

Knowledge Fusion for Cooperative Innovation from Strategic Alliances Perspective

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Abstract: It has been argued that strategic alliances offer opportunities for using purposive inflows and outflows of knowledge to accelerate cooperative innovation. In this introductory article, we seek to identify the means by which knowledge fusion helps create new knowledge and technological innovations. By analyzing the previous researches in terms of fusion and collaboration, we summarize the approaches of knowledge fusion based on IT application. Meanwhile, we also give effectiveness mechanisms and brief agenda for research in this important area. This study offers deep theoretical and managerial insights for firms and other institutions to manage knowledge fusion in strategic alliances.

1 INTRODUCTION

A growing trend in today's innovation environment is intensification of co-competition. In order to compete in a global market, more and more distributed organizations bound to work in alliances to gather and share knowledge by using information technology. Currently enterprises often establish strategic alliances such as patent pools, industry-university collaborative innovation alliances, and industrial technology innovation alliances to cocreate value that involves the sharing of knowledge and expertise for developing new or better products (Dyer and Hatch, 2006; Grover and Kohli, 2012). As noted by Grant (1996), knowledge is the preeminent resource of the firm and organizational capability involves integration of distributed knowledge bases. To maximize the benefits of knowledge integration emanated in multiple organizations environment, the issue of knowledge fusion and innovation gained through collaboration is important (Meijer, 2000; Rundquist, 2014).

Knowledge fusion is defined as recognition and combination of knowledge that are located and extracted from multiple, distributed, heterogeneous sources to generate new products, services, processes, capabilities or competencies (Preece et al., 2001; Heffner and Sharif, 2008). Most contemporary organizations are pursuing competitive advantage from the management information systems.

Advanced information technologies (e.g., the Internet, Word Wide Web, distributed information systems, data mining and searching, simulation and modelling) can enhance the ability to recognize, assimilate, and exploit external knowledge (Alavi and Leidner, 2001; Dittrich and Duysters, 2007). However, most research on knowledge fusion are focusing on IT level (e.g., the ontology, fusion framework, fusion algorithm, multi-agent systems), while this is not enough for knowledge fusion, with many problems remaining to be solved from the knowledge management perspective.

There is a growing stream of literature investigating inter-organizations knowledge management in innovation alliances (Christoffersen, 2013; Vasudeva et al., 2013; Li et al., 2014), in which collaborators and competitors integrate in the pursuit of the codevelopment of technological innovations (Han et al., 2012). Knowledge fusion has been studied as a conversion procedure in knowledge integration with a focus on IT tools to support knowledge availability, sharing, and assimilation. In this paper we take one step toward addressing the gap between engineering science and knowledge science in prior research. We seek answers to the following set of questions for knowledge fusion management: What conditions facilitate knowledge fusion in innovation alliances? What management mechanisms are the most effective in enabling knowledge fusion?

2 CONTEMPORARY RESEARCH THEMES

The knowledge-based view (KBV) suggest that superior profitability is likely to be associated with resource and capability-based advantages which are likely to drive from superior access to and integration of specialized knowledge (Grant, 1996). In order to support the knowledge integration, much of the research into the management issues concerning the role of information technologies has been focusing on the knowledge management system (KMS) (Černe et al., 2013; Sutanto and Jiang, 2013; Wang et al., 2014). Contemporary environment with open information systems (Li et al., 2014) make the combinative capabilities become more and more important. This ability of the firm to generate new combinations of existing knowledge is improved with the knowledge fusion theory developed.

The academic results and practical applications of KRAFT (Knowledge Reuse and Fusion/Transformation) project are considered the most representative study in knowledge fusion research. KRAFT is conceived to investigate how existing proposals for distributed information systems architectures can support fusion of knowledge in the form of constraints expressed against an object data model (Gray et al., 1997). The literature on knowledge fusion in the field of computer science has explored the role of KMS in knowledge storage, sharing, reuse, revealing, generation, entry, integration, transportation, search and indexing (Preece et al., 2001; Smimov et al., 2013). The primary emphasis of this literature is on the architectures and fusion algorithms (Jiang et al., 2012; Zhou et al., 2013).

At the same time, research in knowledge fusion among multiple organizations has raised several questions that must be addressed. Heffner et al. (2008)

articulate the knowledge fusion for technological innovation in organizations as a critical theme for future research. They propose that we need to integrate a number of heretofore disparate research streams, thereby providing a management framework for examining the knowledge fusion activities of organizations connect current researching on knowledge management. A management attitude towards knowledge fusion and innovation is discussed by Meijer (2000), who points out that problem solving comes down to creative processes which very much depend on thought processes that primarily take place inside the brains of individuals, under the influence of the group or the environment in which they do their creative work. By emphasizing how IT-based knowledge fusion is occurred in innovation alliances, fusion mechanisms research can help decision making and problem solving. Figure 1 illustrates the knowledge fusion management framework in strategic alliances.

3 KNOWLEDGE FUSION IN INNOVATION ALLIANCES

The capacity of the information technology to capture, store, and analyze information offers many opportunities for cocreation of business value (Grover et al., 2012), especially in alliances that trust and formal contracts can offer opportunities for knowledge sharing and leveraging. Traditionally, innovation has been created and marketed under closed settings, in which companies internally manage all of the processes involved in the innovation life cycle. Despite the nascent stage of development, many contemporary business enterprises have jumped on the bandwagon of the emerging industrial trend, participating in open

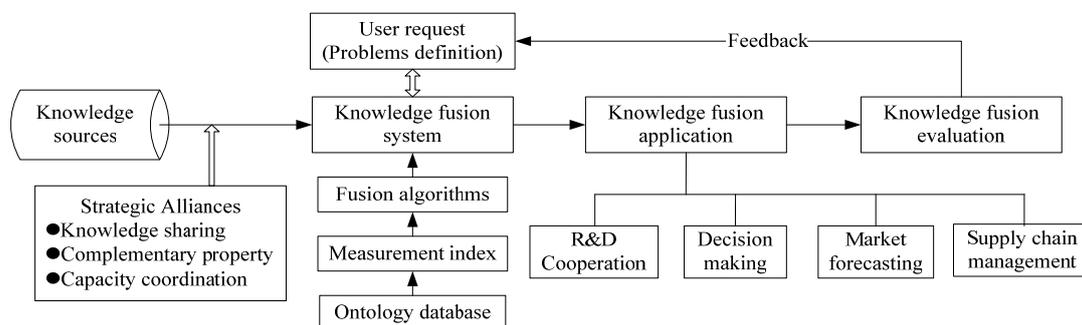


Figure 1: Knowledge fusion management in strategic alliance.

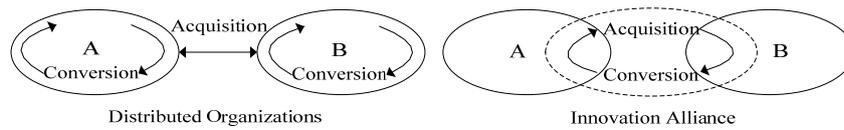


Figure 2: Two knowledge fusion approaches in different environment.

innovation alliances in pursuit of leveraging purposive knowledge inflows and outflows (Han et al., 2012). Knowledge acquisition and conversion are crucial to the knowledge fusion, since it makes possible a much greater degree of innovation ability. Figure 2 illustrates the two knowledge fusion approaches through which firms can acquire and convert knowledge in different ways.

Firms are usually to exploit external knowledge sourcing by capturing or engaging in alliances. From transaction cost economics (TCE) perspective, capturing takes place when organizational boundaries exist and knowledge is valuable, which influenced by the risk of opportunism, information asymmetries, and asset specificity. In contrast, the resource based view (RBV) can extend understanding of firm boundaries because it explicitly recognizes knowledge as a critical resource (Carayannopoulos and Auster, 2010). Joint and interactive learning represents a coupled form of knowledge fusion (Rosell et al., 2014), where acquisition and conversion take place through cooperative efforts between organizations that maintain their separate identities while sharing inputs and control. It seems that innovation alliances offer an interesting context within which knowledge fusion can be studied. Knowledge fusion can also be facilitated by the prosperity of collaborators as well as rivals in multi-organizational environment.

Many studies have examined the role of knowledge management in alliances (Mesquita et al., 2008; Shin and Lee, 2013). However, we limit our review to the studies that focus on knowledge fusion between two alliance partners and its impacts on the cocreating innovation capabilities. Fusions refers generally to the blending of different things into something new, something more than the mere sum of the parts, which in the process of combination release or generate tremendous energy. Based on an analysis of KRAFT project, the core of knowledge fusion is the knowledge conversion which depends on an iterative exploration cycle and information application by capturing both explicit and tacit knowledge. The first step of knowledge fusion is knowledge acquisition which established on the basis of the knowledge sharing. In innovation alliances, it's facilitated to acquire external knowledge sourcing through cooperation between organizations that maintain their separate identities while sharing complementary capability and assets. Figure 3 illustrates the innovation alliance features effect on knowledge fusion.

4 EFFECTIVENESS MECHANISMS FOR KNOWLEDGE FUSION

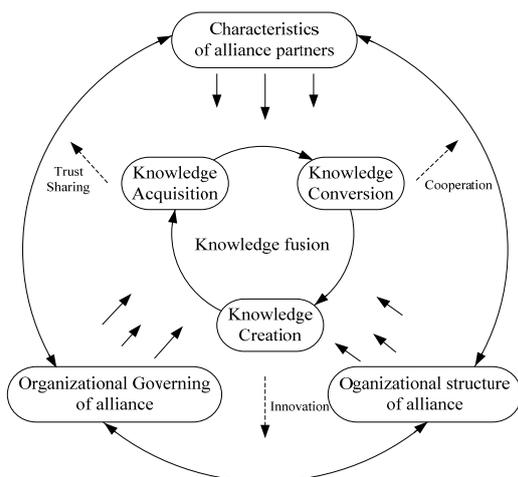


Figure 3: Innovation alliance features effect on knowledge fusion.

We believe that IT-based knowledge fusion from distributed databases and knowledge bases represents one of the most important streams in creativity and innovation that will gain greater importance as firms expand collaborative relationships in innovation alliances. In order to strengthen and promote knowledge fusion we offer some brief effectiveness mechanisms to solve the problems and challenges in practice (Table 1).

1. To expand the knowledge source network. Our framing drew largely from the strategy alliance perspective with the assumption that firms will form a cooperative bond and be willing and able to share knowledge through thoughtful use of IT. However, there are several other aspects that need to be emphasized in order to set a comprehensive research agenda.

Table 1: Effectiveness mechanisms for knowledge fusion.

	Prerequisites	Enablers	Results
Knowledge Source Network	Knowledge sharing and leveraging	<ul style="list-style-type: none"> ● Position ● Size ● Density 	Knowledge spread
Knowledge Fusion Process	Knowledge acquisition, conversion, creation, and application	<ul style="list-style-type: none"> ● Relationship ● Complementary ● Synergic 	Dynamic and continuous set of processes and practices
IT-based Knowledge Fusion Support System	IT infrastructures and elegant thinking	<ul style="list-style-type: none"> ● Brain ● Machine intelligence 	System quality, information quality, and usefulness
Management Initiatives	The role and impact of IT	<ul style="list-style-type: none"> ● Organization ● Control ● Feedback 	Virtuous circle of knowledge fusion and innovation

For instance, although innovation alliances offer opportunities for knowledge sharing and leveraging beyond the firm boundary, they also carry the risk of knowledge leakage to partner firms. Furthermore, of the two main types of knowledge, explicit and tacit, the latter is especially important due to its limited transferability because the tacit knowledge is acquired by and stored within individuals in highly specialized form. In order to solve these problems, it is necessary to expand the knowledge source network, which should not only focus on the knowledge bases but also build some efficient communication channels (e.g., expert systems, discussion forums, knowledge directories, and public innovation platform). For this proposes it is reasonable to reduce potential barriers in knowledge sharing between firms, explore the tacit knowledge transfer ways and means, increase intelligibility of knowledge representation for the users, and promote the spread of open knowledge sources.

2. To focus on the knowledge fusion process. While conceptually the idea of knowledge fusion is intuitive and simple, the process through which innovators can successfully implement it is likely to pose several challenges. How locate data and knowledge relevant to their current needs. The ability of knowledge acquisition which involves searching and retrieving from a wide array of knowledge is the prime condition. This process decides the quantity and quality of the available knowledge resources for knowledge conversion and creation. Regarding interdependencies, the ultimate goal of the knowledge fusion is to use the new knowledge in practice. One of the important implications of the framework is that knowledge fusion consists of a dynamic and continuous set of processes and practices embedded in individuals, as well as in groups and IT structures. So the process of knowledge fusion is not discrete and independent. Another implication of this framework

is that knowledge fusion processes of acquisition, conversion, creation, and application are essential to effective innovation. We contend that the application of IT can create an infrastructure and environment that contribute to knowledge fusion by actualizing, supporting, augmenting, and reinforcing the fusion processes.

3. To develop IT-based knowledge fusion support system. The knowledge fusion support systems heavily rely upon advanced IT infrastructures. Our analysis of the literature suggests that IT can lead to a great depth and breadth of knowledge fusion in organizations. Usually, the knowledge fusion system architecture includes the construction of meta-knowledge, calculation of fusion knowledge metric, knowledge fusion algorithm, and post processing for fusion knowledge, all of these function modules are depend on the IT tools and capabilities. As with most information systems, the success of knowledge fusion support system partially depends upon the extent of use, which itself may be tied to system quality, information quality, and usefulness. At the current stage the knowledge fusion patterns and algorithms are hot research topic in some specific area, but they are not enough to support the common knowledge fusion systems. Some future research is needed such as agent architectures, prototypes for knowledge sharing, virtual reality-based ontology, algorithms and cooperation models. Thus, building IT-based knowledge fusion support system needs comprehensive consideration of knowledge management and information systems.

4. To find the relationship between IT and knowledge fusion management initiatives. It is important to note that managing knowledge fusion in innovation alliances is an important issue and that the main challenge is primarily related to the role and impact of IT. We have discussed the potential role of IT relates to more extensive network and

communication channels, faster access to knowledge, just in time learning, and more rapid application of new knowledge. Meanwhile, we should clear that the actual knowledge fusion for problem solving only happens in the minds of humans. It is the manager's task to provide the technical and environment in which the innovators are inspired to be creative and feel free to communicate. Managers should realize that IT tools are used to support the human's creative work but the IT-based systems themselves are incapable of keeping pace with dynamic needs of knowledge fusion. So the most important consideration is to coordinate machine intelligence and human creativity when individuals or teams engage in a cooperative research and development project. This could create a virtuous circle of knowledge fusion and innovation.

5 CONCLUSIONS

In this paper, we have presented a discussion of knowledge fusion in innovation alliance based on a review, interpretation, and synthesis of a broad range of relevant literature. We also have highlighted IT-based knowledge fusion that is of increasing importance for firms that seek to be cooperative and innovative. With respect to innovation, innovators can be involved in multiple knowledge fusion process chains. In order to solve problems and make decisions, knowledge fusion can take place in human brains and intelligent machines with the help of IT. The patterns and algorithms are the core modules in the knowledge fusion model. Furthermore, we have given effectiveness mechanisms from four layers: knowledge source network, the process of knowledge fusion, IT-based knowledge fusion support system, and management initiatives.

Through this special issue, our goal is to seek effective ways to manage the IT-based knowledge fusion for innovation. As we summarize above, an outline of the knowledge fusion system have been described from the co-competitive perspective. The analysis also yields some conclusions that are potentially important for firm managers and alliance practitioners. They need to regard the choice of knowledge disclosure level and reduce the transaction costs in the process of knowledge acquisition. As the information technology entered a big data era, dynamics of competition and cooperation among firms continue to evolve, and IT-based infrastructures, devices, and software tools create opportunities for knowledge fusion. The ongoing work includes available knowledge resources,

advanced man-machine interactive, efficient knowledge fusion patterns and algorithms, consistent update knowledge database, and effective new knowledge evaluation.

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