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ABSTRACT

Faced with intense competition in the marketplace and aided by advances in information technology, firms are recognizing the importance of inter-firm cooperation and knowledge sharing. Previous research on this topic has implicitly assumed that firms will use the shared information in the same manner and has not examined the distinction between information sharing and information usage in the inter-firm context. We argue that shared information can be used for exploitative or explorative purposes or a combination of both. We draw on boundary management and coordination theory to examine how the digital capability of firms to represent and assess information across organizational boundaries and the allocation of decision rights affect information usage patterns during the course of inter-firm information processing. Our analysis of multiple case studies shows that inter-firm learning requires both effective digital boundary objects and proper decision rights allocation to facilitate its occurrence.

Keywords

Patterns of information usage, exploration, exploitation, coordination theory, case study

INTRODUCTION

Past research has examined the antecedents that may influence the sharing behaviors among partners (Patnayakuni et al. 2006; Straub et al. 2004), the different content of information shared in inter-firm supply networks (Seidmann and Sundararajan 1997; Uzzi and Lancaster 2003), and the business process capability and information system usage needed to appropriate value from information sharing (Clark and Stoddard 1996; Riggins and Mukhopadhyay 1994). Prior research has also quantified the benefits of inter-organizational information sharing under different situations through simulation (Disney and Towill 2003; Smaros et al. 2003; Waller et al. 1999). However, none of these studies has focused on the distinction between information sharing and information usage in the inter-organizational setting. As Rai et al. (2002) note, the relationship between information systems use and performance is important to investigate by focusing on patterns of use in specific contextual settings. Accordingly, we suggest that focusing on usage patterns in inter-firm process settings will enable us to understand differences in performance even when shared information is similar and supported by the same technology. Additionally, the increased level of inter-organizational information sharing fueled by B2B innovations makes it practically relevant to understand differential usage patterns of shared information in inter-organizational settings.

In this study, we attempt to address this question by challenging the implicit assumption of previous research: firms will use the shared information in the same manner. We argue that information can be used for exploitative purposes, explorative purposes, or a combination of both. In addition, we draw on boundary management and coordination theory to examine how the digital capability of firms to represent and assess information across organizational boundaries and the allocation of decision rights affect information usage patterns during the course of inter-organizational information processing. Specifically, we focus our investigation on the following research questions.

1) *What distinct information usage patterns are identifiable in inter-firm process contexts and how do these patterns relate to the characteristics of the inter-firm process boundary?*

2) *How are the properties of digital boundary objects and allocation of decision right for these different information usage patterns?*

This paper is structured into four sections. First, we construct our study lens in the next section. Then we present our research methods and the eleven cases that we examined to address our research questions. Our analysis of observations from these cases follows. Finally, we discuss the insights gained from our analysis in the conclusion section.

THEORY

Information Sharing vs. Information Usage

We define information sharing as the processes and activities that partners use to collect and distribute information through their inter-firm network, and information usage as the processes and activities of partners to manipulate and deploy the information for a specific purpose. This distinction is consistent with Zahra and George's (2002) conceptualization of absorptive capacity. They suggest that absorptive capacity is comprised of two subsets, *potential* and *realized* absorptive capacities. In the inter-organizational setting, information sharing generates potential absorptive capacity for network partners while information usage is the process to achieve realized absorptive capacity. Following Zahra and George (2002), we argue that information sharing and information usage have separate but complementary roles. For example, firms cannot possibly use information without their partners' permission to share it. Similarly, firms may have access to information from partners, but they might not have the capability to transform and deploy the information for maximum value. Therefore, information sharing does not necessarily imply effective information usage.

The following figure (Figure 1) depicts the theoretical framework we used to direct our analysis of the secondary case database that we assembled for our investigation. The factors are discussed in detail in the following section.
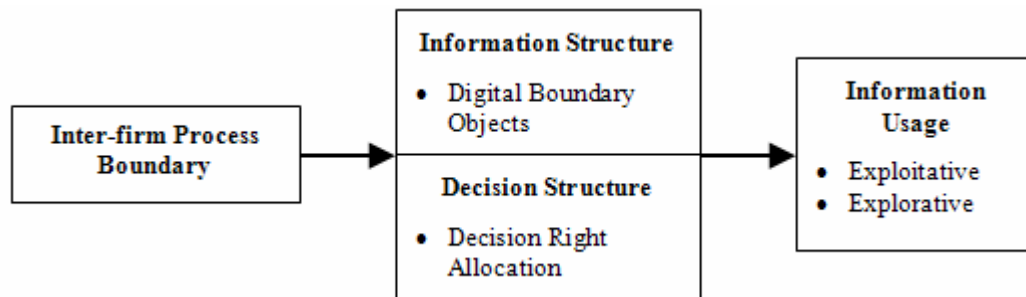

Figure 1: Theoretical Framework

Patterns of Information Usage

Information is data that have a particular meaning within a specific context (Haag et al. 2005), suggesting that different information can be produced through the same set of data in different contexts. In fact, different patterns of information production and usage reflect the types of learning activities that occur in organizations.

In his seminal work on organizational learning, March (1991) put forward two types of learning activities: exploitation and exploration. Following this distinction, we suggest that information shared among organizations can be used for two purposes: exploitative and explorative. Exploitative usage involves the application of information to streamline activities, perform them efficiently, and to achieve greater control over process execution. The outcomes from exploitative usage are usually clearly definable benefits, such as cost reduction and process consistency. In contrast, explorative usage involves the application of information to develop novel solutions to existing problems and to detect new opportunities. The immediate payoff from explorative usage is less certain but can influence a firm's performance in the long-run.

These two patterns of information usage can be illustrated by the way point-of-sale (POS) data is used in the vendor managed inventory (VMI) process. The increased visibility from information sharing allows suppliers to forecast demand more accurately, to remove redundant inventory from the supply chain, and thus to reduce the overall inventory management cost for the partners (Waller et al. 1999). This is an illustration of the exploitative use of information since it streamlines the inventory management process and improves process efficiency while maintaining a high customer service level (Lee and

Whang 2000). Meanwhile, the same POS data can also be used to discover shopping patterns of customers, and then to formulate and enact differentiated marketing strategies for product-market combinations, which is an explorative use of the data.

Boundary Management and Coordination Theory

An important issue for effective information usage in the inter-organizational setting is the coordination of processes and actions across firm boundaries. The establishment of an inter-firm link is viewed in the literature as managing dependencies among tasks and resources across ***inter-firm process boundaries*** by using proper coordination mechanisms (Crowston 1997; Cyert and March 1963). Since companies are constrained by their bounded rationality and must take actions without possessing all relevant information, there must be an ***information structure*** that determines how members perceive and communicate information, and there must also be a ***decision structure*** that determines how members decide what actions to take based on the information they can receive and make use of (Malone et al. 1987; Marschak and Radner 1972). Accordingly, distinctions in these two structures are expected to play a key role in the usage patterns of information that emerge.

Properties of Inter-firm Process Boundary Based on Relational Attributes

Information is created and used within certain contexts. Its localization and embeddness within a certain context make it sticky and thus problematic to transfer to other contexts (Carlile 2002; Szulanski 1996). A change in context then serves as a boundary for the transfer of information. It is important to describe the potential range of circumstances or the relative complexity at a given boundary since different coordination mechanisms are required for each type of boundary to ensure effective information usage.

To characterize the inter-firm process boundary, we draw on Carlile and Rebentisch (2003) who identify three relational properties of information at a boundary: *difference*, *dependence,* and *novelty*. *Difference* in information refers to a disparity in the amount of information accumulated and/or dissimilarity in the type of information accumulated between actors. *Dependency* is defined as information that is produced by one actor and then used by another. *Novelty*, the third property of information at a boundary, describes how new the circumstances are for each exchange. When novelty arises there is often a lack of common understanding to adequately share and assess domain-specific information at a boundary. As difference, dependency, and novelty between the sharing parties' information increase, the amount of effort required to adequately represent and assess information increases accordingly.

Information Structure: Digital Boundary Objects

By drawing on the literature on boundary objects, we suggest that firms have to establish digital boundary objects that enable communication across three distinct levels of communication complexity at inter-firm process boundaries: syntactic, semantic, and pragmatic (Figure 2). Star (1989, p.47) defines boundary objects as objects that work to establish a shared context, that "sit in the middle"). Specifically, three types of boundary objects are documented in the literature (Carlile 2002, Carlile 2004). "Shared syntax" for information transfer supplies a common reference point of data, measures, or labels, so the partners can have shared definitions and values for solving problems. "Shared meaning" for information translation or a mechanism "to reconcile discrepancies in meaning" (Nonaka and Takeuchi 1995) (p. 67) are needed to develop a common interpretation of information. "Shared process" for knowledge transformation provides an effective and concrete means for different groups to share their knowledge and to negotiate their conflicting interests.
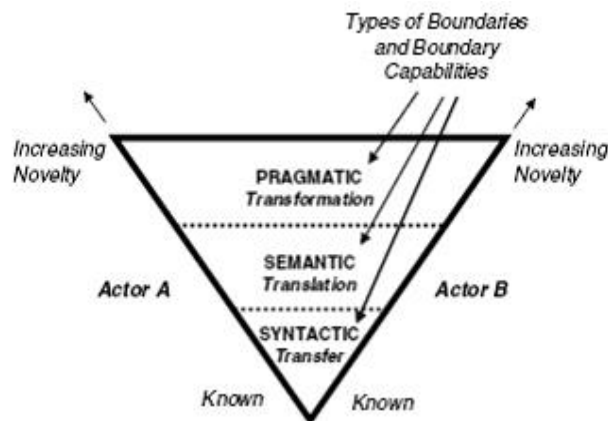

Figure2: 3-T Framework for Managing Information Across Boundaries

(Adapted from Carlile (2004))

Digital boundary objects are different from other inter-organizational IT infrastructures that build connectivity among partners. Their purpose is not only to move information across boundaries, but also to represent information so that it can be understood and utilized by recipients[1].

Decision Structure: Decision Rights Allocation

Organizations always face trade-offs between information cost and agency cost. Retaining all decision rights may be expensive and inefficient considering the cost incurred to obtain and analyze information. On the other hand, releasing decision-rights to others may lead to changes in bargaining power and may even create agency problems (Anand and Mendelson 1997; Clemons and Row 1993).

In many inter-organization processes, sharing information only provides the basic condition for performance improvements. The party making the decisions will determine how information can be transformed and exploited and how the learning results can be applied to improve performance. Learning is not linear, but cyclical. There is no learning without feedback, without knowledge of the results of action (Sterman 2002). People put what they have learned into practice and use the feedback from practice to adjust, or refine what they have learned (Levinthal and March 1993; March 1991). Therefore, decision rights allocation should impact the learning cycle and the usage pattens of information in inter-firm processes.

RESEARCH METHODS

Given that the relationship of digital boundary objects and decision rights to patterns of information usage is relatively uncharted, we use an explorative multiple case study (Yin, 1994) for our investigation.

Decades of research on organizational processes has generated a rich resource of case studies. We limited our case selection to supply networks in order to control for variation in context. We sent emails to five faculty members who are experts in the field of process management. After briefly stating the purpose of our study, we asked them to identify possible resources for cases examining these two processes. Based on their suggestions, the ABI/INFORM and Harvard Business School publishing (www.hbs.pub.edu) databases were chosen as two major sources for our cases.

Selection of Inter-organizational Processes

Two processes, vendor managed inventory (VMI) and new product development (NPD), were identified because of their popularity in contemporary inter-organizational cooperation. VMI is touted as a partnering initiative for improving multi-firm supply chain efficiency, while NPD process has been considered as a source of long-term competitive advantage (Wheelwright and Clark 1995). In addition, these two processes involve different boundary conditions, which provides us an opportunity to study how firms establish digital boundary objects and allocate decision rights for different information usage patterns. Table 1 lists the boundary conditions of these two processes.

	Vendor Managed Inventory	**New Produc Development**
Difference	Low	High
Dependence	High	High
Novelty	Low	High

Table 1: Boundary Conditions in VMI and NPD Processes

The information shared in VMI processes, such as demand data and inventory levels, is essentially product related. Since both parties have a clear idea of what products are flowing through them, the main difference is the specific method used by each company to record the stocks and flows of products. Additionally, since VMI is a repetitive process, the novelty of information across exchanges is comparatively low.

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[1] There are circumstances where information must be transformed or distorted so that it is not understood completely or at all, which are scenarios not examined here.

In contrast to VMI, the NPD process involves professionals from multiple fields with different experiences and backgrounds. Furthermore, because of the nature of the inter-organizational NPD process, it is common that both new personnel and new product characteristics are involved in a project. As a result, novel information across exchanges characterizes this process.

Given that all parties involved in both VMI and NPD need the information generated by others for effective collaboration, dependency is high in both cases.

Database Development

Cases were chosen according to the following rules: (1) the reported case study is related to either VMI or NPD processes; and (2) it is concerned with these processes in a supply network context where at least two firms are involved in the process. The following table lists the cases selected and their source(s). If a case appeared in more than one source, all sources were checked in order to cross-validate the content. Table 2 presents basic information about the cases selected.

	Focal Company	Partner	Industry	Source
VMI	VF Corp.	ShopKo, Wal-Mart, Bradlees and Ames Department Stores	Apparel manufacturer	DSN Retailing Today Stores
	Johnson Control	Climatic Control	HVAC manufacturer	Supply House Times
	Marmon/Keystone	Suppliers that provide 20% of the items which represent 80% of MK's business	Pipe and tubing distributor	Metal Center News
	Northwestern Steel & Wire Co.	Four service center customers already on EDI became the initial participants.	Steel manufacturer (structural products)	Metal Center News Iron Age New Steel
	Campbell Soup	First with HEB, then expanded to other retailers	Food producer	HBS Case
	Barilla SpA	Big distributors, such as Marconi	Food (Pasta producer)	HBS Case
NPD	Cannon	Some ten suppliers, labeled "co-developers"	Optical instrument manufacturer	Journal of Product Innovation Management
	NedCar Product Design & Engineering	Suppliers that have nearly ten-year relationship with NedCar	Car designer and manufacturer	Technovation
	Swedish Auto	Five suppliers	Auto manufacturer	Journal of Engineering and Technology Management
	Red Spot Paint and Varnish	Ford	Auto paints and coatings provider	Journal of Product Innovation Management
	MedSource Technologies	Exacta	Medical device manufacturing and engineering service provider	HBS Case

Table 2: Summary of Selected Cases

After selecting the cases that matched the guidelines above, one researcher carefully read each and recorded the relevant observations and dialogues based on the concepts discussed in the theory section. Then the other researcher examined the observations independently for triangulation. Discrepancies were identified and discussed. This iterative process continued until consensus was reached for each observation. We recorded 104 observations related to information usage patterns, digital boundary objects and decision rights allocation. The results of our analysis are reported below.

ANALYSIS

Vendor Management Inventory

Patterns of information usage

Most of the companies (4 out of 6) use the information in an exploitative way, e.g., timely and accurate channel usage, better forecasting that facilitates manufacturing efficiencies, improved customer service levels, and reduced transactional costs.

> *…a 24-month distributor sales history is collected. This is used to calculate demand curves, seasonality of products and trends. (Johnson Control)*

> *Upon identifying any discrepancy between models and stores' on-hand/on-order counts per SKU, the system calculates a proposed order and compares it against pre-set shipping minimums in the data warehouse. (VF Corp.)*

However, we also noticed some explorative usage of information. VF Corp. developed a module to track and analyze consumer data provided by retailers "based on such variables as lifestyle, household income and market, eventually dividing retailers' outlets into clusters of units whose consumers share similar brand requirements and tastes." This explorative use of information allows VF Corp. to differentiate its marketing strategy for each cluster. VF also extended the benefits of information sharing to its retailers by providing them "recommendations for effective allocation of retail space". Campell Soup also took the opportunity of VMI implementation to expand its relationship with customers and to explore further opportunities to improve channel operations.

Digital boundary objects

Information flowing through the VMI process was consistent across the six cases analyzed. Scanned POS transaction data, product shipments out of the warehouse, inventory level information, sales data, and sometimes downstream customers' demand forecasts were the major types of information transferred across the organizational boundary.

As a Johnson Control employee mentioned, one difference in the shared information is that the downstream customer often uses different systems from the upstream provider to record the products. Hence, one of the most important but time-consuming steps in the VMI process is product data synchronization, or part number matching. Once the two parties have built a common language, or shared syntax for information transfer, the sharing and analyzing process usually will be automated by an in-house-developed or off-the-shelf system. Five out of the six cases examined explicitly mentioned employing electronic data inter-change (EDI) for data transfer.

Focal companies also developed digital capabilities to interpret and manage information as well as to sell their concept. VF used a four-module system to analyze POS transaction data, demographic consumer data and physical store layout for sales planning, outlets clustering and in-store planning.

Decision rights allocation

The name VMI indicates that the right to decide order quantity and shipping schedule should be transferred from downstream customers to upstream providers. But in reality, co-managed inventory seems to be a more proper name for this kind of cooperation. More than one case reported the unwillingness of downstream customers to participate in the VMI program since the transfer of decision rights made them feel that they would lose control of their own inventory and give the upstream provider "the power to push their products into our warehouses." (Brarilla SpA) This is usually caused by retailers' fear of loss of power, as well as their lack of understanding of this process.

> *"Managing stock is my job; I don't need you to see my warehouse or my figures."*

> *"What makes you think that you could manage my inventories any better than I can?"*

To mitigate the fear of downstream customers and to make them feel comfortable, focal companies have to let downstream customers retain part of the decision rights on inventory replenishment.

> *"Shipments are made on a schedule determined by the distributor daily, weekly, monthly, be weight or by dollar amount... ...We want distributors to understand that they still have control over their own inventory." (Johnson Control)*

This concern exists even in the VMI programs initiated by downstream customers. Though Marmon/Keystone allows certain suppliers to manage its inventory after making sure that the selected suppliers understand its way to do inventory, it retains the option of vetoing an order.

New Product Development

Patterns of information usage

Most of the cases show the NPD process as an opportunity for mutual learning. Cannon involved suppliers at an earlier stage of product design. The specialized production knowledge brought in by suppliers helped Cannon designers to find easy-to-produce design alternatives.

> *"We studied the technology together, which was advantageous for all of us. The key suppliers could acquire more knowledge on our FLC technology and its development and we could build know-how within specialized production technology." (Canon)*

Red Spot took the chance of Ford changing its coating material to expand its production design and manufacturing capabilities, and gained competitive advantage in the new coating market.

However, not all NPD efforts are explorative. NedCar includes suppliers in its NPD in a rather exploitative way. It adopted the strategy of modular design. Suppliers are required to design the subsystems outsourced by NedCar. This has greatly shortened the design life cycle of NPD and helped to bring the product to market quicker. But NedCar also expressed the concern that heavy outsourcing may cause the loss of sufficiently detailed knowledge of subsystem design which would impede communication and reduce their bargaining power in the long run.

Digital boundary objects

Information transferred in the process of NPD is rather hard to codify and transfer because of its diversity. The boundary objects involved here are mainly semantic and political.

Prototype and design software are widely employed in these cases. The mis-alignment of software development applications will impede the transfer of knowledge. NedCar reports that the different focus of computer aided design (CAD) software and computer aided manufacturing (CAM) made it difficult for designers and production engineers to exchange information.

Many companies use on-site engineers, engineer rotation, or a joint project team to open communication channels between partners.

> *Engineers are encouraged to start to work at a supplier on a temporary or even permanent basis. In this way, the supplier builds design knowledge and experience. In addition, the engineer will build knowledge on the culture and way of working of the client thus enabling the building of a strong relationship. (NedCar)*

Decision rights allocation

Decision rights are shared among the participants in most cases. Though some manufacturers want to retain the final decision right, as in the case of Cannon and Ford, the suppliers still can influence the product specification and design alternatives by participating in the design process and providing their specialized production knowledge.

> *The company was invited to participate in data sharing and information development in this area so it could aid in developing product specifications and learn about the technology. (Red Spot)*

A clear split in design and manufacturing decision rights may reduce or even eliminate the benefit of cooperation, as in the case of MedSource. Exacta retained full control of product design and specification and made changes rather freely. This caused problems for MedSource since some of the changes were hard, if not impossible, to manufacture. The splitting of decision rights led to a delayed initial shelf stock and unsatisfied cooperation.

DISCUSSION

Table 3 summarizes the constructs for each process and provides for a comparison between them across these processes. The dominant pattern of information usage in the VMI process is exploitative (e.g., to realize operational efficiency, such as decreased lead times, increased customer service level, improved forecast accuracy, and transactional cost savings). The information that flows through this sharing process is mainly explicit and easy to codify. To cope with this exploitative task,

firms develop their digital capability to establish "shared syntax" and "shared meaning" for their information transfer and translation. Most of the work of transfer and translation can be conducted by packaged or in-house developed software.

Constructs	VMI	NPD
Patterns of Information usage	Mostly exploitation. Exploration will increase the benefit.	Mostly joint exploration. Completely outsourcing the project may lead to undesirable results.
Inter-firm Process Boundary	Low difference and low novelty, but high dependence	High difference, high dependence, and high novelty
Digital Boundary Objects	Syntax and simulation models are the main digital boundary objects involved. Intense communication at the beginning of project. After the establishment of syntax and systems, information is transferred and analyzed automatically.	Prototype and on-site engineers. Intense exchange of information throughout the whole process. Joint project team is built to keep both parties working together.
Decision Right Allocation	More efficient if concentrated on the vendor. Joint decision making also works, but more coordination may be involved to achieve effective.	Completely split decision rights may inhibit inter-organizational learning. More beneficial if both parties have a voice there.

Table 3: Comparison between VMI and NPD

The experience of Barilla SpA, a pasta manufacturer, shows that VMI cannot work properly without the transfer of decision rights for replenishment from the distributors to the manufacturer. The joint decision rights in the case of Johnson Control required a lot of coordination work to get the system to function. All the cases show that transfer of decision rights is critical for effective information usage in the VMI process. Joint decision rights can still lead to inter-organizational learning, but these structures are evidently less efficient.

In the NPD process where most information usage is explorative, IT was not identified as playing a dominant role. Face-to-face communication and personal contact serve as the major means to translate or even transform the information received to accommodate the special requirements of each project. For most cases involving the NPD process, joint decision making may be more beneficial for enabling both parties to learn from each other. But the focal company may play a bigger role in the process of product design while suppliers have a dominant voice in the manufacturing phase. However, a clear-cut decision rights transfer can cause companies trouble as in the case of MedSource.

CONCLUSION

Since information is key to the performance of organizations, attention to the processes of inter-organizational learning has increased. Although a lot of research has been done on this emerging field, one central question yet unanswered is "just how does it happen?" (Ingram 2002)

In this paper, we attempt to address this question in an explorative way. Inter-organizational cooperation is one--sometimes the only--method for firms to get access to the proprietary information of other firms. How firms make use of this shared information requires inter-organizational learning. Our analysis of 11 cases detailing VMI and NPD processes shows that learning needs both effective digital boundary objects to digest the shared information and proper decision right allocation to facilitate its occurrence. Towards this end, development of digital boundary objects platforms can be considered as a relationship-specific asset which will help the focal company to integrate with partners to generate profits through relational rents (Subramani 2004). Additionally, transfer of decision rights requires a high level of trust which is essential for inter-organizational learning (Dyer and Nobeoka 2000).

In summary, this study contributes to academic research and to practitioner concerns. Theoretically, we show that digital boundary objects and decision rights allocation shape distinct information usage patterns in inter-firm processes, and that the types of boundary objects and decision structures should be informed by attributes of the process boundary. For practitioners, this research provides an approach to evaluating

the digital boundary objects and decision allocation structures and how these practices may be constraining usage of shared information in inter-firm processes.

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