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The growth in electronic commerce has brought into focus the critical role of inter-organizational systems (IOS) in facilitating various aspects of business transactions between two companies. In the operations and logistics field, supply chain management (SCM) has been touted as one of the major strategies to improve organizational performance and generate competitive advantage. Although IOS are extensively used to facilitate SCM, very few papers have examined the inter-linkages between the two topics. Research has focused on the flow of material and information independently. In this paper we propose to integrate the two concepts, SCM and IOS, and identify management issues related to implementation of an electronic supply chain that integrates traditional supply chain with IOS.

Supply Chain Management

Supply chain management encompasses many activities, but for the purposes of this study will be defined as follows:
"Supply chain management is the integration of all activities associated with the flow and transformation of goods from new materials, through to the end user, as well as associated information flows, through improved supply-chain relationships to achieve a sustainable competitive advantage" (Handfeld and Nichols, 1998).

This definition clearly identifies the two major flow components of supply chain - flow of materials and information along the chain. A supply chain is a series of inter-linked suppliers and customers that takes a basic raw material at one end and delivers a finished product to the ultimate end-user at the other end. The supply chain can be decomposed into many levels. We could have a single level supply chain that just includes the focal firm's immediate set of suppliers and customers, or you could go down *n* levels to include the raw material supplier on one end and the disposal of used finished product at the other end. Supply chain becomes sufficiently complex beyond 2 levels as it is not a simple linear chain, but a complex web of chains, as each firm in the chain has many supply chains with their many suppliers and customers.

There are three components flowing through the supply chain - goods and services in one direction, payments in the other direction, and information in both directions. The transportation carriers and logistics firms are used for movement of goods, banks and financial institutions are used for movement of cash. Information flow can occur between the entities directly or through a third party industry-wide IOS (e.g.: airline reservation system). Typically, a simple supply chain includes the suppliers, customers, logistics carriers, and financial institutions. The recent growth in IOS has enabled the electronic flow of information among the partners of the supply chain. This has brought in new opportunities as well as challenges to the management of the supply chain.

Inter-organizational systems

IOS are application systems that link various partners in the chain using a communications infrastructure. These systems provide the ability for computer-to-computer communication of business transactions and documents. There are three levels of sophistication in IOS - communication, coordination, and cooperation (Kalakota and Whinston, 1996). At the simplest level IOS can be used for electronic *communication* of messages between trading partners. This provides the ability to substitute paper, phone or fax modes with computer communication. These messages may or may not be integrated with the rest of the information systems (IS) in the organization. The second level is *coordination*, where the communication is integrated with the internal IS. An order from a customer is automatically entered, after routine validation into the order processing and production planning system of the organization. There is active coordination between the partners in the areas of production planning, delivery schedule, and logistics coordination. The last level of sophistication is *cooperation* where the two business partners share common goals and use similar performance measures to evaluate their IOS activities. For example, a distributor can share customer information with their partners to support cross selling of some products or develop joint promotional campaigns. IT plays a critical role in many of these cooperative ventures.

Electronic integration among partners opens up a wide range of business opportunities. However, not all of them are easily implementable. Most of the discussions on supply chain and IOS are based on the premise that information will be freely shared among the partners, but the reality is otherwise. The question of how much information can be shared is not a technology question but a business question. Businesses thrive and make money on information asymmetry. Therefore, there are strong disincentives to share information.

Uncertainty, Information Asymmetry and Role of IOS

Organizations often have twin objectives - (i) reduce their environmental uncertainty by obtaining as much information as possible, (ii) increase information asymmetry to gain maximum benefits from interaction with their partners. While all firms in the supply chain want to reduce their uncertainty, it may be at the expense of others in the supply chain. For example, the buyers may be waiting for a sale to buy in bulk rather than provide advance information of their requirements. Some businesses are built on brokering the information among the participating units. Hence, reducing information asymmetry in the supply chain, while ideally optimal, may be threatening the business of these brokers.

Uncertainty can be defined as "the difference in the amount of information required to perform the task and the information already possessed by the organization," (Galbraith, 1971). Daft and Lengel (1992), identified two different forms of uncertainty - (a) uncertainty due to lack of knowledge regarding occurrence of events, and (b) uncertainty due to not knowing how to respond to an event when it occurs. In an open system it is very difficult to completely eliminate uncertainty since information on orders from customers are random events and there is uncertainty related to supplies from the firm's vendors. The firm absorbs the external uncertainty by designing forecasting systems to better predict external events. It also adds some slack in internal design such as excess inventory (safety stock) or excess processing capacity or longer lead-time to deal with external uncertainty.

Firms also experience uncertainty in its internal sub-units. Internal uncertainty among the sub-units is influenced by two factors - (a) how the external uncertainty is distributed among the internal sub-units and (b) uncertainty created by its internal operations and information flow. The level of information sharing among the sub-units influences the uncertainty experienced by the sub-units. Information systems that facilitate the free flow of information within and outside the firm are used to reduce uncertainty. However, organizational realities make it a challenging task to develop an integrated system that reduces uncertainty.

Integrated System - Is it Feasible?

The concept of an integrated system linking information from order processing, inventory control, production planning, warehousing and accounting has been a dream for IS professionals for more than 3 decades. If information is power, and information asymmetry between sub-units provides better opportunities and negotiation capabilities, then there is going to be reluctance to share information. While information asymmetry may cause greater uncertainty among the partners it also provides the ability for one to exploit that uncertainty. Hence, even if it is technically feasible to integrate systems and share information, organizationally it may not be feasible since it may cause major upheavals in the power structure. Despite these predictions, IS designers have been slowly increasing the level of sharing of information in an organization. If the process of opening up the information flow within the organization is a difficult task it is going to be even more difficult across organizations that have widely different business objectives, different stakeholders, and servicing multiple business partners. It is going to require a very high level of trust among the partners. There are many management issues related to development of IOS and integration with the supply chain.

Management Issues

The focus of both SCM and IOS are external to the organization and therefore brings in many issues that are outside the control of senior management. The successful implementation of IOS requires the cooperation of a large number of external trading partners. It is also a complex technical endeavor, as we have to link widely diverse and technically incompatible systems.

Commonality of Business Objectives: IOS are built on the premise that all firms in the supply chain gain from sharing of information as it helps to improve the efficiency of the entire chain. However, the benefits from sharing information may be more for some than for others. The free flow of information may even be a threat to the business of some of the intermediaries as their existence may be solely based on being an information agent or a buffering agent to overcome uncertainty. For example, if information from the retailer to the manufacturer is instantaneous, the existence of a distributor may be in jeopardy, as its primary role is to act as an information broker between the two or as a warehouser, stocking inventory to buffer for uncertainty and demand variation. Goal congruence between two business partners, intent on maximizing their business goals, is a difficult task, especially considering the fact that the firm participates in multiple dyads, both in the upstream and downstream end.

Alignment with Business Strategies: It is not sufficient to design and build a technically sophisticated extranet, if business and marketing strategies are not formulated to complement and support these systems. For example, if a firm wants to design an IOS that establishes a long-term relationship with its supplier, it needs to provide the supplier advance information of its requirements and perhaps even let the supplier monitor its inventory and replenish it as and when necessary. A key component for the success of this system is the mutual agreement and trust that the supplier will supply at a certain price and the

firm will not resort to buying it in bulk during sales promotions in alternative channels. Hence, for SCM/IOS initiatives to succeed there needs to be an alignment of business strategies, and commitment among trading partners for long-term business cooperation.

Internal Systems and Performance Measures: It is not only important for a firm to align its business strategies, but also look inward and redesign internal systems and performance measures to ensure the success of these systems. The organizational structure and internal systems have to be modified to reflect the new buying arrangements. The automation of some of the buying activities may entail relocation of the buying personnel or redesign of jobs. Resistance to such changes is inevitable in implementing these systems.

Technology Infrastructure Issues: The applications and communications architecture, the two pillars of IT infrastructure, needs to provide a strong foundation for growth of IOS. The applications architecture provides a blueprint of the various applications in IOS and the supporting infrastructure. The communications architecture defines the network infrastructure to support these applications. The major issues that need to be addressed in developing the applications architecture are:

What will be the technology choice?
What will be the client-server architecture?
What will be the nature of linkage?

The *technology choices* available are EDI, proprietary application software, simple web-based system, XML, or a combination of these. Some of the factors to be considered in the selection of a technology are the level of sophistication required, technology trends and commercial availability of the technology, technical expertise of the firm and its partners, partners' preferred technology, type of linkage (one to one, one to many) and resource availability. The *client server architecture* provides the blueprint for applications development. A firm has to decide on the front-end and back-end system and the different tiers in the middleware to integrate the two systems. The *nature of system linkage* between the partners can be defined along three dimensions - access mode, access type and update mode. *Access mode* could be message-based or interactive. The user interface could be proprietary, web-based, or a combination of both. *Access type* describes the operations the users are allowed on the system - only query, or query and update of information. The access type is to some extent dependent on the firm's level of trust on its partners. Firms have to assess the level of risk exposure from providing external access. *Update mode* specifies the frequency of update of back-end system with the transaction data from IOS - whether it is batch mode or real time mode.

The communications architecture is dependent on a variety of other factors including the partners' preferred mode of communication, cost, level of security and reliability, traffic volume, number of partners and level of communications expertise. The options available are direct connection using a modem, value-added network (VAN), public Internet infrastructure, and virtual private network (VPN).

Research Propositions

The previous sections highlighted the various issues related to implementation of SCM and IOS. Based on those discussions we propose the following research propositions.

1. The greater the propensity to share information among trading partners greater the success in IOS implementation

2. The greater the propensity to share information among departments greater the success in IOS implementation

3. The success of IOS will be higher in firms that use it along with SCM

4. The better the alignment of IOS/SCM with the firm's business strategies greater the chances of success in IOS implementation

5. The greater the goal congruence between trading partners greater the chances of IOS success.

It is proposed to conduct in-depth case analysis of a few organizations to study the implementation of supply chain management and IOS. It will test the research propositions and also examine the following issues:

1. What relationships exist between SCM and IOS?

2. Are SCM and IOS implemented as independent projects or as integrated projects?

3. What is the role of external trading partners in the implementation of SCM and IOS?

4. What is the role of vendors and service providers in the electronic integration of supply chain members?

5. What technologies have been used in IOS and what criteria were used to decide on the technologies?

References

Will be provided on request.