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How to reduce the negative impacts of knowledge heterogeneity in engineering design team: Exploring the role of knowledge reuse

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Abstract

Typical characteristics of construction projects are uniqueness and complexities, which lead to lack of reuse of previous knowledge in engineering design team (EDT). Furthermore, with the development of construction industry, knowledge heterogeneity continues to strengthen and increases the difficulties of knowledge reuse in EDT. The aim of this paper is to explore how to reduce the negative impacts of knowledge heterogeneity by reusing knowledge effectively in EDT. The study demonstrates that knowledge heterogeneity impact EDT performance negatively in some cases, and effective knowledge reuse and good team atmosphere help alleviate the negative effects to a certain extent. Hence EDT should encourage employees' knowledge reuse behaviors or activities and create harmonious team atmosphere so as to reduce the negative effects of knowledge heterogeneity that will in turn lead to benefits for the organization as a whole.

Keywords: Knowledge reuse; Knowledge heterogeneity; Engineering design team performance; Employee relationships

1. Introduction

One of the major issues for knowledge management in a project environment is the poor project success analysis and the lack of proper documentation on the results of the previous projects (Todorović et al., 2015). Because each project is presented as a temporary, relatively short-lived, phenomenon (Sydow et al., 2004). The vast majority of knowledge is generated during the course of a construction project, but only a small fraction is reused subsequently, which leads to most of the knowledge gained from the project being lost and not shared effectively (Tan et al., 2009). Engineering design team (EDT) as a typical project-based organization, the design projects are usually unique and complex, which need to combine professionals with different backgrounds in order to complete one project. Reusing of previous project knowledge fully means saving design times and reducing design changes for EDT. For example, when designing similar projects they can draw lessons from the successful solutions before, which facilitate reducing the human capital investment and also avoid similar mistakes.

In EDT, there are so many differences in professional backgrounds, skills and professional experiences. Hence all kinds of knowledge blend, collision, which make the trait of knowledge heterogeneity intensifies constantly. The heterogeneity refers to the diversity in skills and knowledge represented on the team (Atanasova and Senn, 2011), and as one of the members' personalities is a typical phenomenon for a long time (Kichuk and Wiesner, 1997). Sometimes different background experts would provide more solutions than single individuals (Devine, 1999), because the synthesis of knowledge process between knowledge heterogeneity and performance would generate new ideas (Rodan and Galunic, 2002). Knowledge heterogeneity will benefit for the innovative and creative potential of managers, which is important for managerial performance and innovation performance (Louadi, 2008; Rodan and Galunic, 2004; Tsai et al., 2014). However, knowledge heterogeneity would impact engineering design team performance negatively in some times.

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Because team performance is influenced directly by three team processes: communication and collaboration, conflict management, and proactiveness (Atanasova and Senn, 2011). When the degree of knowledge heterogeneity is too high, it will increase the difficulties of team communication and collaboration to a certain extent, thus impacting the enthusiasm of team members, then leading to underdeveloped team performance.

Engineering design is a process of knowledge acquisition, sharing, application, and innovation, so as to realize the continuous knowledge reuse cycle (Fig. 1). In EDT, heterogeneous knowledge converts to homogeneous knowledge continuously (in this case, the meaning of homogeneous knowledge is easily to be understood and applied by the whole team, rather than the homogeneous knowledge in the traditional sense). Because engineering design project is complex and the heterogeneous knowledge converts into homogeneous knowledge constantly in different project cycle. In the dynamic transformation process, the ratio of heterogeneous and homogeneous knowledge changes in different project stages. There exists an optimal ratio between heterogeneous knowledge and homogeneous knowledge in the ideal state. When the combination of heterogeneous knowledge and homogeneous knowledge reach the optimum reuse, the EDT performance will be the highest in principle.

Through reusing existing knowledge, an individual can receive benefits of saving time and effort and ensure the quality of knowledge (Watson and Hewett, 2006). Knowledge reuse is able to coordinate different resources from several aspects, which facilitate the designers to better analyze and solve problems, then create new solutions. Knowledge reuse also can provide a reference for similar project and improve the quality of engineering design. Therefore, for EDT, knowledge reuse improves the team ability, innovation ability, survival ability and competition ability. However, in most EDTs, the knowledge reuse rate is not high. One of the most important reasons is that knowledge heterogeneity increases the difficulties of knowledge reuse. In today's engineering design environment, designers are limited in their ability to maximize knowledge reuse by the fact that there are so many difficulties to search for, access, and integrate reusable design knowledge across multiple sources. Because knowledge reuse provides more time for innovation, and makes the organization more creative (Baxter et al., 2008). Knowledge reuse also accelerates the speed of knowledge transfer and share, and improves the team agility (Liu et al., 2015). Hence, one approach to improve engineering design is through reusing previous knowledge.

Humans can use knowledge gained from previous experience to make decisions when face with inadequate information (Bollacker and Ghosh, 1998). Sometimes employees would not share their knowledge due to the feeling of losing competitive advantage, and leading to employees not applying and reusing the useful knowledge (So and Bolloju, 2005). The employee's willingness of sharing knowledge and the level of knowledge storage of organizers determine the frequency and quality of knowledge reuse. For EDT, the cost of developing knowledge is huge, reusing knowledge effectively is saving cost in a sense. So it is important to arouse the enthusiasm of the employee's knowledge reuse in EDT, and try best to reusing and incorporating knowledge from other projects and parts of the organization (Mohrman et al., 2003). Although academia and industry realized the positive impact of knowledge heterogeneity on team innovation performance, they did not realize that when the level of knowledge heterogeneity is too high, knowledge could not be reused fully, thus leading to the poor team performance. Nowadays, EDT should face such questions: in the context of knowledge heterogeneity, how to realize knowledge reuse effectively? How to improve team performance through knowledge reuse effectively? Previous studies have not realized the negative impacts of knowledge heterogeneity on team performance and the importance of knowledge reuse in EDT. This paper aims to explore how to overcome the disadvantage of knowledge heterogeneity, by reusing the team knowledge effectively, then saving cost for EDT maximally.

2. Research model and hypotheses development

2.1. Knowledge reuse in engineering design team

Effective experience reuse and lessons learned are increasingly important assets of enterprises and represent sources of competitive advantages in various domains (Bonjour et al., 2014). Unfortunately, even in a large construction company, there is no mechanism for capturing, storing, and reusing for generating knowledge (Esmi and Ennals, 2009), which leads to not full knowledge reuse. Knowledge reuse is defined as one

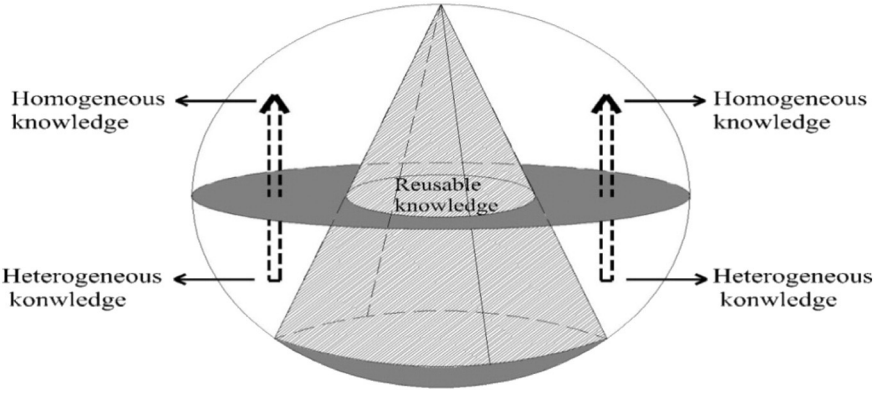

Fig. 1. The knowledge reusable process of EDT.