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Exploring the effect of boundary objects on knowledge interaction

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ABSTRACT

This study attempts to tackle cross-boundary knowledge management problems by examining how knowledge can be generated efficiently. The subjects comprised 81 pairs of users and student analysts. To understand the similarities and differences among 81 records of knowledge interactions, a max–min model was employed to analyze project performance and calculate knowledge interaction efficiency. The analysis involved one output factor (project performance) and four input factors (frequencies of encountering four different types of boundary objects). Cluster analysis and the subsequent comparisons among the clusters suggest that the occurrence of metaphoric boundary objects is the key to good project performance in the context of software system analysis. This paper successfully demonstrates that observing knowledge interaction through the lens of boundary objects can be fruitful, and that some boundary objects are more important than others. However, the context-dependent nature of knowledge interaction mandates further studies in other contexts.

1. Introduction

Organizational performance is commonly linked to an organization's ability to manage knowledge effectively [22]. During the 1990s, knowledge management as a discipline was characterized by diverse foci with studies examining both within and across boundary phenomena [10,16,18,36,42]. Yet the increasing sophistication of professional specializations mandates a shift in focus toward cross-boundary knowledge management [2,23,25]. Organizations that desire efficient knowledge production need to establish an environment that facilitates ample opportunities for effective interactions among knowledge workers across boundaries [24,28,29]. Nickson and Zenger [29] stated that effective organizations should focus on the efficiency of alternative organizational forms when generating knowledge. Their emphasis was on producing knowledge efficiently, rather than merely exchanging it.

Because most innovation takes place along the boundaries between specializations [27], organizations tend to promote collaboration across multiple domains to trigger innovation. Knowledge workers' cross-boundary interactions facilitate cross-boundary knowledge exchange, transfer, and creation. Hence, organizations should not only provide appropriate ways for people to collaborate and accomplish tasks, but also pay attention to how interactions can be conducted efficiently.

As boundaries pose difficulties in knowledge flows, organizations should strive to reduce the influence of boundaries on multi-domain collaboration by either breaking them or, if they are difficult or impossible to eliminate, finding a way to communicate across them. This can be done via the boundary objects that can exist between boundaries, as suggested by Star and Griesemer [39]. These authors stressed that people should respect the different views arising from the many intersecting worlds of different actors. At these intersections, boundary objects emerge to facilitate existing knowledge exchange and new knowledge generation. According to Star and Griesemer, a boundary object is "an analytic concept of (those) scientific objects which both inhabit several intersecting social worlds and satisfy the informational requirements of each of them".

Star and Griesemer further explain boundary objects in the following statement:

> They are weakly structured in common use, and become strongly structured in individual-site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable…

They claimed that "The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds". This coherence, which is made possible by the creation and management of boundary objects, is a necessary condition for efficient knowledge interaction. Thus, in this study we propose that knowledge interaction can be observed through the lens of boundary objects.

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When knowledge workers in different domains interact with one another, the resources involved in the interaction are not the knowledge workers themselves, but the forms of knowledge that they deploy. Hence, the interaction is termed a *knowledge interaction* (KI) [45], which is defined in this study as the knowledge transformation that occurs when actors interact. The term knowledge interaction is preferable to knowledge transformation, because when the latter term is used the emphasis is normally on processes and stages, whereas in this study attention is directed to the entities that can be observed during the transformation. As knowledge workers communicate, KIs occur and take different forms, similar to the interaction patterns discussed by Nonaka [30] or the processes discussed by Hedlund [20]. Nonaka identified four patterns of interaction between tacit and explicit knowledge–socialization, externalization, internalization, and combination–and modeled the pattern relationships as a spiral of knowledge. According to Hedlund, knowledge is transformed through eight processes that include articulation, internalization, reflection, extension, appropriation, dialog, expansion, and assimilation. Hedlund further stated that the quantity and quality of "dialog" and "reflection" are important determinants of the knowledge management approach needed and whether the prescribed knowledge management is effective. In this regard, if knowledge workers improve their "dialog" and "reflection" through the use of boundary objects, knowledge interaction efficiency is more likely to be enhanced.

With the development of information systems, organizations have gone to great lengths to fulfill explicit knowledge sharing [19]; however, technologies that can facilitate effective tacit knowledge sharing are only just emerging. Although some forms of tacit knowledge are being explicated for effective sharing, and are better understood, the central quality of tacit knowledge is inherently hard to explicate. In this regard, the focus of knowledge management has been shifting from information exchange models to social interaction management [38], as social interaction seems to provide a sharing solution for both explicit and tacit knowledge [11]. Further, organizations have noticed the importance of knowledge exchange across boundaries through interactions among people, technologies, and techniques [4]. At the international level, while investigating how members of global product-development organizations generate and sustain knowledge in their distributed operations, Orlikowski [33] emphasized the increasing importance of an organization's ability to operate effectively regardless of time, geography, politics, and culture. He referred to this as "distributed organizing", the ability to manage knowledge interactions across boundaries to solve problems.

When new knowledge is generated from existing knowledge domains during KIs, the effectiveness of the interactions is crucial to new knowledge creation. As boundary objects are the media of interactions, they greatly influence the workings of KIs and hence are tightly coupled with output performance. In the context of software system analysis, output performance is measured by the quality of the analysis report. If a high quality report is produced with fewer resources, we can infer that the KI seen during the course of the analyst–user communication is efficient. Although much research has been devoted to knowledge management, more attention has been focused on knowledge management inside organizations than across organizational boundaries. In an attempt to fill this gap and find ways to enhance cross-boundary knowledge management performance, this study approaches the KI performance issue from the perspective of efficiency, and formally calculates KI efficiency based on max–min models, with boundary objects as the input resource.

In this study, types of boundary objects are summarized, and the occurrences of each boundary object type are identified and counted using analyst journals and analyst–user communication recordings. These are the data of the max–min model input factors, whereas the output factor data are the system analysis report evaluations. Finally, max–min models are applied to calculate the maximum and minimum possible efficiency of each KI.

2. Literature review

During the interaction of knowledge workers from multiple domains, various types of boundary objects can be observed. In the following, categories of boundary object are reviewed and summarized. Then a max–min model is introduced, which is the basis for the evaluation of KI efficiencies in this paper.

2.1. Boundary objects

It is inevitable that cross-disciplinary collaboration takes place both inside and between organizations. If effective collaboration is desired, people who share a common goal must create common understandings, ensure reliability of communication across domains, and gather information that retains its integrity across time, space, and local contingencies. Further, the impact of the domain boundaries between disciplines should be reduced to improve cross-disciplinary collaboration performance.

Star and Griesemer [39] proposed the concept of "boundary objects"—objects adaptable to different viewpoints within domains and robust enough to maintain their identity across boundaries. As various subgroups in different domains must reconcile different meanings in order to collaborate successfully, they can use boundary objects as nexuses or bridges to aid cross-boundary communication. According to Star and Griesemer [39], using boundary objects could improve common representation and in turn increase the efficiency of communication between actors from different professional domains. In contrast, it is difficult to reach a common understanding in the absence of appropriate boundary objects, leading to a lesser chance of successful innovation [26]. The more an organization understands the nature of various boundary objects, the more likely it is that it will overcome existing barriers.

Star and Griesemer's work defines four boundary object categories: repositories, ideal types, coincident boundaries, and standardized forms. Collaboration success relies on the interaction of all parties, who need not only to share their own knowledge, but also to assess each other's knowledge during interactions. Cross-boundary knowledge interaction is a challenge because boundaries are shaped by gaps in party specialty and effective collaboration depends on overcoming this challenge.

Carlile [7] adopted Star and Griesemer's list of boundary objects in describing their use by individuals in observed settings and proposed three object categories–syntactic, semantic, and pragmatic–that support the parties working across such boundaries. In Carlile's classification of boundary objects, syntactic boundary objects map closely to Star and Griesemer's "repositories", semantic boundary objects map to "standardized forms and methods", and pragmatic boundary objects map to "ideal types" and "coincident boundaries". Carlile [8] later examined knowledge management based on these three types of boundary objects and indicated the importance of clarifying knowledge worker relationships in order to manage knowledge effectively across boundaries.

Syntactic boundary objects refer to physical repositories, reports, databases, or libraries, whereas semantic boundary objects refer to standardized forms [7]. Since the term "pragmatic" was first proposed in Carlile's work, the essence of this type of object has been continually enriched by recognizing pragmatic boundary objects in empirical contexts. These include Gantt charts, milestone charts, PERT charts, and project timelines [44], which are used to achieve common schedules. They also include engineering design drawings and sketches [21], which are read by designers of different engineering disciplines to help them focus on their aspects of the representation. All of these visual artifacts were useful tools in achieving cross-boundary understanding.

The boundary object types described above are all explicit in nature. Tacit-type boundary objects seem to be missing, though several have been proposed. An example is described by Cook and Brown [13] in the "bread-making machine" case, in which the term "twisting stretch" is regarded as a "genre" and functions as a boundary object that straddles bread-making and machine-making domains. Additionally,