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Managing projects with distributed and embedded knowledge through interactions

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Abstract

In project-based industries studies show difficulties in extracting, distributing and applying embedded and practice knowledge across structural and organisational boundaries. We focus on interorganisational projects consisting of distributed and embedded knowledge. Interaction becomes important in order to cooperate and share interorganisational and distributed knowledge. The aim of the research is to explore how sharing and generating practice based and distributed knowledge occurs through interaction in interorganisational projects and how this is managed. The study focuses on the design phase and relates traditional design practices to concurrent design practices. In the study we observed six cases of design meetings in the construction and oil and gas industry and performed 31 interviews. The paper contributes with the following: (1) understanding and visualisation of interaction patterns, (2) insight in use of various forms of interaction, and (3) ways of managing distributed and embedded knowledge through interaction.
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1. Introduction

Changes in terms of globalisation, development of new information and communication technology (ICT) as well as economical crises have had an impact on ways of working in many industries. The focus has shifted towards knowledge work (KW) and how to improve knowledge work performance and thereby productivity. KW is the creation, distribution, or application of knowledge by highly skilled and autonomous workers using tools and theoretical concepts to produce complex, intangible and tangible results (Pyöriä, 2005; Schultze, 2000). Although, there are different perspectives on knowledge, in this research we regard knowledge as situated and representing a social and collective phenomenon (Currie and White, 2012). From this perspective, knowledge is embedded in actions and practice and is an ongoing social accomplishment in everyday practice (Orlikowski, 2002). Knowledge work is increasingly performed in cooperation with others in teams for complex tasks (Pyöriä, 2005), in multiple and changing contexts. Especially, in the case of project-based firms, in which complex projects are performed, often involving multiple organisations and disciplines, either collocated, or geographically distributed, it becomes difficult to share embedded knowledge. Team members working in these settings can simultaneously work in multiple projects with different members. The teams are closely embedded in a social system having fluid borders, working in changing and often temporary contexts with multiple actors. The knowledge in such projects often crosses over organisational, disciplinarial and sometimes geographical boundaries and is therefore perceived as distributed knowledge (Tsoukas, 1996). In this article we focus on the construction industry, which is an example of a project-based industry (Gann and Salter, 2000). The industry

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works in projects, consisting of situated and distributed knowledge based on embedded practices, know-how, and organisational culture from multiple firms. From earlier literature we know that project-based industries have difficulties of extracting, distributing and applying knowledge across both cultural and structural boundaries (Bosch-Sijtsema and Postma, 2009; Prencipe and Tell, 2001). The knowledge is sticky, situational and often locally embedded (Szulanski, 1996; Von Hippel, 1998), which makes it more difficult to collaborate in such settings.

The focus of our study is primarily on interaction in an interorganisational project consisting of distributed and situated knowledge. Interaction in this respect is perceived as human-to-human communication as well as human-to-artefact communication with help of various means (i.e., sketches, ICT, 3D models). Communication and interaction are perceived as indicators for project success in terms of knowledge work (Ramírez and Nembhard, 2004) and interaction is perceived as the process through which negotiations of meaning and co-creation of knowledge occur (Gunawardena et al., 1997). Furthermore, the use of new communication means as well as information and communication technologies (ICT) can support part of the knowledge work.

However, literature also suggests that communication is one of the primary concerns in the construction project environment, as both structural and cultural barriers exist. These barriers hinder the transfer of information across and between professional and project boundaries (Dainty et al., 2006).

Our study focuses on the design phase in the construction industry. Construction design is a multifaceted process continuing to extend complexity due to the increase of specialist knowledge needed in the design phase (Gray and Hughes, 2001). As the design process in construction projects involves a variety of stakeholders, i.e., clients, architects, contractor, structural engineering, and heating, ventilation and air condition (HVAC), there is a constant exchange of information and knowledge needed (Chiu, 2002; Gray and Hughes, 2001). However, especially communication and transfer of information have been found to be problematic during the design process (Dainty et al., 2006). Research discusses in this respect; difficulties to create a shared understanding amongst all different players, a fragmented use of information and data (Anumba et al., 2002), lack of sufficient incentives for collaboration and communication, as well as ineffective cooperation due to unclear information dependencies (Senescu et al., 2013), and difficulties to share distributed and embedded knowledge throughout the project.

Many mention the development of new working methods like concurrent design (Anumba et al., 2002; Kamara et al., 2002), extreme collaboration in which different stakeholders come together in a particular room or space to collaborate (Garcia et al., 2004), and the use of new ICT and visualisation means as options to improve interaction between the different stakeholders. Several of these working methods focus on parallel processes, working in multi-disciplinary teams, and providing a working environment facilitated through the integration of various information and communication tools (ICT) that support these methodologies. Especially the focus on the use of space supporting social interaction is discussed as one school in knowledge management, i.e., spatial knowledge management (Earl, 2001). The use of space supports interaction, discussion and tacit knowledge transfer.

Studies have argued for knowledge sharing in project-based industries, but have focused to a large extent on the difficulties and complexity of sharing knowledge (Bosch-Sijtsema & Postma, 2009; Prencipe and Tell, 2001). From knowledge management literature we know that sharing embedded and practice-based knowledge can be supported by face-to-face communication (Hislop, 2005) and the use of communication means like ICT. However, few studies discuss how distributed and embedded knowledge is shared over disciplinary and organisational boundaries in temporary cooperative projects. In this study we focus primarily on interaction. The aim of the research is to explore how sharing and generating practice based and distributed knowledge occurs through interaction in interorganisational projects and how this is managed. This research studies how a combination of concurrent and extreme collaboration work processes aided by a variety of visual communication means influences the interaction and information sharing of distributed knowledge in the project. We are especially interested in the interaction between the different project partners and relationships and how such distributed and embedded knowledge transfer and creation is managed and maintained. The paper contributes with (1) understanding and visualisation of interaction patterns during design; (2) insight in use of various forms of interaction, and (3) ways of managing a distributed knowledge through interaction.

The article is structured as follows. In Section 2, the literature concerning interaction in design teams is discussed as well as research on boundary spanning. Section 3 discusses the methodology applied for this study, which is based on a comparative case study analysis with observations and interviews. In Section 4, the results are discussed and related to literature. Finally a conclusion with main contributions and future research is taken up.

2. Design project interaction

An important element for successful cooperation during the design process is the interaction between different project participants and stakeholders. This interaction can be affected by both internal and external factors. Internal factors can be related to the interpretation and context of the message or medium through which is interacted. External factors impacting interaction can be the availability of tools and different types of interference or noise that can lead to misinterpretations, misconceptions, and confusion (Dainty et al., 2006). From earlier literature we know that many different aspects influence how information and knowledge can be shared within a project. However, for sharing embedded and distributed knowledge in a project consisting of multiple firms and stakeholders, the techniques, means and tools to support different types of interaction, e.g., visual communication, as well as ways of working and working culture are argued to be important.

2.1. Forms of interaction

Interaction is concerned with a dialectic process of acting, reacting, and interacting either based on human-to-human

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