

Information Sharing as a Collaboration Mechanism in Supply Chains

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Abstract

Sharing information is regarded as one of the most effective ways of improving supply chain (SC) performance. However, the implementation of SC information sharing in practice is challenging. Effective information sharing across organizations with different objectives and perspectives means sharing the right information, at the right level of detail, using the right language, at the right time, in the right context, with the right people. A failure related to any one of these factors can lead to an information sharing breakdown.

This paper introduces information sharing as an essential activity in all SC collaborative work. Since the scope of information sharing varies widely in the literature, the focus of this paper will be on how the absence of information sharing (i.e. asymmetric information) may affect the SC and how SC information sharing can be defined in terms of what, to whom and how information is shared, with an emphasis on the benefits and challenges of SC information sharing.

Keywords: supply chains- asymmetric information- information sharing.

1. Introduction

Supply chain management entails the delivery of the right product to the right place at the right price. Towards this end, manufacturers and retailers have been re-engineering their supply chains (SC). Many of these re-engineering techniques are aimed at reducing inventory-related and shortage-related costs within the supply chain. For instance, quick response is a strategy that focuses on reducing lead times for fashion merchandise. Other strategies such as efficient consumer response, continuous replenishment program, and collaborative planning forecasting and replenishment allow manufacturers and retailers to share inventory and demand data in order to reduce the "bullwhip effect" in a distribution channel (Lee et al 1997). The cornerstone of these techniques is the sharing of information between trading partners within a supply chain because the decisions made at each level have implication across the entire chain. However, credibility is a key factor in the exchange of information because each party may have an incentive to distort its information to influence the receiver's decisions. In addition, the possibility of the party receiving the information to use the information only for its own benefit may give rise to certain disincentives to information sharing. Hence, mechanisms that can diminish such opportunistic behavior while allowing for increased benefits from information sharing are critical to the creation of efficient supply chains.

This paper discusses the impacts of information sharing in supply chains. The fundamental questions are: what information should be shared, with whom should it be shared, how it should be shared to optimize competitiveness and profitability, and what are the challenges for sharing information?

The rest of the paper will be organized as follows. Section 2 presents the problem of SC asymmetric information. Section 3 discusses the SC information sharing, the definition is presented in subsection 3.1 followed by answering of questions about what, to whom, and how information is shared in subsections 3.2, 3.3 and 3.4 respectively. Section 4 discusses the information sharing challenges, the role and impact of connectivity is discussed in 4.1, the role and impact of willingness is discussed in 4.2, and the information sharing incentives is discussed in 4.3. . Finally, Section 5 concludes the results.

2. Asymmetric Information

Asymmetric information refers to different players in a SC having different states of private information about resources (capacity, inventory status, and funds), various data, related costs, the chain operations (e.g., sales, production, delivery schedule, forecasting), performance status, and market conditions. One player has private information that the others do not have to make good decisions (Simatupang & Sridharan 2001). For example, the retailer has better projected customer demand compared with the manufacturer. The manufacturer has better information about products, delivery lead-times and production capacity than the retailer. Thus asymmetric information is inherent in SC.

The problem of asymmetric information arises because participating firms generally lack the knowledge required about each other's plans and intentions to adequately harmonize their services and activities. The chain members often do not wish to share their private information completely and faithfully with all other chain members due to the economic value of that information (actual or perceived). As a result, the SC suffers from (i) incentive misalignment, (ii) suboptimal decisions, and (iii) difficulty in dealing with market uncertainty (Simatupang & Sridharan 2002).

(i) Incentive Misalignment

The chain members easily slip into misunderstanding about the mutual efforts of collaboration because they have different positions in the SC and thereby have different aims, strategies, and roles.

Incentive misalignment occurs when a player makes decisions considering only local rewards and penalties, which typically often differ from maximizing the overall profitability. This *Opportunistic behaviour* that stems from the player's self-interest comes sometimes at the expense of the others.

The problem of incentive misalignment arises because firms generally lack the means to compel others to adjust their policies and priorities to align with the overall profit. Often, actions and decisions by one member result in uncompensated costs or benefits to others. This phenomenon has been known as *externalities*, *spill-over*, or *neighborhood effects*. For example, the retailer makes a decision on an order quantity which is less than the optimal SC quantity because he does not consider the supplier's profit margin (Simatupang & Sridharan 2002).

Unless the SC members share the sensitive information required to develop mutual goals and strategies, they become involved in conflict about conflicting objectives, decision rights, and responsibilities. This conflict may lead to unproductive allocation of resources, and redundant or overlapping activities.

(ii) Suboptimal Decisions

Sub-optimal decisions occur when the chain members do not have sufficient visibility to resolve various trade-offs in decision-making because lack of information causes decisions to be made in a narrow scope that cannot ensure that products flow properly to end customers. Moreover, with limited information sharing, the chain members do not have consistent perceptions of market needs and visibility over performance at the other levels of the SC. As a consequence, decisions are made based on either the best estimation of the available data or on educated guess. Such decisions can be biased and prevent the individual chain member from attaining the optimal solution of the chain. For example, the manufacturer often uses incoming orders with larger variance - and not sales data - from the retailer as a signal about the likely future product demand (Simatupang & Sridharan 2002). Also, the manufacturer often delivers large batches of products to minimise transportation costs, but this upsets on-time delivery performance because there is no visibility about what end customers want and the level of inventory that is available at the retail stores. Therefore, without global visibility, the players cannot make good decisions that can improve the overall chain performance (Simatupang & Sridharan 2001).

(iii) Difficulty in Dealing with Market Uncertainty

There are three distinct sources of uncertainty that affect a SC: suppliers, manufacturers and customers. Uncertainties are caused by delayed deliveries, machine breakdowns, order fluctuations, etc., which necessitate increased inventories (Yu & Cheng 2001).

Differences in information about market conditions among the players lead to difficulty in dealing with market uncertainty. Uncertainties will propagate through the SC in the form of amplification of ordering variability. This phenomenon is known as, the bullwhip effect.

The bullwhip effect phenomenon has been described in the literature over many years; however, it is only in the past decade that the full extent of the problem has been recognized, which has stimulated the interest of a number of researchers (see, for example, Lee et al 1997; Chen et al 2000; & Alony & Munoz 2007).

The bullwhip effect is a distortion of demand information when this information is transmitted as orders along the SC up to the most upstream suppliers. Since the bullwhip effect is characterized by distortion of information, it is generated endogenously by the behavior and policies of the SC members.

The retailing companies, for example, have better access to customer demands compared to other upstream players. They often accumulate demand information and transfer data in large batches to the immediate upstream members. Data may include ordering and customer needs. As the downstream players have the ability to distort demand conditions, the upstream players may experience larger variance of customer demand. Besides a lack of visibility of end customer demand, other factors that contribute to increased demand swings include promotions and pricing to end customers and trade deals among the chain members (Simatupang & Sridharan 2001). Figure

1 shows how the bullwhip effect propagates on a simple SC with only three companies: a retailer, a wholesaler and a factory. The retailer sells to the customer and buys from the wholesaler, the wholesaler sells to the retailer and buys from the factory and the factory sells to the wholesaler and buys from an unknown supplier. The ordering patterns of the three companies share a common, recurring theme; the variability of an upstream site is always greater than those of the downstream sites. The bullwhip effect is measured by the standard deviation σ of orders.

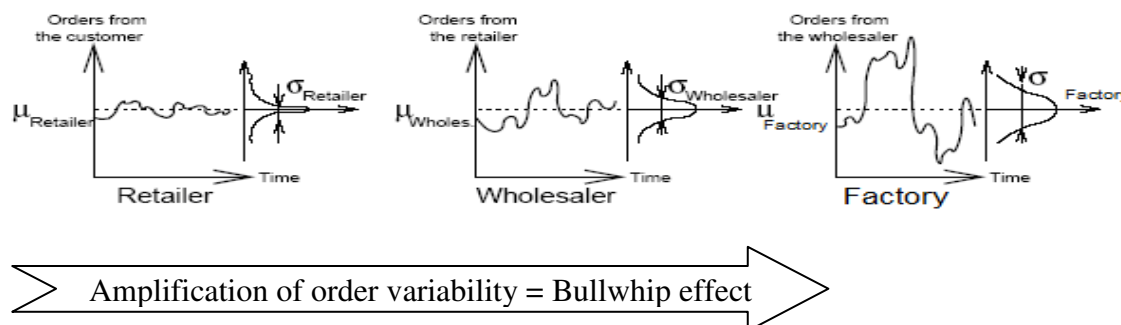


Figure 1: The Bullwhip Effect (Lee et al 1997)

The bullwhip effect has been identified as one of the biggest causes of inefficiencies in a SC, these include:

- Large demand and supply fluctuation result in the need for high inventories to prevent stock outs.
- Poor customer service as all demand might not be met.
- Production scheduling and capacity planning becomes difficult due to large order swings.
- Extra plant expansion to meet peak demand.
- Conflict between SC players.

Figure 2 depicts the logic network structure which explains why inadequate visibility of customer demands leads to lower profitability. A large error in forecasting leads to frequent updates of schedules, difficulty in managing genuine capacity scarcity, long lead-times, and the maintaining of speculative inventory. Furthermore, lack of information about customer needs makes it difficult to design the products which are seen as being the most desirable, especially for innovative goods.

3 Information Sharing

3.1 Information Sharing Definition

Defining the term "information sharing" in the information technology lexicon has a long history. Traditional information sharing referred to one-to-one exchanges of data between a sender and receiver. These information exchanges are implemented via dozens of open and proprietary protocols message and file formats.

According to Department of Defense, United States of America (2007), Information sharing is defined as, "Making information available to participants (people, processes, or systems)". Information sharing includes the cultural, managerial, and technical behaviors by which one participant leverages information held or created by another participant. The goal of sharing information is to provide information to others, either proactively or upon request, such that the information has an impact on another person's (or persons') image of the world, i.e., it changes the person's image of the world, and creates a shared, or mutually compatible working, understanding of the world.

But what, specifically, is meant by "information sharing" in a SC?

The Global Logistics Research Team (1995) defines SC information sharing as "The willingness to exchange key technical, financial, operational and strategic data". The shared information should be in a form that is usable and meaningful to other parties, otherwise the shared information will not make any difference to the SC's processes (Baihaqi et al 2008).

Handfield et al (2004) defines information visibility within the SC as the process of sharing critical data required to manage the flow of products, services, and information in real time between suppliers and customers. If information is available but cannot be accessed by the parties most able to react to a given situation, its value degrades exponentially.

A common information requirement has been simply defined as the right information in the right amount in the right place at the right time. This raises up some questions like: “what information is shared?”, “to whom information is shared?”, and “how does sharing take place?” Better answering these questions can greatly improve information sharing results: avoiding overload or deficiency, reducing sharing cost, and being more responsive. These questions are going to be answered in the following subsections.

3.2 What Information is Shared?

In order to answer this question two dimensions have to be considered; the types of the information that have to be shared and the quality of shared information. Since, inadequate information exchange and poor quality of information seems to have an impact on the efficiency of the SC performance.

3.2.1 The Types of Information to Be Shared

There is a wide range of information that could be shared within the firm and across the SC. The chain members share the information in both forward and backward flows that provide adequate visibility across both internal functions and organizations. The data which are most often shared include the availability of resources (e.g., capacity, inventory, funds, and capability), the status of performance (e.g., time, quality, costs, and flexibility), the status of processes (e.g., forecasting, ordering, delivering, replenishing, and servicing), and the status of contract.

Many research works were devoted to answering the question on ‘what information to share’, for example, Li et al (2001) consider four common types of information sharing for a SC of a single product: (1) order information sharing where every stage of the SC only knows the orders from its immediate downstream stage; (2) demand information sharing where every stage has full information about consumer demand; (3) inventory information sharing where each stage shares its inventory levels and demand information with its immediate upstream stage; and (4) shipment information sharing where every stage shares its shipment data with its immediate upstream stage. They find that a hybrid information sharing strategy, which uses the demand information sharing policy in the distribution network while using the inventory information sharing policy in the supplier network, is a better strategy to improve the overall performance of a SC of customizable products when the variability of demand mix is high.

Huang et al (2003) also suggest that there are six categories of production information that may be shared with SC partners or affects the SC performance. The information is identified as product information, process information, inventory information, resource information, order information and planning information (see table 1). Their study focuses on the importance of sharing production information in order to reduce variability of orders and inventory level.

In view of different levels of decision making in SC, information sharing can be strategic, tactical and operational (see table 2). Facility allocation decision is classified as a strategic SC decision. Production/distribution planning, capacity allocation, inventory allocation, outsourcing and safety stock decision are classified as tactical SC decision. On the other hand, order replenishment and shipment decision are categorized as operational SC decision making.

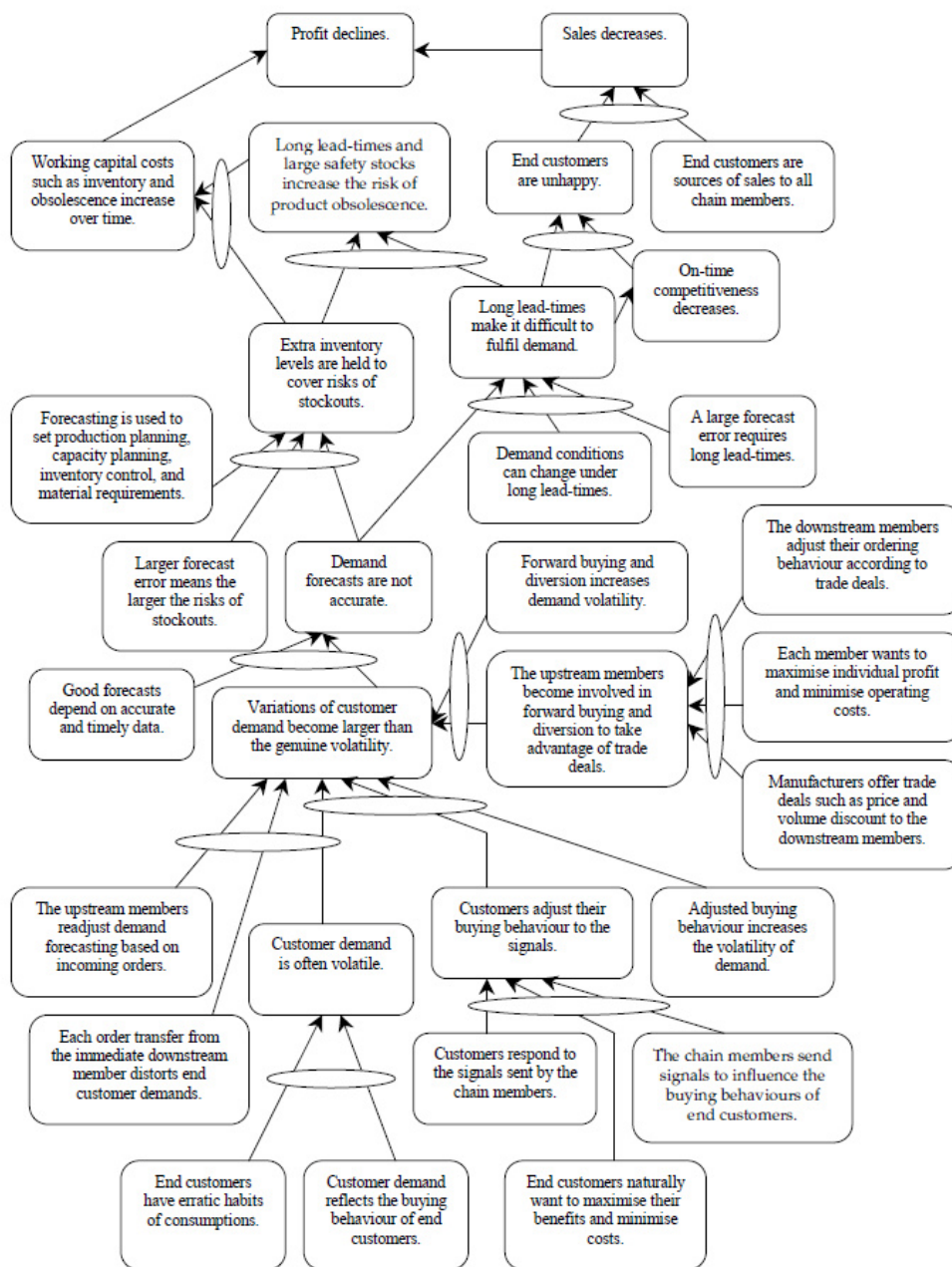


Figure 2: The Logic Network Structure of why Inadequate Visibility of Sales Data Leads To Lower Profit (Simatupang & Sridharan 2001) (It is read IF 'tail of arrow' THEN 'head of arrow'. The oval means AND)

Table 1: Classification of Production Information (Huang et al 2003)

Category	Production Information	Category	Production Information
Product	Product Structure	Resource	Capacity Capacity Variance
Process	Material Lead Time Lead Time Variance Order Transfer Lead Time Process Cost Quality Shipment Set-up Cost	Order	Demand Demand Variance Order Batch Size Order Due Date Demand Correlation
	Inventory	Inventory Level Holding Cost Backlog Cost Service Level	Planning

Table 2: Decision-Making levels in SC (Chandra et al 2007)

Decision-making level	Timeline	Type of decision made
Strategic	5-10 years	Investment on plants and capacities. Introduction of new products. Creation of a logistics network.
Tactical	3 months-2 years	Inventory policies to use. Procurement policies to be implemented. Transportation strategies to be adopted.
Operational	Day-to-day	Scheduling of resources. Routing of raw materials and finished products.

A large number of researches have focused on sharing demand information and how it can reduce the bullwhip effect, achieve cost savings and reduce inventory levels (see: Lee et al 2000; Chen et al 2000, Wang & Seidmann 1995; & Xu et al 2001). Other studies have indicated that exchange of forecast information has a positive impact on SC performance (see : Cachon & Lariviere 2001). Table 3 presents types of information that have been discussed in the literature of information sharing in SCs.

Table 3: Types of Information Sharing Discussed in the Literature

Authors	Shared Information
(Cachon & Fisher 2000)	Demand and inventory information
(Cachon & Lariviere 2001)	Demand and demand forecasts information
(Chen et al 2000)	Demand information
(Croson & Donohoue 2003)	Sales information
(Forslund & Jonsson 2007)	Forecast information
(Huang et al 2003)	Production information (product, process, resource, inventory, order, and planning)
(Lau et al 2002)	Demand, order and inventory information
(Lee et al 2000)	Demand information
(Li et al 2001)	Demand and inventory information
(Ramayah & Omar 2010)	Operational and strategic information
(Simchi-Levi & Zho 2003)	Demand information
(Waller et al 1999)	Inventory level and demand information
(Wang & Seidmann 1995)	Demand information
(Xu et al 2001)	Demand information
(Yu et al 2001)	Demand and order information
(Zhang et al 2006)	Shipment quantity information

It is clear from table 3 that most research has focused on the downstream or the demand-side information (e.g., the sales information or inventory status at point of sales), which only represents a small part of the total information flow in a SC. The upstream information sharing or supply-side information forms another type of information sharing that has been also proved crucial for the SC management (Li & Gao 2008). This type of information sharing includes sharing aspects, such as, Lead-Time, new-product introduction, and plant operations. In contrast to the downstream information sharing, the upstream information sharing has received less attention (Chen 2003). A recent trend stresses its importance as a complementary approach to sharing the downstream information.

The new trend of sharing the upstream information is driven by two factors. The first factor considers the availability of the technologies required for applying this type of information sharing. This includes the Enterprise Resource Planning (ERP) systems, Customer Relationship Management (CRM) systems, and Business-To-Business (B2B) exchanges. The second factor is the increased customer awareness of the importance of information sharing and, as a consequence, the increased customer pressure for sharing the information including the upstream information (Jain & Moinzadeh 2005).

Although sharing upstream information appears to be widely applicable now, its full impact on the SC has not been fully studied. Most of the existing models about upstream information investigate sharing the lead time or supply availability information. For example, Chen & Yu (2005) quantify the value of sharing the lead time information in a single-location inventory system. They assume a model with a single supplier that knows exactly the lead time for every replenishment order. The study shows that the cost savings from sharing the lead time information can be significant. Jain & Moinzadeh (2005) study a one-manufacturer one-retailer inventory system in which the retailer is allowed to access the inventory information of the manufacturer. The numerical investigations lead to insights about the value of this type of information to the retailer and demonstrate how upstream information sharing might increase the manufacturer's profits. The model also leads to insights that provide guidance to managers on when and how to apply upstream information sharing.

Lee et al (1997) discuss the possibility of preventing the bullwhip effect through sharing the manufacturer inventory information with the downstream agents. Croson & Donohue (2005) examine the effectiveness of giving the SC agents access to the downstream inventory information for alleviating the bullwhip effect. They find that sharing only upstream information offers no significant performance improvement. Rather than sharing the lead time or supply availability information, Li & Gao (2008) analyze the effect of sharing the upstream information of the introduction of a new product. They contrast the case in which the manufacturer does not

share the upstream information about the new-product with the retailer and the case in which the manufacturer shares the information. They demonstrate that information sharing improves the performance of both SC entities. They find also that when demand variability increases, information sharing adds more benefits to the SC.

Recently, upstream information sharing has been recognized as an essential complementary approach to downstream information sharing in supply chain management. For example, Ibrahim & Deghedi (2012) discuss how sharing the information of factory sudden-disruption can effectively help blocking the evolution of risk in a SC with two factories.

3.2.2 Information Quality

Besides the availability of the different types of information, information quality is also important in SC management. Information sharing would only be of value to SC partners if it is reliable in making better decision and improving performance.

"Information quality" is a measure of the value which the information provides to the user of that information. "Quality" is often perceived as subjective and the quality of information can then vary among users and among uses of the information.

Wang & Strong (1996) identify four information quality dimensions, each dimension consists of a number of elements used in assessing subjective information quality: (1) Intrinsic information quality consists of accuracy, objectivity, believability, and reputation; (2) Contextual information quality consists of relevancy, value-added, timeliness, completeness, and amount of information; (3) Representational information quality consists of interpretability, ease of understanding, concise representation, and consistent representation ; (4) Accessibility information quality consists of accessibility, and access security. Therefore, high quality information should be intrinsically good, contextually appropriate for the task, clearly represented and accessible.

A number of researchers have identified several important characteristics of information quality needed for SC management. Monczka et al (1998) stress that information quality should encompasses the elements of accuracy, timeliness, adequacy and credibility of information exchanged. Similar attributes were used in the study of Forslund & Jonsson (2007) to measure information quality. However, Miller (2005) measures information quality based on accuracy, believability, objectivity, precision and reliability of the information, relevancy, timeliness, completeness and information appropriateness, comprehensibility, interpretability, consistency, conciseness, format and appearance of the information, accessibility , security and availability. Lee et al (1997) focus on timeliness and accuracy in measuring information quality. According to their study, sales information should be transmitted to the upstream SC members in a timely manner in order for appropriate activities to be done accordingly. The reason for this is that information tends to lose its usefulness due to delay in communicating the information and inaccurate information. Timely information sharing provides early signal for corrective action to be taken besides preventing disruption in the upstream SC, and inaccurate customer orders can cause the demand to be amplified across the upstream SC.

In order to improve SC performance, managers need quality information to make operational, tactical or strategic decision. Access to the right information at the right time would enable firms to reduce uncertainty, be more proactive in responding to changes in market conditions thereby becoming more focused in meeting customer needs, and improve planning which in turn improves their profitability. On the other hand, Customer dissatisfaction, increased cost and low employee morale, ineffective decision making and inability to implement effective strategy are related to poor information quality. In addition, increase in costs is attributed to correcting errors that have been incurred due to poor information quality (Omar et al 2010).

3.3 With Whom Should Information Be Shared?

This question can be approached from different perspectives. First, how far information should be shared both upstream and downstream in a SC? And which partners at each stage should be involved? These decisions are related to the structure of the SC (D'Amours et al 1999).

The SC structure represents how business enterprises are arranged, by upstream and downstream links, to form a SC. It also indicates a buyer-supplier relationship between business entities (Huang et al 2003). So, dimensions to consider include the length of the SC and the number of suppliers and customers at each level (Lambert & Cooper 2000). This is particularly important as the implementation of information sharing is not costless and may require significance changes in companies' business operations.

Research determining with which partners in a SC a company should share information is very limited. Lau et al (2002) find that the levels of benefits by sharing information vary with different players involved in the SC. They examine various combinations of sharing between stages in a SC comprising a manufacturer, two

distributors, and two retailers. Four combinations of sharing demand and inventory levels are studied: no information sharing; sharing demand and inventory level between retailers and distributors only; distributors and the manufacturer; and full information sharing. The second mode of information sharing results in the highest total SC cost compared to other modes, even that of no information sharing. The lowest total cost is gained in the full sharing mode.

According to Mentzer (2004), companies must evaluate their partnering orientation which is the pattern of shared values and beliefs between partnering companies. Mentzer insists that it is not possible to include all SC members. Potential partners must be identified based on their importance to companies' competitive advantage.

Lambert & Cooper (2000) suggest that companies need to determine carefully with which partners of SC they should be closely integrated. They also point out that not all links throughout the SC should be closely coordinated and integrated.

The key is to sort out some basis for determining which members are critical to the success of the company and the SC and, thus, should be allocated managerial attention and resources.

According to Lambert & Cooper (2000), the members of a SC include all companies with whom the focal company interacts directly or indirectly through its suppliers or customers, from point of origin to point of consumption. However, they distinguish between primary and supporting members. They define primary members of a SC to be "*all those autonomous companies or strategic business units who carry out value-adding activities (operational and/ or managerial) in the business processes designed to produce a specific output for a particular customer or market*". In contrast, supporting members are "*companies that simply provide resources, knowledge, utilities, or assets for the primary members of the supply chain*". Although the distinction between primary and supporting SC members is not obvious in all cases, they believe that this distinction provides a reasonable managerial simplification and yet captures the essential aspects of who should be considered as key members of the SC.

The question of which partners should be recruited and recruitment criteria remain unclear as partner selection in SC involves complex processes ranging from strategic to operational.

3.4 How to Share the Information?


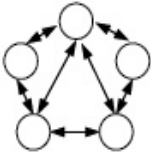
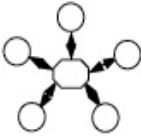
Another aspect of the problem is how to share the information. Towards this end, various methodologies are proposed, such as Electronic Data Interchange (EDI), Web-enabled portals, enterprise resource planning, data warehouse management, etc. the choice of the information sharing method depends on the SC structure. According to the SC structure, Rong & Kumar (2003) classify information sharing into: sequential, reciprocal, and hub-and-spoke (see Table 4).

(1) Sequential information sharing: In this structure, the output of one partner's activity will flow into the next trading partner as its input. The information sharing will link the collaborative processes together into a sequential chain. This is the simplest arrangement to implement. Since information flow is sequential, each pair of partners can establish their own protocols for exchange without the need for any universal standard. They could rely on EDI or some other communication mechanisms.

(2) Reciprocal information sharing: This is a more complex information sharing structure. Information flow is bi-directional and each partner may communicate with several others. Since there are multiple flows, inconsistencies can arise between the information of different partners. To reduce uncertainty and conflict in the collaboration, the best coordination mechanism for partners is to synchronize and integrate the interactive processes.

(3) Hub-and-spoke information sharing: This arrangement is based on a central hub that communicates with all partners. In general, an Internet-based e-hub serves a virtual marketplace, thus facilitating a full range of business processes and interactions between trading partners. The hub coordinates, stores, aggregates, and maintains information about each partner, makes decisions, and then communicates them to all partners. A definite advantage of an e-hub-based architecture is its "plug-and-play" capability with few integration points between applications. Collaborative planning, forecasting, and replenishment is based on the idea of such a centralized hub. Standardization plays an important role in such architectures because all partners must use common standards for information description, storage, and exchange. Large efforts and expenses are required for making disparate information systems integrated and compatible. The problem is exacerbated when transactional decision-making components of various systems are also linked (Chandra et al 2007).

Table 4: Information Sharing Structures (Rong & Kumar 2003)

Information Sharing	Sequential	Reciprocal	Hub-and-Spoke
Structure			
Level of collaboration	Between neighboring partners only (one-way)	Two-way, multiple partners	Two-way, centralized
Coordination Mechanism	Information flow upstream, goods downstream	Multiple information flows	Intelligent hub
Technologies	EDI	Networking, email, videoconference	Web services

Many managers define and manage information sharing as a technology issue. They tend to believe that by investing in technology, people and companies can be meaningfully connected. Yet, many organizations have been disappointed with the returns from these investments. One possible reason for the disappointment is that the technologies have not been supported by commensurate investments in organizational cultures that promote open sharing of information.

A few companies, however, appear to treat information sharing quite differently. They act as if sharing is a behaviour embedded in organizational cultures. Only when companies are willing and able to share vital and often proprietary decision-making information can trust be established and collaboration promoted. Technology becomes a tool to augment and promote information sharing and real collaboration (Rash et al 2010). Common sense suggests that the technological ability and the willingness to share information should work supportively together to enhance the quality and impact of SC decision-making (Fawcett et al 2007). In the next subsections the role and impact of technology, the role and impact of willingness, and the information sharing incentives will be discussed as the major challenges that face information sharing.

4.1 The Role and Impact of Technology

Recent technological advancements have dramatically increased companies' ability to connect. Information and communication technologies (ICT) play a central role in SCM. They enable companies to collect, analyze, and disseminate information among members of the chain to improve decision making. Through connecting managers across functional and organizational boundaries and providing them with relevant, accurate, and timely information, ICT reduces temporal and spatial distance enabling them to make better, more collaborative decisions.

The role of (ICT) in the SC has been a topic of interest for many researchers (see, for example, Rabren 2010; Fawcett et al 2007; & Yu et al 2001). ICT could provide real time information sharing among SC partner, allow quick communication between buyers and suppliers and enable the sharing of large quantity and quality of information on tactical and strategic operations. For example, the Internet allows organization to transfer digital data instantly and with high fidelity at nearly zero marginal cost.

According to Fawcett et al (2007) enhanced connectivity promises to change SC competitive capabilities in various ways:

- Information can substitute for inventory in the chain. In the past, when information cost was high, inventory was held to manage uncertainty. Today, when information technology continues to reduce information costs, uncertainty can be reduced resulting in lower inventory requirements.
- Enhanced connectivity is also shortening new product development cycles and order fulfilment lead times.
- Real-time connectivity also provides less-tangible benefits such as empowering managers to detect environmental trends and inflection points earlier, helping companies respond to changing competitive rules.
- Further, real-time connectivity helps companies monitor customer behaviour on a continuous basis. Immediate feedback to members of the chain can be used to drive learning and the development of "smart services". The ability to dynamically optimize chain performance to meet emerging customer needs may provide unparalleled competitive advantage.

So, Connectivity is positively correlated to a company's performance.

4.2 The Role and Impact of Willingness

Connectivity creates the capability to share information. However, people make the decisions regarding what will be shared and when. The old saying, “information is power” holds true in today’s business world. As a result, many individuals are unwilling to share information that they perceive may place their organizations at a competitive disadvantage.

A company’s willingness to share information – that is, its openness to sharing relevant information honestly and frequently –ultimately determines the extent of sharing that takes place. Huge investments in technology can be negated by an unwillingness to share needed information (Rash et al 2010).

Organizational theory suggests that company culture influences how willing its people are to share information. This cultural influence holds for sharing across internal functions such as marketing and engineering as well as across organizations in the chain. Indeed, each organization may have a different attitude toward information sharing. Thus, for a SC to take full advantage of the benefits of information integration; the diverse firms that comprise the chain must cultivate a high degree of willingness among all key players (Fawcett et al 2007).

Based on Fawcett et al (2007) interview with various companies they find that when the levels of connectivity and willingness are both high, relationships are strategic and built on high levels of trust; accurate data about joint decision makings are shared in timely basis; and, opportunities are available for high levels of collaboration.

4.3 Information Sharing Incentives

Managers can influence the level of willingness by supporting programs that enable individuals to develop initiatives and opportunities to share information. To justify investments in willingness, the chain members need to identify and quantify the benefits of information sharing. Furthermore, a chain member with superior information wants to ensure economic benefits from information sharing, given the positive impact of shared information on performance (Fawcett et al 2007).

Information sharing seems to require immediate costs- the collection, dissemination, and use of information may lead to differences in benefits and burdens between the receiving party and the disclosing party. If the benefits and the burdens are inequitable, then the members are tempted to distort shared information. Unreliable information results in lower overall performance and thereby both parties cannot capture the potential mutual benefits. Therefore, how to measure the benefits and burdens and associated mechanisms for fair compensation become a critical issue in information sharing.

A SC should jointly design incentives for information sharing that link to performance metrics. All the benefits of improvements in the performance must be distributed fairly according to each member’s contribution. If information sharing provides equal distribution of the benefits, then the chain member with superior information may not wish to join the SC.

One way to solve this problem is to tie the retailer's actions - such as better customer service and appropriate retail pricing - to the improved sales. The resulting savings can be shared between the manufacturer and the retailer. Access to point of sales data enables the manufacturer to deliver incentives and to direct the retailer in improving the service level.

Another way to solve the inequitable benefits and burdens of information sharing is to recognise externalities surrounding the processes of collection, dissemination, and use of shared information. Both positive and negative externalities can occur when the independent actions of a member unintentionally spill over onto the others. Positive externalities provide benefits in the form of lower inventory, reduced costs, and lower price. Negative externalities include an increase in technology investment, inventory costs and a higher transfer price. The participating members can negotiate for a charge in resource allocation that makes everyone better off at the same time. The principle is to increase individual responsibility for attaining better overall performance (Simatupang & Sridharan 2001)

Actually, a number of mechanisms are available to provide decision makers with incentives to consider the external costs and benefits of information sharing. When parties are independent decision makers (i.e., a self-interest party), rules and procedures such as side payments, subsidies, penalties, auctions, and willingness to pay for information sharing can be used. When parties have mutual interests, other incentive schemes can be employed such as, productive-behaviour-based incentive- which means rewarding the steps of observable actions that lead to a specific mutual objective, rather than the attainment of the objective itself, pay-for performance-which means setting performance metrics to evaluate the partners and rewarding them based on outcomes of the most important activities. And equitable compensation-where partners carry out open book practice that consists of both the overall costs and benefits and the individual costs and benefits. They share risks and fairly assess the

actual performance in determining the fair distribution of gains (Simatupang & Sridharan 2002).

5. Conclusion

This paper discussed how asymmetric information which is inherent in SCs results for suffering of the SC from incentive misalignment, suboptimal decisions and difficulty of dealing with market uncertainty. These problems can be avoided by information sharing.

Information sharing in SCs was defined as “The willingness to exchange key technical, financial, operational and strategic data”. This process has to flow in both directions from downstream up and vice versa, however most research has focused on the downstream or the demand side information while the upstream information has received a little attention. Besides the availability of the different types of information, information quality is also important in SC management.

The paper also discussed the major challenges that face information sharing which relate to technology, willingness, and finally the incentives to share information.

We concluded that, while connectivity creates the capability to share information, people make the decisions regarding what will be shared and when. So, technology is just a tool to augment and promote information sharing and real collaboration and the human factor is very important in this process. Incentives also have to be given to the chain member with superior information to ensure economic benefits from information sharing, given the positive impact of shared information on performance.

References

- Alony, I., & Munoz, A. (2007). The Bullwhip Effect in Complex Supply Chains. *International Symposium on Communication and Information Technologies ISCIT, 2007*, 1355-1360.
- Baihaqi, M., Beaumont, N., & Sohal, A. (2008). Information Sharing in Supply Chains: A Survey of Australian Manufacturing. *International Review of Business Research Papers*, 4(2), 1-12.
- Croson, R., & Donohue, K. (2003). Impact of POS Data Sharing on Supply Chain Management: An Experimental Study. *Production and Operation Management*, 12(1), 1-11.
- Croson, R., & Donohue, K. (2005). Upstream Versus Downstream Information and Its Impact on The Bullwhip Effect. *System Dynamics Review*, 21(3), 249–260.
- Chen, F., Drezner, Z., Ryan, J. K., & Levi, D. S. (2000). Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times, and Information. *Management Science*, 46(3), 436-443.
- Cachon, G. P. & Fisher, M. (2000). Supply Chain Inventory Management and the Value of Information Sharing. *Management Science*, 46(8), 1032-1048.
- Chandra, C., Grabisz, J., & Tumanyany, A. (2007). Problem Taxonomy: A Step Towards Effective Information Sharing in Supply Chain Management. *International Journal of Production Research*, 45(11), 2507–2544.
- Chen, F. (2003). Information Sharing and Supply Chain Coordination. *Research and Management Science*, 11, 341–422.
- Cachon, G. P., & Lariviere, M. A. (2001). Contracting to Assure Supply: How to Share Demand Forecasts in a Supply Chain. *Management Science*, 47(5), 629-646.
- D'Amours, S., Montreuil, B., Lefrancois, P., & Soumis, F. (1999). Networked Manufacturing: The Impact of Information Sharing. *International Journal of Production Economics*, 58, 63-79.
- Department of Defence, United States of America. (2007). Information Sharing Strategy. *Information Sharing Executive, Office of the Chief Information Officer*. Available on line at: <http://www.acqnotes.com/Attachments/DoD%20Information%20Sharing%20Strategy.pdf>
- Forslund, H., & Jonsson, P. (2007). “The Impact of Forecast Information Quality on Supply Chain Performance.” *Inter. J. Operations. Prod. Managemen.*, 27(1), 90-107.
- Fawcett, S.E., Osterhaus, P., Magnan, G.N., Brau, F.C., & McCarter, M.W. (2007). Information Sharing and Supply Chain Performance: The Role Of Connectivity And Willingness. *Supply Chain Management: An International Journal*, 12(5), 358-368.

Global Logistics Research Team (1995). *World Class Logistics: The Challenge of Managing Continuous Change*, Council of Logistics Management, Oak Book.

Handfield, R., Barnhardt, R., & Powell, N. (2004). Mapping the Automotive Textile Supply Chain: the Importance of Information Visibility. *Journal of textile and apparel technology and management*, 3(4), 1-19.

Huang, G. Q., Lau, J. S. K., & Mak, K.L. (2003). The Impact of Sharing Production Information on Supply Chain Dynamics: A Review of the Literature. *International journal of Production Research*, 41(7), 1483-1517.

Ibrahim, Y., & Deghedi, G. (2012). Sharing Breakdown Information in Supply Chain Systems: An Agent-Based Modeling Approach. *Information and Knowledge Management*, 2(4), 19-29.

Jain, A. & Moinszadeh, K. (2005). A Supply Chain Model with Reverse Information Exchange. *Manufacturing & Service Operations Management*, 7(4), 360-378.

Lambert, D. M., & Cooper, M. C. (2000). Issues in Supply Chain Management. *Industrial Marketing Management*, 29(1), 65-83.

Li, Z., & Gao, L. (2008). The Effects of Sharing Upstream Information on Product Rollover. *Production And Operations Management*, 17(5), 522-531.

Lau, J. S. K., Huang, G. Q., & Mak, K. L. (2002). Web-based Simulation Portal for Investigating Impacts of Sharing Production Information on Supply Chain Dynamics from the Perspective of Inventory Allocation. *Integrated Manufacturing System*, 13(5), 345-358.

Lee, H., Padmanabhan, V., & Whang, S. (1997). Information Distortion in A Supply Chain: The Bullwhip Effect. *Management Science*, 43(4), 546-558.

Li, J., Shaw, M., Sikora, R., Tan, G. W., & Yang, R. (2001). The Effects of Information Sharing Strategies On Supply Chain Performance. *Working paper*, College of commerce and business administration, university of Illinois at urban-Champaign. Available on line at: citebm.business.illinois.edu/b2bresearch/ieee_em.doc

Lee, H. L., So, K. C., and Tang, C.S., (2000). "The Value of Information Sharing in a Two-Level Supply Chain." *Management Science*, Vol. 46, No. 5, pp. 626-643.

Mentzer, J.T. (2004). *Fundamentals of Supply Chain Management: Twelve Drivers of Competitive Advantage*. Thousand Oaks: CA, Sage publications.

Miller H. (2005). Information Quality and Market Share in Electronic Commerce. *Journal of Services Marketing*, 19(2), 93 - 102.

Monczka, R. M., Petersen, K. J., Handfield, R. B., & Ragatz, G.L. (1998). Success Factors in Strategic Supplier Alliances: The Buying Company Perspective Decision. *Decision Sciences*, 29(3), 553-577.

Omar, R., Ramayah, T., Lo, M.C, Sang, T.Y & Siron, R., (2010). Information Sharing, Information Quality and Usage of Information Technology (IT) Tools in Malaysian Organizations. *African Journal of Business Management*, 4(12), 2486-2499.

Rabren J. (2010). Technology, Integration and Data Drive Supply Chain Visibility. *Material Handling Management*, Retrieved Business Source Complete database, 65(3).

Rashed, A. A., Azeem, A., & Halim, Z. (2010). Effect of Information and Knowledge Sharing on Supply Chain Performance: A Survey-based Approach. *JOSCM*, 3(2).

Rong, E., & Kumar, A. (2003). Leveraging Information Sharing to Increase Supply Chain Configurability. *Twenty-Fourth International Conference on Information Systems*, 523-537.

http://test.scripts.psu.edu/users/a/x/axk41/icis03_reprint.pdf

Ramayah, T., & Omar, R., (2010). Information Exchange and Supply Chain Performance. *International Journal of Information Technology and Decision Making*, 9(1), 35-52.

Simatupang, T.M., & Sridharan, R. (2001). A Characterisation of Information Sharing in Supply Chains. Proceedings of the 36th Annual ORSNZ Conference, 16-25.

Simatupang, T.M., & Sridharan, R. (2002). The Collaborative Supply Chain: A Scheme for Information Sharing and Incentive Alignment. *The International Journal of Logistics Management, Revision*, 2, 1-32.

- Simchi-Levi, D., & Zhao, Y., (2003). The Value of Information Sharing in a Two-Stage Supply Chain with Production Capacity Constraint. *Naval Research Logistics*, 50(8), 888-916.
- Waller, M., Johnson, M. E., & Davis, T. (1999). Vendor-Managed Inventory in the Retail Supply Chain. *Journal of Business Logistics*, 20(1),183-203.
- Wang, E. T. G., & Seidmann, A. (1995). Electronic Data Interchange: Competitive Externalities and Strategic Implementation Policies. *Management Science*, 41(3), 401-418.
- Wang, R., & Strong, D. (1996). Beyond Accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems*, 12(4), 5-34.
- Xu, K., Dong, Y., & Evers, P.T. (2001). Towards Better Coordination of the Supply Chain. *Transportation Research Part E: Logistics and Transportation Review*, 37(1), 35-54.
- Yu, Z., Yan, H., & Cheng, T. C. E. (2001). Benefits of Information Sharing with Supply Chain Partnerships. *Industrial Management & Data Systems*, 101(3), 114-119.

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