A Systematic Approach to Analyze the Information in Supply Chain Collaboration: A Conceptual Framework

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Abstract In recent competitive business scenario, many supply chain players act together to perform well to earn profit. In this attempt, several supply chain (SC) informations are being exchanged under collaborative framework. Some information will be used for planning, production, replenishment, and forecasting; while the other information will just overload the system. Hence, it is obligatory for supply chain players to know the value of each piece of information for its role in the supply chain processes. In this chapter, first we try to model the SC information and then validate the information so as to use in the SC processes. In this approach, we suggest a framework to list and evaluate SC information. We also attach quality attributes to each of the information listed. On identifying the important information and related quality attributes, managers can decide including the information in the SC processes. This approach can help the managerial decision making in two ways—managers can identify the important information based on its attached quality attributes and can revisit the supply chain collaboration for further information need.

1 Introduction

After successful adoption of collaboration in companies like Wal-Mart and P&G, supply chain collaboration (SCC) has gained much attention from many businesses. Recent SCC framework namely Collaborative Planning Forecasting and Replenishments (CPFR) intends to improve overall performance of supply chains, having information exchange as a backbone (VICS 2002). However, the

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information exchange among players varies widely across different supply chains. For instance, retailers in the supply chain are more interested in promotional sales and hence need to know about recent price reduction and upcoming promotions. On the other hand, manufacturers are interested in knowing point of sales data and inventory levels at retail outlets for production planning, material resource planning, logistics planning, and also for avoiding excess inventory.

In collaborative SCs, both upstream and downstream members exchange information to improve overall performance of SC (Ramanathan and Muyldermans 2010). Transparent information sharing in SC helps to reduce uncertainty and avoid excess inventory (Holweg et al. 2005; Chen et al. 2000). Li and Wang (2007) asserted that the benefit of information sharing is dependent on content and use of information (Lee and Whang 1999, 2001; Lee et al. 2000; Raghunathan 2001). Improper use of important information will make no difference in the performance of SC. To ensure success in global businesses, it is essential for SC players to have right information at the right time.

However, identifying the important information, that can improve SC performance, is hard in any supply chain (Ramanathan 2012). This is mainly because every piece of SC information has some desired qualities (Forslund and Jonsson 2007). For any supply chain player, establishing an appropriate collaboration with other partners to obtain required supply chain information with the desired quality is a difficult task. With the purpose of filling this gap, our research intends to suggest a simple conceptual framework in order to identify the appropriate information before considering the same for either SC planning or forecasting or production. Rest of the chapter is organized as follows: Sect. 2 gives a brief outline on the role of information in SC collaborations. A conceptual model is developed in Sect. 3 and steps to analyze the model are also discussed. Section 4 illustrates the model and analyses through a case study. Finally, Sect. 5 summaries the contribution of this research and includes notes for future research.

2 Role of SC Information in Collaboration

The supply chain (SC) information and its role in various business performances are widely discussed in the literature by both academics and practitioners. Sharing of demand information with upstream members help reducing manufactures' supply chain cost in Collaborative Forecasting and Replenishment (Raghunathan 1999). Knowledge on demand information also reduces inventory cost of both supplier and customer (Gavirneni et al. 1999; Lee et al. 2000; Graves 1999). Meanwhile, sharing demand information along with current inventory status facilitates achieving reduction in inventory cost (Chen 1998; Cachon and Fisher 2000). Depending on capabilities (technology and manpower) of SC members, the benefit of information sharing will also range from basic inventory reduction to higher profit earning. Manufacturer could reduce variance in demand forecast if

readily available historical order data is being used efficiently (Raghunathan 2001). But more update on point of sales data (POS) can improve forecast of promotions and new products (Smaros 2007; Ramanathan and Muyldermans 2010). The POS data and market-data-sharing are found influential in achieving forecast accuracy in Chang et al. (2007)'s augmented CPFR model. More detailed literature on value of information sharing in supply chains is given in Li et al. (2005). Sanders and Premus (2005) attempted to model the relationships between firms' IT capability, collaboration, and performance. However, the information sharing, planning, and forecasting have not been discussed in detail.

Most of the above-discussed literature lists the benefits of exchanging information either on POS data or inventory data but there is not enough detail on exchanging other demand-related information. Recognizing the type of information, that needs to be shared among supply chain members, to build more visibility is still a big challenge in achieving successful collaboration (Barratt and Oliveira 2001). Ryu et al. (2009) presented a simulation study on evaluation of supply chain information sharing. The authors compared the value of exchanging short-term forecast and long-term forecast among SC players. Under high demand variability, the long-term forecast performed better than the short-term forecast. Under low demand variability, the short-term forecast performed better than long-term forecast. Using store-level SKU data Ali et al. (2009) found that simple time series forecasting will be appropriate for normal sales without promotions. The authors suggested using advanced techniques for sophisticated input to improve forecast accuracy of promotional sales. Refer to Table 1 for more literature on information sharing in SCs. While most of the articles support sharing of POS data for reduction of cost or inventory, a recent paper by Nakano (2009) claimed that internal forecasting (with-in the firm) had significant impact on logistics and production performance but not external collaborative forecasting (with other supply chain players). The author using survey data from Japanese manufacturing identified a positive relationship between internal forecasting and planning, and external (upstream/downstream) collaborative forecasting and planning.

Most of the literature discussed earlier have described the information exchange among supply chain partners as a performance improvement tool (Cachon and Fisher 2000; Byrne and Heavey 2006; Lee et al. 2000). While Kulp et al. (2004) related different forms of information and knowledge integration to evaluate the supply chain performance, Steckel et al. (2004) questioned the importance of point of sale information (POS). Steckel et al. (2004) argued that the POS information may distract decision making particularly if product demand is highly fluctuating. However, Aviv (2001, 2007) supported the sharing of sales information and local forecasts between retailers and manufactures to improve the accuracy of demand forecasts. Overall performance of supply chain was proved to be higher with high quality centralized information (Forslund and Jonsson 2007). Paulraj et al. (2008) emphasized the inter-organizational communication as a relational competency in SCC. Although, many of these journal articles are focusing on different areas of supply chain, the relationship between the SC performance and characteristics of

Table 1 Some literature on SC information exchange

Authors	Information sharing (Data type)	Purpose
Bourland et al. (1996)	Inventory	Minimizing inventory cost
Cachon and Fisher (1997)	Historical data	Decision on technology investment
Chen (1998)	Demand and inventory	Minimizing total inventory cost
Gavirneni et al. (1999)	POS and inventory	Minimizing inventory cost
Cachon and Fisher (2000)	Demand and inventory	Minimizing inventory cost throughout whole SC
Lee et al. (2000)	Demand information	Minimizing inventory cost
Raghunathan (2001)	Order history	Decision on technology investment
Kulp et al. (2004)	Demand information (asymmetric)	Improve supplier benefit
Byrne and Heavey (2006)	Inventory, sales, order status, sales forecast, production/ delivery schedule	Total supply chain cost saving
Chang et al. (2007)	POS and market data	Improve responsiveness to demand fluctuations
Ketzenberg (2009)	Demand, recovery yield, capacity utilization	Capacity utilization showed more value than any other information in a capacitated closed loop supply chain.
Ryu et al. (2009)	Demand information	Study changes in inventory level and service level
Ali et al. (2009)	SKU-store level data	Forecast promotions
Ramanathan (2012, 2013)	Sales data and promotion plans	Improve planning, forecasting, and replenishment

the information are not explained to a great extent. This is evident from the recent review paper on supply chain coordination (Arshinder and Deshmukh 2008; Bahinipati et al. 2009). Some previous researchers used conceptual models to design supply chain collaboration (Simatupang and Sridharan 2005; Gunasekaran et al. 2004). Similarly, in this chapter, we develop a conceptual framework for validating SC information using data from a case company. We try to achieve this in three stages (see Fig. 1).

In stage one of the information validation process, we propose to list all possible SC information. This will help to decide on whether to use or not to use the information in organizational decision making. In stage two, the selected list of information will be evaluated for its quality. This research suggests some useful steps to validate the SC information in the next section. This stage of validation process aims to guide the firms to include appropriate SC information in top management decision making. Then the information with desired quality will be included in the SC processes. Stage three will suggest the SC players to continue with the current SCC or to improve, based on the quality of the available SC

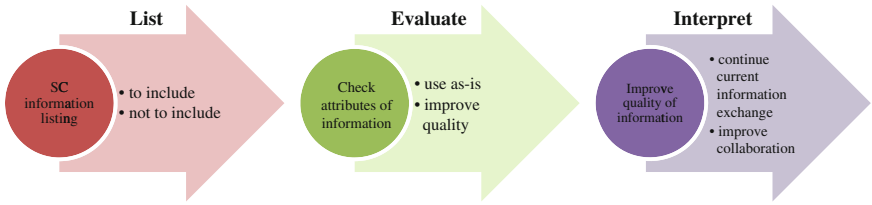

Fig. 1 Three stages of the SC information validation

information. If required, the SC members will attempt to strengthen their collaborative relationship in order to improve the quality of the SC information. The following section explains the conceptual model in detail.

3 Development of Conceptual Model

Although a lot of information related to sales, inventory, and replenishment are exchanged in almost all modern SCs, all the information is not being used by every SC member (Ramanathan 2012, 2013). As explained in Sect. 2, some of the information are used more frequently, while the others are rarely or never used. Inclusion of the information on decision making is based on the quality of the information and its impact on the performance of SCs (Forslund and Jonsson 2007; Zhao et al. 2002). Some previous researchers have used cost-benefit analysis and forecast accuracy as indicators to measure the quality of information and the performance of SC (Aviv 2007; Forslund and Jonsson 2007; Sari 2008).

Cost and benefit of obtaining and using information are acting as base lines to SC information exchange (Sari 2008). The cost involved in information exchange is measured either in terms of investment on technology and/or amount spent on obtaining the information. The benefit of information exchange can be represented through good forecast accuracy (Ramanathan and Muyldermans 2010). Although the accuracy of information is obligatory in reduction of forecast error, it is highly subjective—to the explanatory power of the partner involved in the process of information exchange and also to the accuracy of information at the time of predicting demand (Aviv 2007). The benefit can also be measured through improved inventory, production, and replenishments (Gavirneni et al. 1999).

It is also important to mention that the ability of observing any small changes in the potential market and also descriptive nature of the observer can alter the quality or accuracy of the information used for demand forecasts (Aviv 2002). For example, a sudden change in local weather such as high temperature or rain may increase the demand of umbrellas. But this information on the local weather will not help to alter any production plans, in a very short notice. However, a proper inventory deployment and good coordination among supply chain players will assist smooth replenishment. This indicates that the action-ability of the

information is partially related to the performance of the supply chain. Based on the literature, in this study, we consider six major attributes of the information exchange namely—source, cost, availability, reliability, action-ability, and importance (Ramanathan 2012, 2013). These attributes aim to act as evaluation criteria for deciding the quality of the SC information.

3.1 Source of Information

Source of information indicates the parties involved in information exchange. In particular, source can help to identify who observes or owns the data. In simple terms, 'source' indicates the whereabouts of the information available.

3.2 Cost of Information

Cost of information denotes the cost incurred by the SC members to obtain information.

3.3 Availability of Information

This indicates the status of the availability of the information with specific time scale such as always, intermediate, short term, sometimes, after, and before event. Time scale is dependent on duration of special events/sales promotions in a particular company.

3.4 Reliability/Accuracy of Information

Descriptive nature of observer and market can alter the reliability of the information (Aviv 2002). Hence, it is obligatory for managers to know the accuracy of the information before using it in company's decision making.

3.5 Action-Ability of Information

The extent to which the available information can be used in forecasting, production and replenishment is represented through action-ability. Here, the action-ability represents the capability of using the available information in the SC.

3.6 Importance/Benefit

Importance of information in the supply chain processes, such as planning, forecasting, production, and replenishment, decides the need for information exchange among the supply chain members.

Of the above six attributes, the source of information and the cost of information are directly related to company top management decision making. In general, any management decisions will consider using the action-able quality information from a dependable source with premium cost in the SC processes. The capability of using the correct information at the right time will be evident through an effective supply chain performance. For example, quick transfer of sales information (such as electronic POS data) will have a positive impact on the planning and hence improve responsiveness of supply chains to any demand fluctuations (Bourland et al. 1996; Chang et al. 2007; Cachon and Fisher 2000) rather than using historical data. However, the use of technology can alter the speed of the data transfer which will affect the response to supply chain changes. If all the information available is used effectively to respond quickly to the demand, the benefit of supply chain will be in the form of forecast accuracy, inventory reduction, cost reduction, etc. (Cachon and Fisher 2000; Bourland et al. 1996).

As a first step towards developing a conceptual framework to evaluate the supply chain information, we make use of all of the above-mentioned attributes of the SC information in a single structure. This conceptual framework will suggest systematic collection of supply chain information and its analysis (refer to Fig. 2). In Fig. 2, the supply chain information 1, 2,…..n represent various information being used in a supply chain from different possible sources. By analyzing this framework, any company can understand the importance of information in its supply chain processes.

As every business has a very different information requirement depending on its business objectives, it will be a good idea to set general steps to easily identify the need for any improvement in the SC information. However, earlier literature on supply chain information did not suggest any structured approach to analyze or evaluate the information. In this research, we suggest evaluating all of the SC information before including the same in the SC processes. To support this procedure, we develop a set of steps to evaluate SC information. Accordingly, every single data (information) will go through the following steps before deciding whether the particular piece of information needs more attention or not. To facilitate this analysis, we suggest some constructive iteration of analysis of the SC information to help collaborating members to decide on information exchange.

Step 1: If both or any one of ‘Importance’ and ‘Action-ability’ of information is marked low, there is no need to use the information in the SC processes. Revisit the SC information framework. Else go to step 2.

Step 2: If any one of ‘Importance’ or ‘Action-ability’ of information is marked either medium or high then perform Step 3.

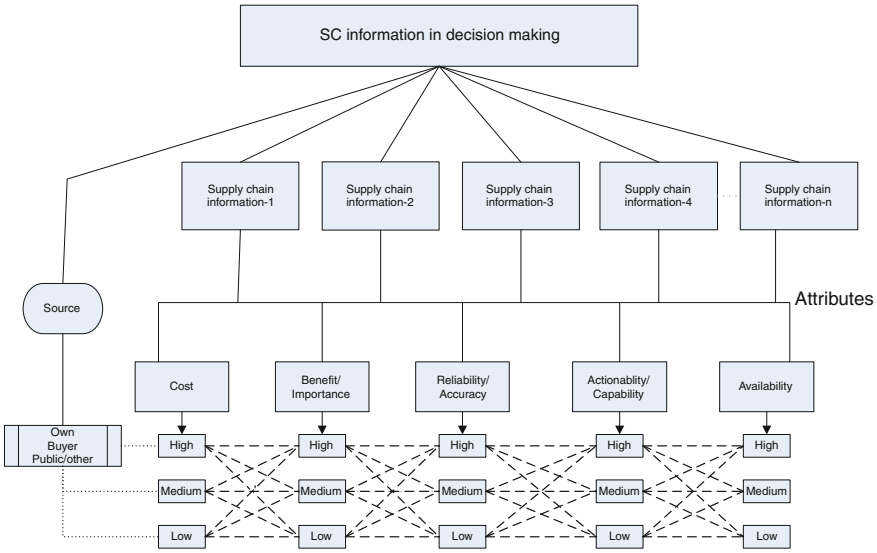

Fig. 2 Identifying important SC information—a conceptual framework

Step 3: If both 'Reliability' and 'Availability' of information are marked high, then the SC information is appropriate for decision making. Continue the information exchange (as-is). Else go to Step 4.
Step 4: If any one of 'Reliability' or 'Availability' of information is marked either medium or low then revisit the SC information framework.

Using Step1, the importance and action-ability of the SC information will be identified. Further, Steps 2 and 3 will guide the SC manager on whether to use the information or not. To better understand the given conceptual framework, we use a practical case study in the next section. Through this case, we explain the adoption of the framework and the suggested steps to evaluate the SC information.

4 Evaluation of Conceptual Framework Through a Case Study

Company-A is an established textile company operating globally. Most of the production plants of the company are located in Asian countries. Finished products (textile materials) of the company are sold around the globe. Currently, the company is trying to establish a well-connected network with all its customers.

The company considers establishing the basic communication at transactional level with new customer or relatively new customer. However, for promotional sales it communicates extensively with their retailers for planning, production,

replenishment, and forecasting. Currently, the company motivates customers for a future collaboration by providing free samples. The satisfied customers plan their sales promotion in collaboration with the Company-A. During the sales promotions, both the Company-A and retailers share their plans on production and replenishments. They also share their demand forecasts. But communication between these two SC partners concentrates only on the promotional sales. This relationship is not generally extended further during normal sales. In other words, the information exchange between their customers is highly focused at the time of promotions but restricted at the other period of time. The source of information for Company-A is mainly their retailers. The cost involved in the information exchange and promotional advertisements is being shared by the Company-A and the retailers. The promotional planning, forecasting, and replenishment are jointly made by the company and the retailers.

The current collaborative arrangement of the Company-A with respect to the promotional sales looks short sighted and it needs further expansion to involve retailers in the SC processes at all the time. Our conceptual SC information model aims to help the company to identify the important supply chain information and its contribution for the SC performance improvement. As mentioned in Sect. 2, the stage one of the SC information validation process includes initial listing of all the available SC information and its characteristics. This will help the company to structurally identify the useful information.

In the stage 2 of the SC information validation, based on the present practice of the company's information exchange, we have identified two different types of information. One is internal to the SC and another is external to the SC. Here, the internal SC information refers to the information specific to particular SC that is exchanged among SC members. The external SC information refers to the information that is not normally provided within the SC, but available externally either publicly available data or through third party information providers. The internal SC information and the external SC information specific to the Company-A is given as follows:

Internal SC information. Promotional sales, sales data, order data, discount information, inventory level, trend, local forecasts

External SC information. Economic factors, competitors' information, seasonality, government policy, and regional preferences

The promotional sales plans are discussed frequently by the Company-A with their retailers, approximately, 3 months before the start of the promotions. Normally, the Company-A does not get the sales data from the retailers. However, the sales data is exchanged on daily basis during promotions. On a regular interval, say once a week, the company is being updated on the inventory at the retailers' outlet. Occasionally, the retailers offer shop discounts for some products without any prior notice to the manufacturer. In such cases, the inventory data helps the Company-A to plan their production and replenishments. Local forecast and local trend on products are regularly communicated.

In the conceptual model, the second stage of validation of the SC information is done in two phases. In the first phase, the Company has rated each of its internal

and external SC information for its attributes. With reference to each attribute, all the information is rated as low or medium or high. Both the internal and the external SC information along with their corresponding rates are presented in Tables 2, 3.

In the second phase, the SC information of the case company is analyzed for its quality attributes. Using the steps suggested in Sect. 3, each data has been analyzed.

In the third stage of the SC information validation, the results of the analysis of conceptual model (see Table 2) of the company identified that the exchange of details on promotion, order, and trend was appropriate. Hence, we have suggested the company to continue using the information in the SC processes (marked as 'continue' in Table 2). This also directs the managers to continue exchanging the information in the same level (as-is). However, the other information such as sales, local forecasts, inventory, and discount details need to be updated. Currently, the Company-A uses all the available internal SC information (from customers) on sales planning, inventory planning, forecasting, and replenishments. From our analysis, it is clear that all of the SC information is not appropriate to be used in the immediate supply chain processes as it needs improvement. Hence, we have suggested the company to revisit their SC information framework. By revisiting the framework, it is possible for the Company-A to improve the quality and availability of SC information either by improving the collaboration relationships or by investing in technology.

Similarly by testing and interpreting the external SC information, decision maker can decide the level of involvement of third-party information providers in the supply chain.

From Table 3, it can be seen that the SC information related to the economic factors and seasonal factors can be used in the decision making. However, the competitors' information and the regional preferences cannot be included in the supply chain decision making as these two information lack the desired quality. This analysis gives a useful insight to the company on obtaining the competitors

Table 2 Evaluation of the internal SC information—Company A

Information Attributes	Sales	Promotions	Order	Local forecast	Inventory	Trend	Discount
Importance	High	High	Medium	High	Medium	Medium	High
Action-ability	High	High	High	High	Medium	Medium	High
Reliability	Low	High	High	Medium	Low	High	Medium
Availability	Low	High	High	Low	Low	High	Low
Step 1	× Go to step 2	× Go to step 2	× Go to step 2	× Go to step 2	× Go to step 2	× Go to step 2	× Go to Step 2
Step 2	✔ Go to step 3	✔ Go to step 3	✔ Go to step 3	✔ Go to step 3	✔ Go to step 3	✔ Go to step 3	✔ Go to Step 3
Step 3	× Go to step 4	✔ continue	✔ continue	× Go to step 4	× Go to step 4	✔ continue	× Go to Step 4
Step 4	Revisit	———	———	Revisit	Revisit	———	Revisit

Table 3 Evaluation of the external SC information—company-A

Information Attributes	Economic factors	Competitors' information	Seasonality	Regional preferences
Importance	High	High	Medium	Medium
Action-ability	Medium	Medium	Medium	Medium
Reliability	High	Medium	High	Medium
Availability	High	Low	High	Low
Step 1	× Go to step 2	× Go to step 2	× Go to step 2	× Go to step 2
Step 2	✔ Go to step 3	✔ Go to step 3	✔ Go to step 3	✔ Go to step 3
Step 3	✔ continue	× Go to step 4	✔ continue	× Go to step 4
Step 4	———	Revisit	———	Revisit

information. Currently, the company incurs an extra cost to obtain competitors information as it feels the importance and action-ability of competitors' information are high. However, the lack of good quality information impacts on overall benefits of the SC. Hence, it is important for the mangers to decide whether to obtain competitors information from the same source or do they need to explore other possible sources. Similarly, good knowledge on the preferences of local customers of the retailers is vital for the manufacturer to improve long-term planning. The company needs to improve the SC collaboration with the retailers to obtain details any such details on local customers' preferences.

Though the economic factors, competitors' information, seasonality, regional information are not directly related to the SC collaboration, the information is usually incorporated in various supply chain processes. Hence, it is necessary for the company to validate both the internal and the external SC information before including them in the decision making. Some times, the external nature of the SC information (as they are publicly available data or third-party data) needs expert judgements. In many occasions, the external SC information is not incorporated in the immediate supply chain process but in the long-term planning of the company.

5 Conclusion and Scope of Future Research

In this research, we have developed a simple framework of SC information and also have suggested steps to evaluate this framework. Six main attributes of information quality were described. This procedure was illustrated through the case of a textile company. The managerial implication of this procedure governs the top management to decide on the supply chain collaboration based on their need of information exchange. Partners of supply chain collaboration exchange information in various stages of the SC processes. Verifying the quality of the information at every stage will help the mangers to identify and improve any inappropriate information.

For instance, the managers interested in involving the SC information in forecasting can check the appropriateness of information before material resource planning and production. If needed it is also possible for them to revisit collaboration arrangement in order to strengthen the information quality. Earlier research of Forslund and Jonsson (2007) insisted the quality of information to improve performance of the supply chain. This chapter has extended the attribute of quality information into six types. This can be considered as a guideline for future work on supply chain information quality specific to the supply chain collaboration.

This research evaluated the supply chain information framework through a single case study. The supply chain information specific to the company was analyzed for its quality attributes. More case studies with details on specific role of each of the supply chain information in various processes will improve the understanding on the role of information in the supply chain collaborations.

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