistic view of knowledge emphasizes on the knowledge storage and communication technology, while pays little attention to the social and behavioral aspects [14]. So there is a lack of efforts to accommodate the knowledge management systems to organization contexts. Second, most existing studies were conducted at the organization level, without elaborative investigation on individual members, who are the actual knowledge holders [33].

Knowledge sharing is an interactive process between organization members [37]. Knowledge sharing relationships constitute a social network joining all members together, and no knowledge sharing activity is possible outside the network [51,56,66,69]. In the same vein, construction PBOs are not merely collections of contractual arrangements, but complex networks of members as knowledge holders [22]. Knowledge sharing is inherently a network process, and thus, should be understood from the network perspective [14]. Anklam [2] pointed out that knowledge flows along communication paths in organization network, so SNA can be performed to obtain deeper insights on knowledge sharing in business activities. Zhang and Wang [66] and Le, et al. [41] studied safety and health knowledge sharing in construction organizations by network analysis. In this light, we adopt the network perspective and model knowledge sharing by social network analysis.

2.1.2. An information hierarchy perspective of knowledge sharing

Knowledge sharing is intangible in nature [69]. Underlying the definition of knowledge is the implicit intuition that data, information, knowledge and wisdom constitute a pyramid structure, often quoted as the information hierarchy [70,71].

To clarify the information hierarchy in construction project settings, we take the concrete temperature control process as an illustrative example. For the purpose of crack prevention, the temperature of newly poured concrete is gauged. These temperature *data*, observed either manually or automatically, describe the properties of objects, events and their environments [71]. They can be formatted, reduced and thereafter documented as *information* in project implementation reports. The data processing procedures produce *information* and derive concise answers to questions such as "what was the average temperature within 3 days" and "how many cracks developed due to high temperature" [70]. By identifying common patterns in the *information*, *knowledge* (such as "how does high temperature influence concrete cracking" and "what is the permissible temperature to prevent cracks") can be obtained. The transformation of *information* to *knowledge* produces actionable principles such as "when should we take measures to control the temperature of concrete". Combining these principles facilitates more informed decisions and creates the ultimate organizational *wisdom* [70]. With a comprehensive description on organization knowledge structure, information hierarchy provides several useful implications to modelling knowledge sharing.

First, the boundaries between hierarchies are vague, especially the boundary between *information* and *knowledge*. Knowledge sharing is embodied in information sharing, and it is arbitrary to make a definitive distinction between the two constructs [70]. This is reflected in the difficulty of capturing knowledge sharing by questionnaire survey, since it is no easy task for respondents to tell knowledge sharing from information sharing and data sharing [25]. Zhao and Chen [67] suggested to extract knowledge sharing networks from enterprise