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Implementation of Information Systems Infrastructure for Supply Chain Visibility

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IMPLEMENTATION OF INFORMATION SYSTEMS INFRASTRUCTURES FOR SUPPLY CHAIN VISIBILITY

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ABSTRACT

Despite the considerable recognition of the importance of and the need for supply chain visibility, organizations experience difficulties in actually achieving such visibility. This may be attributed to two major reasons. First, organizations adopt different types of information technologies such as electronic data interchange or business-to-business for supply chain activities, which cannot communicate with each other without the adoption of many common "standards" for data representation and transmission. Second, organizations may have initially adopted supply chain information systems for different reasons such as mandates and may have engaged in selective "automation" of communication with its partners. Consequently, information systems within supply chain networks are "isolated" and organizations lose supply chain visibility. This study examines the implementation of supply chain management information systems at real-world organizations for achieving supply chain visibility. The findings of this study will be useful to organizations as they strive to implement solutions for supply chain visibility.

Keywords

Supply chain, information systems, visibility, adoption, and implementation

INTRODUCTION

Supply chain visibility has been and continues to be a major concern for organizations (Bradley 2002; McCrea 2005; Francis 2008). Although supply chain visibility has been defined and interpreted in different ways in research and practice, there is a general consensus that supply chain visibility is "the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events" (Francis 2008).

While there is some recognition of what constitutes supply chain visibility and the medium for achieving supply chain visibility, organizations generally struggle to actually realize supply chain visibility in their operations. This is demonstrated by industry surveys by Aberdeen Group and Computer Sciences Corporation in which organizations report supply chain visibility as one of the top priorities for their operations.

This paper identifies the information systems issues that impede supply chain visibility and also illustrates ways in which organizations may design and implement their information systems solutions through case studies of real-world organizations. The lessons learned from these real-world cases would be useful for organizational managers looking for visibility in their supply chain operations and as they design and implement information systems solutions for supply chain operations.

EXTANT RESEARCH ON SUPPLY CHAIN VISIBILITY

Organizations typically participate in multiple supply chains – each chain made up of suppliers from multiple tiers offering raw materials and customers buying finished products – forming a *network of supply chain relationships* among their various partners (Jeyaraj and Sethi 2009; Lambert, Cooper and Pagh 1998). The network includes the focal organization, its direct partners (i.e. Tier I supply-side organizations and demand-side reseller organizations), and its indirect partners (i.e., partners of the direct partners, essentially Tier II supply-side organizations and demand-side customer organizations), and the ties between focal organizations and its direct and indirect partners. This suggests that supply chain visibility is to be understood from the perspective of the various linkages that make up the network of supply chain relationships (Lambert et al. 1998).

Supply chain visibility has been used interchangeably with the concept of information sharing (Swaminathan and Tayur 2003). Prior research has paid considerable attention to the concept of "information sharing" in the context of supply chains (e.g., Moberg et al. 2002). Arguing that information technologies enable greater information sharing, prior research has

generally assumed that the adoption of information technologies by organizations can positively impact information sharing to the extent that organizations can derive benefits. Such benefits included quick response, efficient customer service, and data sharing (e.g., Aviv 2001).

An alternative approach has recognized that supply chain visibility goes beyond simple information sharing between organizations involved in supply chain relationships. For instance, prior research has recognized various mechanisms for supply chain visibility such as vendor managed inventory; collaborative forecasting and replenishment; and collaborative planning, forecasting, and replenishment (Waller, Johnson and Davis 1999; Raghunathan 1999; Aviv 2001). Supply chain visibility has been known to yield improvements in responsiveness, forecasting capabilities, and replenishment capabilities (Armistead and Mapes 1993).

Prior research has also argued that information sharing is an activity whereas supply chain visibility is an outcome of the information sharing activity (Barratt and Oke 2007). This particular view recognized the ability of organizations to achieve supply chain visibility through the sharing of useful and meaningful information (e.g., Mason-Jones and Towill 1998). There is recognition that mere information sharing and the availability of infrastructure mechanisms for information sharing are not sufficient conditions for achieving supply chain visibility.

Regardless of the conceptualizations of supply chain visibility, there seems to be a general assumption in prior research that the information systems used in supply chains are robust, compatible, and interconnected. This can be a severe limitation in understanding supply chain visibility since the information technology infrastructures and solutions come in various configurations, possess different capabilities, and deployed quite distinctively by organizations in the supply chain. This study examines the information systems that support supply chain operations and how they impact supply chain visibility.

INFORMATION SYSTEMS IN SUPPLY CHAIN NETWORKS

Organizations may have implemented various types of supply chain information technologies that possess different capabilities and require different organizational routines. Such technologies include electronic data interchange (EDI), inter-organizational systems (IOS), and business-to-business (B2B) systems (Son and Benbasat 2007; Iskander et al. 2001; Grover and Saeed 2007). These systems possess unique capabilities (e.g., real-time vs. batch data sharing and transfer) and make use of different types of infrastructures (e.g. web vs. non-web networks). Consequently, information systems for supply chain activities at an organization and its partner may not be compatible with each other. The organizations may be able to overcome such compatibility problems between their information systems by adopting "standards" (for data representation and transmission). This is not a particularly straightforward activity as it depends on the number of partners and the number of different information systems at the various partners.

Furthermore, organizations may have adopted supply chain information technologies due to a variety of reasons such as mandates, capabilities, efficiencies, or bandwagons (Jeyaraj et al. 2006). While these reasons may not have been the sole contributors, such different reasons would have contributed to organizations doing one of the following: a) no automation with certain partners, b) one-way automation (i.e., either automatic upload or download of data, but not both) with certain partners, and c) two-way automation with certain partners. The effect of such different levels of automation is that organizations face "gaps" since not all partners have adopted or implemented supply chain information systems for the same reasons.

These two related issues – data representation or transmission standards and level of automation – quite extensively impede supply chain visibility for organizations. Without data representation or transmission standards, supply chain information systems at an organization and its partners become "isolated" and hence the organization is not privy to events at its partners and vice versa. Without automation or with only partial levels of automation, supply chain information systems at an organization and its partners would still be "isolated" resulting in problems with supply chain visibility.

These have important implications for organizations aiming to achieve supply chain visibility through the design and implementation of supply chain information systems. First, organizations need to understand the specific capabilities and infrastructures that are required for automating the link between their own information systems and their partners' information systems. Second, organizations need to appreciate the specific ways in which they can actually alter their current capabilities and information systems to achieve supply chain visibility. This next section describes a real-world organization and how it strives to achieve supply chain visibility.

CASE STUDY

MFG-CO is a manufacturing company headquartered in a suburban region of Midwestern United States and has been in operation for more than 100 years. It manufactures a variety of custom products such as hoods, fenders, security cabinets, and

safes. The company also offers services such as metal fabrication, prototyping, and compressed lead time manufacturing. The production floor is located on a large facility (greater than 100,000 square foot) which is divided into different work centers such as fabrication, manufacturing, and prototyping.

MFG-CO uses an enterprise resource planning (ERP) system for maintaining data on its internal operations, including the production floor. The ERP system, Syteline, has been implemented with its full range of capabilities such that MFG-CO can track even the work-in-process inventory as they move through the various cells. To facilitate the most accurate data on current inventory, MFG-CO has installed wireless-enabled data capturing devices at vantage points all over the production floor, and has instituted processes whereby the production workers necessarily use the wireless devices to transmit the status of inventory at various cells to the Syteline software.

MFG-CO deals with more than 100 supplier organizations for its raw materials necessary for its production operations. Since these suppliers are typically small to medium sized enterprises, they typically do not have sophisticated information systems, such as ERP, for their internal operations. Hence, MFG-CO generally communicates its requirements for raw materials to suppliers via traditional channels such as the telephone, fax, or electronic mail.

MFG-CO sells its products and services to more than ten customer organizations. These customers include small, medium, and large organizations and a handful of them account for a vast majority of the volume of transactions. MFG-CO uses different methods to communicate data with its customer organizations. These include traditional channels such as the telephone, fax, and electronic mail for most of its customers and information technology (IT) channels for its major customers. The IT channels are generally based on EDI solutions implemented in different ways depending on the customer.

The major customers of MFG-CO are CUST-A, CUST-B, and CUST-C, and require MFG-CO to adopt different mechanisms of data transfer. While all of these interactions are based on EDI, the mechanisms are distinctly unique. CUST-A has its own EDI standard and requires MFG-CO's data communications to be automated. Thus, MFG-CO has to prepare documents consistent with the EDI standard prescribed by CUST-A. CUST-B and CUST-C also have their own EDI standards; however, they do not require automated data communications from MFG-CO. Thus, MFG-CO has some flexibility over the data communication mechanisms.

MFG-CO thus faced severe problems with supply chain visibility. Not only was its communication and data sharing on the procurement side totally non-automated (and required MFG-CO to spend considerable amount of time and labor in keeping up with its suppliers), the communication and data sharing on the demand side was a mixture of no automation, partial automation, and full automation depending on its customers (which also required MFG-CO to expend considerable time and resources in managing different infrastructures and keeping up with its customers).

MFG-CO's data communications with CUST-A, CUST-B, and CUST-C were based on a combination of different techniques. These included data files transmitted via electronic mail, data files shared using FTP (file transfer protocol), or data embedded in electronic mail communications. Following these, MFG-CO obtained hardcopies of the data files, which were then processed by its personnel — which included verification of the data, manual entry of the data into its ERP system, etc. This process was very time consuming (sometimes lasting three days) and prone to errors in data entry, resulting in considerable expenses in labor, losses in productivity, and lags in turnaround time to customers.

To address these problems, MFG-CO initially enlisted the help of VNDR-CO for achieving supply chain visibility. VNDR-CO offered two different SCM solutions: SCM-IT and SCM-NET.

- SCM-IT is a translator that can interface with a variety of internal IT systems maintained by organizations. It manages the transmission and receipt of business data between organizations. SCM-IT enables the separation of business data from the IT system such that organizations can migrate to newer IT systems without disruption. The business data is recast into the SCM-IT standard such that it can be transmitted to and received from organizations independent of their internal IT systems. SCM-IT is currently capable of interfacing with several ERP (enterprise resource planning) systems including Intuitive, Stelplan, EStelplan, SyteLine, Made 2 Manage, and QAD.
- SCM-NET is VNDR-CO's own data transmission network which allows organizations to communicate with each other. It transfers the business data between organizations. While SCM-NET is capable of transmitting data in any format, it is optimized for the SCM-IT standard. SCM-NET offers 128-byte encryption technologies that protect business data during transmission. The service also includes several customer-oriented functions such as message archiving, tracing, managing data and access, etc. SCM-NET is an array of sophisticated servers that are typically commissioned on demand depending upon required capacity, thus providing a cost-effective data transmission alternative to organizations.

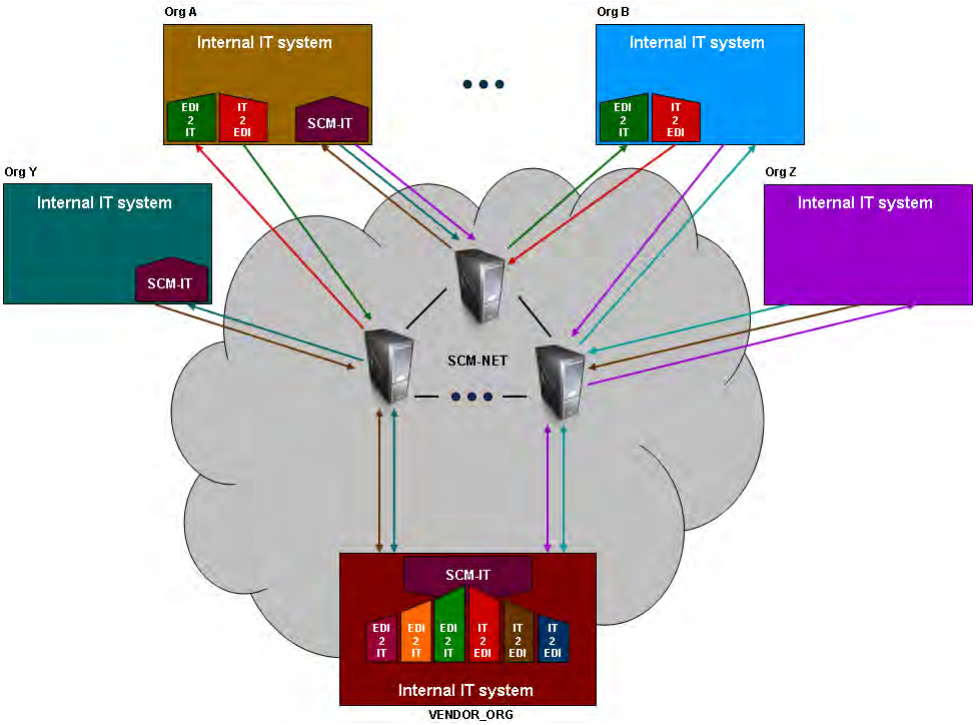

Figure 1. Supply chain information technology infrastructure

VNDR-CO presented several options to MFG-CO for supply chain operations as explained below based on Figure 1: Organizations (e.g. OrgA and OrgB) may choose to follow their own data standards but conduct the transmission through SCM-NET. Organizations (e.g. OrgA and OrgY) may choose to follow the SCM-IT data standard and conduct the transmission through SCM-NET. A SCM-IT-enabled organization (e.g. OrgY) may choose to communicate with another non-SCM-IT-enabled organization (e.g. OrgZ) through SCM-NET. Organization (e.g. OrgB and OrgZ) may choose to communicate with each other through SCM-NET without relying on any standard. Thus, MFG-CO had the option of using one or both SCM solutions.

Depending on the specific requirements of its major customers, MFG-CO requested VNDR-CO for two different interfaces. For outbound data to CUST-A, VNDR-CO customized its SCM-IT technology to interface with MFG-CO's Syteline system and translated the relevant ERP data into CUST-A's EDI standard. VNDR-CO then transmitted the CUST-A-compliant documents through SCM-NET. For inbound data from CUST-A, VNDR-CO's SCM-IT system automatically translated CUST-A data into Syteline-compliant data. For CUST-B, VNDR-CO's interface involved only the SCM-NET solution, which was used to transmit and receive data, since there was no requirement to fully automate data transfer. CUST-C instituted EDI recently and hence MFG-CO has not yet employed SCM solutions by VNDR-CO for engaging in EDI data transmission.

MFG-CO now has immediate access to information from CUST-A and complete visibility of that particular link. The SCM-IT and SCM-NET solutions from VNDR-CO allowed for near real-time sharing and availability of information to MFG-CO's SyteLine system. Further, the SCM-IT and SCM-NET solutions were configured for automatic data refreshes such that MFG-CO did not have to wait for data or to engage in manual capture and translation as it did before.

MFG-CO has also experienced significant improvements in its supply chain operations. First, the manual entry of CUST-A data into MFG-CO's Syteline system and related processing for data verification has been minimized to a great extent. In rare cases where the transmitted data is not consistent with expectations or deemed to contain errors, MFG-CO's personnel will engage in verification and manual data entry. However, the time involved in this process is now closer to three hours rather than three days in the early years. This has also yielded labor savings and improvements in turnaround time to customers. Second, due to the elimination of work related to the development and maintenance of the various EDI translation maps, MFG-CO is able to more efficiently allocate its personnel to other important activities within the organization that need more

attention. This also allows MFG-CO to operate with a small IT department. Finally, MFG-CO has the flexibility of maximizing and benefiting from its current capabilities by selectively extending or expanding its relationships to other partners on the supply chain.

CONCLUSION

This paper identified the potential problems for organizations when striving to achieve supply chain visibility and described the ways in which a real-world organization has implemented information systems infrastructures towards that seemingly elusive goal. While recognizing that multiple sites need to be examined before these findings can be generalized, this paper provides initial evidence of how organizations may begin to plan for and achieve supply chain visibility. The case reveals that organizations may need to manage a portfolio of information technology infrastructures to achieve supply chain visibility.

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