Supply Chain Management in the Big Data Era

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A volume in the Advances in Logistics, Operations, and Management Science (ALOMS) Book Series

IGI GLOBAL
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Published in the United States of America by
IGI Global
Business Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

Library of Congress Cataloging-in-Publication Data

Names: Chan, Hing Kai,1973-editor | Subramanian, Nachiappan, 1973-editor | Abdulrahman, Muhammad Dan-Asabe, 1966-editor.
Title: Supply chain management in the big data era / Hing Kai Chan; Nachiappan Subramanian; Muhammad Dan-Asabe Abdulrahman, editor.
Description: Hershey, PA : Business Science Reference, [2017] | Series: Advances in logistics, operations, and management science | Includes bibliographical references and index.
Identifiers: LCCN 2016032838| ISBN 9781522509561 (hardcover) | ISBN 9781522509578 (ebook)
Subjects: LCSH: Business logistics--Management. | Business logistics--Data processing.
Classification: LCC HD38.5 .S8875 2017 | DDC 658.50285/57--dc23 LC record available at https://lccn.loc.gov/2016032838

This book is published in the IGI Global book series Advances in Logistics, Operations, and Management Science (ALOMS) (ISSN: 2327-350X; eISSN: 2327-3518)

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

Chapter 3
How Smart Operations Help Better Planning and Replenishment?
Empirical Study – Supply Chain Collaboration for Smart Operations

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ABSTRACT

This chapter discusses various roles of smart information in Supply Chains (SC) of digital age and tries to answer an important question - What types of collaborative arrangements facilitate smart operations to improve planning, production and timely replenishment? We have conducted longitudinal case studies with firms practicing SC collaborations and also using smart information for operations. Based on the case analysis, the companies are further classified as 'smart planning' and 'traditional planning'. Research findings show the importance of aligning SC partnerships based on smart information requirements. These findings are based on case studies of Indian firms with global SC collaboration. We also discuss the role of Big Data for the companies using smart planning.

DOI: 10.4018/978-1-5225-0956-1.ch003

INTRODUCTION

In current competitive business scenario, it is widely recognized that supply chains, not individual organisations, are responsible for the success or failure of businesses. This has necessitated close relationships among supply chain (SC) members. In the past few decades, in an attempt to improve the overall performance and the efficiency of SCs, many companies have been engaged in collaboration with other SC members. Consequently, several SC management initiatives such as Vendor Managed Inventory, Efficient Consumer Response, Continuous Replenishment and Accurate Response have been proposed in the literature to improve the flow of materials as well as information (Sari, 2008; Ramanathan & Muyldermans, 2010). In this line, Collaborative Planning Forecasting and Replenishment (CPFR) is a relatively new initiative that combines the intelligence of multiple trading partners in planning and fulfilment of customers' orders by linking real time sales data and marketing best practices. In this chapter, we have used the case study approach to understand the actual level of collaboration among SC partners for information exchange. The companies (or firms) chosen for this purpose of study have global operations, maintaining SC collaborations with upstream and downstream partners. These studies are rather used to compare the supply chain collaboration (SCC) practices in information exchange and smart operations, and not intended for cross-country comparison.

In general, businesses interested in improving either cost effectiveness or overall SC performance tend to collaborate with other SC members (McIvor et al., 2003; McCarthy & Golicic, 2002; Matchette & Seikel, 2004). In this line, the businesses with similar objectives work closer to achieve the desired excellence in common SC processes such as planning, forecasting, production and replenishment (Ramanathan & Muyldermans, 2010). However, the extent and intensity of collaboration vary greatly based on individual business objectives, which in turn define the level of SC collaboration (Larsen et al., 2003, ECR Europe, 2002; Ramanathan, 2012). Precisely, the company's attitude and behaviour towards transparent information exchange in line with their business objectives decide the level of collaboration. In SC collaborative relationships, information exchange is considered an integral part of bridging all the SC members (Ramanathan & Muyldermans, 2010). While, the exchange of point-of-sales (POS) information and inventory records are widely encouraged within the SCs (Gavirneni et al., 1999; Raghunathan, 1999), the role of other real time information such as promotional plans, forecasts and production levels for planning are not much discussed in great detail in the literature. Until recently, significance of smart planning and role of social media are not explained in such a way to motivate many SC members to use and analyze big data for business enhancement.

The research study reported in this chapter explores the operations of supply chain collaboration and highlights the corresponding benefits in different firms using case studies of companies operating in 'smart planning' and 'traditional planning' environments. The main reason for considering two different types of companies is that the information exchange may or may not be important for companies operating in traditional planning (similar to make-to-stock) as the general objective of the business is selling the products in stock (both finished and work-in-progress stock). Meanwhile, in smart planning environment the production is mainly based on the real time demand or orders placed by the downstream buyers and hence there may or may not be a need for other information. In simple terms, 'smart planning' uses real time data and 'traditional planning' uses historic data. In this research, the role of information exchange among collaborating partners is analysed with a focus on its role in demand planning. Here real time data refers to the sales data, information from social media such as twitter, Facebook, on-line feedback and complaints.

The rest of the chapter is organized as follows: Section 2 explores the literature on SC information exchange and also describes the research approach of this study. Section 3 explains the research design and the role of case companies in the SCs. Section 4 discusses the cross-case analysis in detail. The role of smart information in case companies are further discussed in Section 5. Based on the importance of SC information, the role of SC collaboration is analyzed in Section 6. Finally, section 7 summarises the findings and also discusses the possible future work.

LITERATURE ON SUPPLY CHAIN INFORMATION AND RESEARCH APPROACH

Today's competitive and unpredictable business world complicates the demand planning. In many SCs, order variability increases from downstream to upstream and can result in excess inventory and huge obsolescence throughout SCs (Lee et al., 1997). To avoid such problems, information exchange and SC collaborations are encouraged in the literature. Sports Obermeyer (manufacturer of fashion skiwear) identified that the real success of a product was dependent on customers' response to the product (Fisher et al., 1994). In case of Sports Obermeyer the exchange of POS data from downstream members helped the upstream members to understand the demand patterns, which in turn assisted the future planning, production and replenishments. But any such information exchange is possible only when there is a mutual benefit for SC members on collaboration (Toktay et al., 2000).

According to CPFR, the purposes of various SC relationships are mainly of three types: production planning, information sharing and forecasting, and replenishment. Companies that collaborate for production planning may need to have

cross-functional activities and clear power sharing agreements to better align their production processes (Akkermans et al., 1999; Beamon, 1999). Companies that collaborate for information sharing and forecasting may need to accept organisational changes, both internal and external to the company, to improve the performance (Barratt and Oliveira, 2001; Forme et al., 2007). This will help the SC partners in joint decision making. Companies that collaborate for timely replenishment need to maintain effective logistical performances (Simchi-Levi & Zhao, 2005; Chen & Paulraj, 2004). Most of these studies have discussed the purpose of the SC relationship, but in isolation from the effort of SC information sharing.

Lee (2002) has presented a framework that matched SC strategies with demand and supply uncertainties of both functional and innovative products. Normally, the functional products are those with stable demand patterns (Fisher, 1997). However, the demand of functional products need not be quite stable in the presence of sales promotions. In recent years, sales promotions at retail outlets have become a common practice, especially in the UK to increase normal sales. These sales promotions result in huge fluctuations in the demand pattern of the functional products in contrast to a stable demand pattern as defined in Lee (2002) and Fisher (1997). On the other hand, to execute sales promotions, active participation from all SC partners is highly critical. The SC collaboration may be a good option to improve the agility in SCs (Aviv, 2007). This is mainly because the CPFR framework encourages transparent information exchange as one of the key elements of collaboration (VICS, 2002). This particular aspect of information exchange in SC collaborations is considered further in this research to identify the role of information exchange in SC processes.

In contrast to traditional SC practices, today's SC management is more transparent to all SC operators. Healthy collaborative arrangements among SC partners have been proved to be a successful integral part of many world-class businesses such as Wal-Mart, Sara Lee, Nabisco etc (Lee, 2002). Following the successful adoption of CPFR in the US, many companies around the globe have tested the collaborative partnerships in SCs (Seifert, 2003). In this effort of collaboration, transparent information exchange among SCs hopes to reduce uncertainty and avoid excess inventory (Holweg et al*.,* 2005; Chen et al*.,* 2000).

Initially at the inception of CPFR, understanding of the collaboration process and the framework to collaborate have been considered the two basic requirements for a collaborative SC (Barratt & Oliveira, 2001; Ramanathan et al., 2011). In later stages, the information sharing has been recognised as one of the key elements for the success of the collaboration (Seifert, 2003). Li and Wang (2007) asserted that the benefit of information sharing is dependent on two factors: one is content and another is proper use of information. Distorted information due to behavioural issues (such as lack of trust and less-transparent business operations) and an inefficient use of available data will lead to poor business performance such as excess inventory in

each level of the SCs (Nyaga et al., 2010). Hence, it will be important for the collaborating companies to decide on what information to exchange in order to reduce costs, to create more accurate demand forecasts, to make flexible production plans, and also to achieve timely replenishments (Ramanathan & Muyldermans, 2010).

Once the information is in place, data analysis is another important aspect for the companies to plan and decide. Sharing of demand information with upstream members can help reducing the manufactures' SC cost (Raghunathan, 1999) and also can reduce the inventory cost of both supplier and buyer (Gavirneni, et al., 1999, Lee, et al., 2000; Graves, 1999). Sharing demand information along with current inventory status facilitates achieving reductions in inventory cost (Chen 1998; Cachon & Fisher, 2000). Depending on the data analysis capabilities (technology and manpower) of the parties involved, the benefit of information sharing will also range from basic inventory reduction to higher profit earning. The manufacturer can reduce the variance in demand forecasts if POS data and market-data-sharing are found influential in achieving forecast accuracy. A more detailed discussion on the value of information sharing in SCs is given in Li et al. (2005). Sanders and Premus (2005) attempted to model the relationship between firms' IT capability, collaboration and performance.

Most of the above discussed literature lists the benefits of exchanging POS or inventory data but not any other real time information such as social media data. Recognizing the types of information to be shared among SC members to build-in more visibility is a big challenge in achieving collaboration (Barratt & Oliveira, 2001). Ryu et al. (2009) presented a simulation study on the evaluation of SC information (SCI) sharing. They compared the value of exchanging short term forecasts and long-term forecasts among SC players. Under high demand variability, long-term forecasts analysis performed better than short-term forecasts analysis. Accordingly, under low demand variability, short-term forecasts analysis performed better than long-term forecasts analysis. Using store level SKU data, Ali et al. (2009) found that simple time series forecasting will be appropriate for normal sales without promotions. They suggested using advanced analysis techniques for sophisticated input to improve forecast accuracy of promotional sales. See Table 1 for more literature on information sharing in SCs for various purposes.

While most of the articles supported sharing the POS data for cost reduction and forecasting, a study in Japanese manufacturing sector by Nakano (2009) claimed that internal forecasting analysis (with-in the firm), but not external collaborative forecasting (with other SC players), had significant impact on logistics and production performance. However, his structural equation model results identified a positive relationship between internal forecasting analysis and planning, and external (upstream/downstream) collaborative forecasting. Sometimes the POS data may distract decision making particularly if the product demand is highly fluctuating

Table 1. Literature on purpose of information sharing

Authors	Information	Purpose
Bourland et al. (1996)	Inventory	Minimising inventory cost
Cachon and Fisher (1997)	Historical data (no need to invest)	Decision on technology investment
Chen (1998)	Demand and inventory	Minimising total inventory cost
Gavireneni et al. (1999)	POS and Inventory	Minimising inventory cost
Cachon and Fisher (2000)	Demand and inventory	Minimising inventory cost
Lee et al.(2000); Smaros (2007)	Demand information	Minimising inventory cost ; Demand forecast
Raghunathan (2001)	Order history (no need to invest)	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 SC cost saving
Chang et al.(2007)	POS & market data	Improve responsiveness to demand fluctuations
Ketzenberg (2009)	Demand, recovery yield, capacity utilisation	Capacity utilisation showed more value than any other information in a capacitated closed loop SC.
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 and Muyldermans (2010); Ramanathan (2012)	Electronic point of sales data	Improve promotional sales forecasting and help managers to identify the actual demand factors

(Steckel et al., 2004). Aviv (2001; 2007), using mathematical models, proved that collaborative forecasting (CF) could improve the forecast accuracy of products with short lead times and also CF could improve the overall performance of SC by about four percentage. However, depending on other factors, such as explanatory power of the SC partners, the supply side agility, and the internal service rate, the performance improvement will differ (Aviv, 2007).

The quality of the information exchanged among the SC partners is another important factor of analysis that decides the performance. The overall SC performance has been proved higher with high quality information from SC partners (Forsuland & Jonsson, 2007; Zhao et al., 2002). But, obtaining the high quality information in

the SC requires a high level of cooperation and trust among various players (Barratt and Oliveria, 2001; Fliedner, 2003). Good inter-organisational communication among various SC players is therefore necessary (Paulraj et al., 2008). This inter-organisational communication is vital especially during sales promotions to achieve good forecast accuracy because the buying behaviour of customers are influenced by various factors (Sun, 2005). Identifying the underlying demand factors using SCI can help improving the accuracy of demand forecasting, particularly for promotional sales (Ramanathan & Muyldermans, 2011; Danese & Kalchschmidt, 2011). In 21st century, companies operating in high competitive markets are using Big data, especially social media data, to understand demand fluctuations, to identify issues with product/delivery and also to analyse the customer needs.

Further in this research, case analyses of five manufacturing and processing companies unveil the operations of SC collaborations with a special focus to information exchange for demand planning and hence supports the decision making.

RESEARCH DESIGN AND CASE DESCRIPTIONS

Research Design and Case Studies

We employ a case study approach to understand the extent of collaborative arrangements of manufacturers/suppliers with downstream SC members. In this effort, companies operating in different environments such as 'smart planning' and 'traditional planning' are studied. As suggested by Yin (1994), in this research five different types of cases are considered for descriptive analysis (Table 2). However, all these multiple cases are chosen under a single unit of analysis namely SCI exchange for data analysis (Voss et al., 2002). All the five case companies practice SC

Table 2. Research plan for case studies

		Complexity of Planning	
		Easy to Plan	**Difficult to Plan**
Type of Environments	**Smart Planning**	Petroleum Company	Textile Company Electrical Company Frozen-food Company
	Traditional Planning	Packaging Company Electrical Company Frozen-food Company	Textile Company

collaboration with downstream customers. We have used a three stage approach to analyses the cases under study:

Stage 1: Understand the operations using real-time information for planning and decision making
Stage 2: Critically analyze the modifications made in the operations' planning and decision making in line with the SC information
Stage 3: Compare the changes made in planning & decision making in the presence and the absence of the SC information

We have further classified the products of the case companies based on the level of difficulty of demand planning (Ramanathan, 2012). From the case study observations, based on the demand forecasts accuracy we classify the products into two categories – 'easy to plan' and 'difficult to plan'. 'Easy to plan' represents 'planning matching with execution' (for example timely replenishment) with accuracy of 50% and above. The planning accuracy of products falling below 50% has been considered as 'difficult to plan'. From the cases studied, it has been identified that the products are following two main types of planning – 'smart planning' and 'traditional planning'. Hence, this research analyses the cases in two main dimensions, namely type of planning and complexity of planning due to demand variability (easy to plan and difficult to plan) (see Table 2).

Case Descriptions

Study 1: Frozen-Food Manufacturer

The first case involved a leading frozen food manufacturer, Frozen-food Co and some of their customers (retailers and wholesalers), located in the UK and Europe. The case company produces a variety of 'ready-made' food and sells those products through major retailers in the UK and European countries. Frozen-food Company is involved in various promotional sales and hence it maintains a healthy collaborative relationship with their customers. The demand planning complicates at the time of promotional sales. In this study, the main focus is relation between Frozen-food Company with its downstream partners and the role of SCI exchange. The company uses quarterly point of sale data and order demand information for planning delivery.

Study 2: Fashion Textile Material Manufacturer

The second case study involves a manufacturer of textile materials, Textile Company, situated in India. They export their products to many countries around the

world. The company produces both customised and standard textile materials. The company collaborates with their downstream partners for information exchange and replenishment. Since 2006, the company has been involved in a formal collaborative arrangement with some of its customers in the USA (Wal-Mart and Jo-Ann stores). The company uses the latest communication technology for quick data transfer. Information technology and data transfer are of prime importance for this company to compete in the competitive market. For repeat orders with standard product specification, the company follows traditional planning. Although the company is involved in both traditional and smart planning, decision making at times of complexity seems to be under strict control of top management.

Study 3: Petroleum Company: Refiners and Distributors

The third case study was conducted in a Petroleum company who refines and distributes crude oil within India. This company owns and operates the largest refinery in the country producing crude oils of international standards. With a capacity of 335,000 Metric Tonnes per annum this refinery accounts for over 40% of the country's total oil production. The company has retail outlets all over the country. The case study was conducted at its main distribution centre. This company has just one primary supplier; while it has many customers. The case company is a main distributor for the products namely Gasoline, High Speed Diesel, Superior Kerosene Oil, Furnace Oil, Light Diesel Oil, and Aviation Turbine Fuel. The customers of the company are mostly distributors to many other private and public customers. The company has strong SC collaborations with both the upstream and the downstream partners. Real time information exchange between the company and their clients is mainly used for timely replenishments and placing orders.

Study 4: Packaging Material Manufacturer

Packaging Company is a manufacturer of packing materials, situated in India. This company was established in 1966 in India and has four manufacturing plants across the country. The products of the company include Jumbo size bags for - the petrochemical industry, the mineral industry, the dyeing industry and the pharmaceutical industry. This firm has manufacturing plants in four different locations in India. The products of Packaging Company are being used by their customers to export the goods and machinery internationally. The company manufactures to stock and also to orders. The company's communication with their customers is mainly through the recent online technology namely iMail Server. The company's recent upgrade of communication technology has removed earlier communication difficulties and has

helped avoiding replenishment delays. This smart information is being used for ad-hoc planning. However, main planning of the company considers using historical data.

Study 5: Flame Proof Electrical Equipment Manufacturer

The fifth case study is about an electrical equipment manufacturing company, Electrical Company. This is a privately owned Electrical Engineering Company based in Melbourne, Australia. Since 1949, the company has been functioning as a manufacturer and supplier of Explosion Protected Lighting and Electrical equipment of high quality for domestic and international markets. Their products are used by oil companies in Australia and are exported to over 20 countries in the Asia-pacific and Middle East regions. Due to its global operations, the company has manufacturing plants and distribution centers across the world. We have conducted this study in India. This company uses two different approach of planning depending on facilities available in their client base as not many clients are having smart technology for instant information exchange.

The interviews with all five case companies have been conducted in different periods of time with top and middle managers. A list of the main contacts, the period of interviews, the number of personal and telephonic interviews is shown in Table 3. The prime focus in this research is to better understand the collaborative arrangement and information exchange with downstream partners in each of the companies, to facilitate the process of demand planning including production and replenishment. Interviews and company visits helped to understand the SCI for demand analysis and also to understand the use of SCI in planning and its further role in firm's decision making. Since quantitative sales information were made available only by some companies, in this research, we have not attempted to compare the benefit of collaboration in terms of sales.

The purpose of collaboration in the case companies is mainly to forecast and/or plan timely replenishment. Accordingly, each of the case companies differs in its information need, which is analysed further by comparing each of the cases with the other company on various attributes.

CROSS-CASE ANALYSIS

Table 4 reports the case study details of all of the five cases considered in this research. This cross case detail outlines the products of the company in the environment of 'smart planning' and 'traditional planning'. The supplier base of Petroleum Company and Frozen-food Company are local operators, while the other companies

Table 3. Details of case company interviews

Company	Main Contact	Period	No. of (Face-to-Face) Interviews	No. of Telephone Interviews	Total Hours
Frozen-food Company	Planning Manager	2012	2	-	6
	Customer Demand Analyst				
Fashion textile Company	Secretary to MD*	2007-2009; 2011;2015	6	5	12
	Planning Manager				
Petroleum Company	Distribution Manager	2007-2008;2011	3	1	6
	Logistics Manager				
Packaging Company	Managing Director	2007-2009;2012	6	3	12
	Planning Manager				
	Demand Analyst				
Electrical Company	Operations Manager	2007-2008	3	0	5
	Distribution Manager				
				Total hours of interview	**41**

*people at different positions were interviewed

have global supply base. Except Petroleum Company all of the other companies have more than 5 suppliers. Customers of Petroleum Company are operating locally within the countries. However, all of the other companies are also dealing with global customers. This necessitates intense information exchange. Some products of the case companies are considered as functional while textile products are considered as fashion driven and electrical products are considered as innovative. All the companies have more than 5 product lines with more than 15 stock keeping units (SKU).

Frozen-food Company is the newest companies of all the cases considered. Petroleum Co. is in the market for more than 50 years with mature products, while the life cycle stage of other products are either in mature or growth stage. This classification of product life cycle is given by the company based on the products. The shelf life of all of the products varies from 2 days to 2 years and more. The production and distribution lead time also varies widely from 2 days to 6 months. Except Petroleum Co. all the companies have low supply uncertainty. But demand uncertainty of promotional products is quite high while demand varies from low to medium for other products under ‘smart planning’ and ‘traditional planning’ environ-

Table 4. Case study details

	Frozen-Food Co. Study-1	Textile Co. Study-2	Petroleum Co. Study-3	Packaging Co. Study-4	EEM Co. Study-5
Planning Environment	Traditional	40% Smart 60% Traditional	Smart	Traditional	75% Smart 25% Traditional
Location of suppliers **Number of suppliers**	India 7-15	Yarn: India Machinery: Switzerland, Italy 10-30	India 1	Jute: India Paper: India Machinery: India, Japan 5-15	India, Australia 5-10
Location of customers **Number of customers** **Type of customers**	UK and Europe > 4000 Retailers	Europe, USA, UK, Dubai, Abu Dhabi, & India > 200 Wholesalers/ Retailers	India > 2000 Distributors wholesalers/ retailers	India, Japan (more than 100 Customers) >100 OEM/ Wholesalers	India, Australia, Thailand, Malaysia, Korea, Japan, Iran, Australia, Indonesia, Saudi Arabia, Qatar, India > 50 OEM/Wholesalers
Product type	Functional	Fashion driven	Functional	Functional	Innovative
Number of product lines/ product families	10	5	6	5	5
Number of SKUs	>80	>50	>15	Unlimited	Unlimited
Product life cycle length	Very long	Short	Very long	Long	Short or Medium
Product life cycle stage	Growth / Mature	Growth	Mature	Growth	Growth
Product shelf life (Short/ Medium/ Very long)	2 days - 9 months (Short)	2 - 6 months (Short)	Very long	1-2 years (Medium)	Very long
Total lead time	3 days – 2 weeks	6 weeks – 8 weeks	Real time basis (refining 24 hours)	3-4 days (excluding logistics)	One week – six months
Supply uncertainty	Low	Low	Medium	Low	Low
Demand uncertainty	Normal sales-Low Promotions-High	Normal sales-Low Promotions-High	Low	Low	MTS-Medium MTO- Low
Main reasons for demand fluctuation	Promotions	Promotions, seasons, trend	Price, new vehicles and new customers	Government policy and new product introduction of downstream partners	New projects and new regulations on safety products

continued on following page

Table 4. Continued

	Frozen-Food Co. Study-1	Textile Co. Study-2	Petroleum Co. Study-3	Packaging Co. Study-4	EEM Co. Study-5
Main reasons for collaboration with downstream members	Promotions Timely replenishment	Promotions Timely replenishment	Timely replenishment	N/A	N/A
Main reasons for collaboration with upstream members	Timely replenishment	Timely replenishment	Timely replenishment	Timely replenishment New projects information	Timely replenishment New projects information
Purpose/ information exchange	Planning Replenishment	Planning Replenishment	Replenishment	Replenishment	Replenishment
Technology used to communicate and for information exchange	Web based	Advanced communication: Blackberry for all partners and workers to check email; kiwi to contact Switzerland and Germany, Skype to communicate with UK and USA.	Advanced automated inventory status, emails, web server, SMS, phone and fax	Simple communication: Telephone, fax and emails	Simple communication: Telephone, fax and emails, web based information exchange is under development to check inventory position.
Important information exchanged - downstream	Promotion plans, inventory, price, delivery time, order, feedback	Promotional sales discount, trend, seasonal, order, replenishment plans inventory, local forecast, feedback	Inventory, replenishment plans, order, feedback	Inventory, production, order, local forecast	Inventory, production, order, local forecast, Feedback and complaints
Information used in forecasting	Historical sales promotional plans, local forecast, special days	Historical sales promotional plans, local forecast, seasons and trend	Historical sales	Historic sales	N/A
Information used in replenishment	Sales forecast and inventory status	Historical sales, discount, trend, production, logistics, Government policy	Inventory status	Inventory status	Inventory status

ment. Both demand and supply uncertainty are classified as low or medium or high based on the products.

The use of SCI for forecasting and replenishment is different for all these companies. This is mainly because the main purposes of collaboration in each of the case companies are of two types - promotional planning and timely replenishment. The companies involved in promotional sales (Frozen-food Company and Textile Company) exchange detailed information with downstream partners for planning and forecasting analysis while the others exchange limited or less detailed information with downstream partners and it is mainly for timely replenishment. To facilitate such information exchange, each of the case companies is engaged in different levels of SC collaborations with downstream SC partners. Frozen-food. and Textile Company are involved in intense SCI exchange with downstream partners especially for promotional sales. However, frozen-food Company has not invested in real-time information exchange due to financial constraints. But still it is trying to use web-based low cost technology to maximize the information exchange.

ROLE OF SMART INFORMATION

Some of the case companies studied use selective SCI for planning, forecasting and replenishment, while the others use commonly or easily available SCI for planning the daily operations. For example, the historical sales information is used by the Frozen-food Company for planning and forecasting and POS data is used for replenishment; however, the sales information is used mainly for the long-term planning in Packaging Company but not for the short term-planning.

The products of all of the cases studied can be classified under two main categories ‘smart planning’ and ‘traditional planning’. Planning and forecasting of petroleum products is rather simple in comparison to the other companies. Hence, these products are further classified, based on the level of difficulty in demand planning, into ‘easy to plan’ and ‘difficult to plan’. It is important to note that the short term forecasting is more important for products, such as standard packaging materials and frozen-food, than other products. This is because in a traditional environment, orders are received from customers and hence the demand is known. In this case, the demand forecast is important to avoid the bullwhip effect (Lee et al., 1997). Accurate demand forecasts can also help reducing stock-out and excess inventory. Based on the levels of difficulty in demand planning, different forecasting approaches are applied.

Currently, Frozen-food Company uses simple forecasting technique, and the company gets irregular orders from its suppliers (from European buyers). This leaves the company from not benefitting by the quantity discounts offered by logistics

operators (i.e. when orders are placed as full truck loads). Planning manager of the company expressed his views as:

We understand that we could save at least 15% of our logistics cost by making use of full load or economic order quantity. Currently we place orders to our suppliers as and when we get orders from our buyers. However, in future we will try and use real time information and demand forecasts to place our orders that will help us to avail discounts on full truck load, offered by our logistics partners.

Interview with frozen-food gave a clear indication of its plan of using - the simple forecasting techniques, namely moving average to predict the demand and Economic order quantity (EOQ) models to order a full truck load in obtaining price discount. Companies would benefit from reduced inventory levels, while maintaining high service and at the same time earning the quantity discounts when it would engage in a closer collaboration for example with suppliers of frozen-food. That collaboration could involve making end customer demand visible, applying simple forecasting procedures and EOQ policies (with possibly joint replenishments for the slow-moving items) and perhaps even engaging in a VMI arrangement with suppliers.

Petroleum Company maintains a good collaborative relationship with down-stream SC partners so as to make timely replenishments. A highlighting point on forecasting from a Logistics Manager of the company is

We do not want to spend a huge amount of time and money in forecasting as our supply source is limited. Our daily sales records make us prepared for future timely replenishments.

Currently, Petroleum Company exercises VMI and inventory pooling with some retail customers. This inventory pooling facility can be extended to others to obtain full benefit of SC collaboration. Demand variability of products at Petroleum Co. is low, and hence the demand for these two products can be determined by simple forecasting techniques, for example, moving average or exponential smoothing method.

From the cases, it is clear that the SC companies, manufacturing frozen-food products and textile products, are difficult to forecast when sales promotions are offered by retailers. To forecast these products, different demand factors need to be identified (Ramanathan and Muyldermans, 2011). More sophisticated planning and decision tools can be used to better match the demand with explanatory factors (Ramanathan, 2012). It is possible to say the products that are 'difficult to plan' can combine both traditional quantitative data and other quantitative social media data

for analysis and decision making. This can help the company to improve demand planning and timely replenishment (see Table 5). Difficult to plan situation will arise in the following cases:

- **Sales Promotions:** Frozen-food and textile Company.
- **Products with Short Shelf Life or Short Life Cycle:** Textile Company for fashion driven products.
- **After Market Spare Parts:** Electric Company for maintenance revamping and overhauling.

The demand for petroleum and crude oil are mostly stable and smooth. Hence, it should be easy for Petroleum Co. to forecast the demand using standard forecasting techniques such as exponential smoothing or moving average method. However, SC collaboration with downstream partners is essential to make end customers' demand visible and also to ensure timely replenishments.

The companies operating in 'Traditional environment' such as Packaging Company and Electrical Company do not make any short-term plans using the SCI from downstream partners. SCI from downstream partners is normally used to make long term forecasts and material resource planning. From the above discussions, we can understand that the type of companies, classified based on the number of echelons, will not necessarily have a common planning requirement. The complexity of order fluctuations based on the end-demand normally helps to identify the SC collaborative arrangement for planning. Based on the current practices of SCs, we discuss the SC collaboration appropriate to each of these case companies further in the next section.

Table 5. Suggested SC collaboration

		Complexity of Planning	
		Easy to Plan	**Difficult to Plan**
Type of Environments	Smart Planning	• Use standard forecasting techniques for demand planning • Make end customer demand visible • Use VMI to ensure timely replenishment	• Use Big data to identify demand factors • Analyse data for decision making • Use SCC for transparent information exchange
	Traditional Planning	• Use SCC to know demand information	• Make end customer demand visible • Involve SC partners in planning and decision making

SUPPLY CHAIN COLLABORATION IN THE CASE COMPANIES

New Managerial Approach for Current Practices

Frozen-food Company maintains a good collaborative relationship with downstream partners, especially retailers. But, the promotional sales information is not well communicated in all cases. This is reflected in the high order variability. By establishing collaboration with up- and downstream partners, the company can improve the visibility of end customer demand. Engaging in a VMI arrangement could be highly beneficial (regular replenishment of orders in full truck loads). In order to achieve this VMI arrangement, the company needs to have reliable staff representatives working in close relationships with European retailers.

Textile Company believes that establishing the basic communication at transactional level is enough with new customers or relatively new customers (Ramanathan, 2012). Currently, Textile Company motivates existing customers for future collaboration through offering free samples. If these 'free samples' sell quickly in the local market, customers may plan the future promotion in collaboration with Textile Company. The communication between the two parties concentrates on promotional sales only. In other words, the information exchange between Textile Company and their customers is elaborate at the time of promotions but restricted at all the other times. This relationship on promotional sales can generally be extended by the company further on future business expansions. As this company is also seeking customer feedback, this qualitative information can be fed into the process of decision making.

Petroleum Company has well established collaboration and VMI with downstream partners (nearly 20 percent customers) to ensure timely replenishment. This arrangement can be extended further for the remaining customers. Electrical and Packaging Companies do not maintain well established downstream SC collaboration for a few customers with irregular orders as they do not find much value on downstream SCI. These two companies can think of establishing both downstream and upstream SC collaboration. As most of the products are manufacturing to orders, the collaboration with upstream SC partners may help the companies to have raw materials on time for production.

All the case companies studied are using POS data for demand forecasting analysis and social media data for understanding the market. Reviews, complaints and feedback are main concerns of the company managements for planning and quality improvements (long-term plans). In case of the Textile Company, social media comments are of high importance for product design development and delivery.

The suggestions made in this section (see Table 5) have been conveyed to the case companies. Later at the time of writing this chapter that was nearly after three

years of conducting the case studies, we were informed by the companies that they were progressing well in the SCI and demand planning, after adopting the suggested levels of SC collaborations.

New Perspectives of SC Collaboration

This research has considered functional products, fashion products and innovative products in two different environments. However, the demand fluctuations of functional products are not the same for all cases considered in this study. Some companies have promotional sales as a regular feature of business strategy. The cases considered for this study included both functional products (frozen-food products) and fashion driven products (textile products). According to Lee (2002) functional products will have low demand variability compared to innovative (fashion apparels) products. However, the demand patterns are highly fluctuating for these two products as the sales are affected by promotions. Analysis of these cases suggested considering all possible SCI to improve forecasting and replenishment. Hence, for Textile and Frozen-food Company a high level collaboration with downstream SC partners will be beneficial. In simple terms, supply chain collaboration with information exchange for smart operations will be ideal for these two companies.

Demand for crude oil or petroleum products are easy to predict and hence planning is not complicated. In this case information from downstream SC partners is required to ensure timely replenishment. Information exchange includes aggregated demand and inventory status. Based on stock levels, the replenishment can be made on time. Hence, vendor managed inventory (VMI) is suggested for these types of companies. Demand planning of products of Packaging Co. and EEM Co. do not benefit much by information from downstream SC partners. Hence, transactional level of collaboration is found beneficial by these two companies. In summary, it is possible to conclude that the environments where planning is difficult, require a high level of collaboration with downstream SC partners (e.g. CPFR), the environments where planning is easy require a medium level of collaboration with downstream SC partners. The companies with smart planning can achieve timely delivery with the help of SC collaboration and inventory can be managed by vendors. Here, it is also ideal to use the social media data to make any adjustment on original plans of delivery based on current real-time difficulties. Recent conversation with Textile Company in 2015 revealed that the company has started using social media data, especially Facebook and twitter, in their planning and delivery operations to improve operational performance of the company.

While the previous literature identified that different levels and degrees of collaboration were possible (Larsen et al, 2003; Danese, 2007; Ramanathan, 2012), this current research related SCI with type of planning and its level of complexity

to decide on the appropriate level of SC collaboration. Our research has answered a main research question on types of collaborative arrangements and forecasting approaches in SCs. This can be considered as one of the key contributions to the literature.

CONCLUSION AND FUTURE RESEARCH

All the cases analysed were of two types: Planning with traditional approach and planning with smart information. In the traditional planning environment, SCI from downstream partners helped short-term forecasting and replenishments. In the smart planning environment, SCI from downstream partners was used for both long-term and short-term forecasting and planning. It has been largely agreed that the use of Vendor Managed Inventory will be sufficiently supporting the replenishment when planning is easy with smart information. The demand planning is complicated for some companies even in the presence of smart information due to its complex nature of operations. Those companies can involve in high level 'futuristic' SC collaboration with transparent information exchange (Ramanathan, 2012). Adapting web-based collaborative tool, such as CPFR, is one of the options to have high level of SCC with real-time data. In the cases we considered some products with traditional planning approach were easy to plan while the others were difficult to plan. Easy to plan products, following traditional approach of planning, can be controlled by planning with the help of knowing demand information. However, 'difficult to plan' environment following traditional planning approach will warrant support from downstream SC partners in order to obtain detailed demand information. In this case, higher level of information exchange (such as Big data) and data analysis can be used in planning and decision making.

Significant results have emerged from this research. The results strongly support SC collaboration in traditional planning environments with promotional sales. It is also evident that the exchange of detailed sales information from downstream to upstream SC members might improve the accuracy of demand forecasts. Information exchange is also required to ensure timely replenishment. Lucrative benefits of collaboration encourage many SC members to initiate the process of collaboration. This is reflected in recent SCs having information exchange as one of the core processes in a formal or less formal collaboration (Chang *et al*., 2007). Some companies use the demand forecast information in other SC processes to operational performance (Danese and Kalchschmidt, 2011). It is widely agreed by academics and practitioners (Fisher, 1997; Lee, 2002) that in order to achieve good SC performance, it is essential to have collaboration among SC members. This research has identified the need for SC collaboration in all cases. But high level of data requirement is identi-

fied for companies operating in a high competition and volatile market. In these cases information from SC members may not be sufficient to sustain the market and hence the concept of Big Data of combining qualitative and quantitative sales data will support planning operations and replenishment. It is also important to consider future investments on Big Data carefully for data use and information sharing in relation to the profitability.

The data analysis and further consultation of companies, namely Packaging Co. and EEM Co., helped to point out that the short term planning is not so important because the company receives orders from customers, hence demand is known. But material requirements planning is vital to ensure compliance with due dates and also to make sure the company get raw materials from its suppliers on time. A close relationship with upstream SC members may help them to have smooth production process with shorter lead times and also to ensure timely replenishment. Supply side collaboration with smart operations may assist companies in

- Resource planning.
- Supplier selection based on lead time/quality/reliability.
- Real-time information exchange including sales data and social media data.
- Delivery plans.

Future research on supply side (upstream) collaboration can potentially guide the managers to decide on what information needs to be exchanged with upstream SC partners. Such information exchange can guide them to decide on whether to make or buy raw materials required for production. For example, Packaging Co. is currently producing its raw material (fabric). But in case of urgent orders, to reduce lead time the company buy fabric from other suppliers. SC collaboration with upstream partners may be particularly interesting in certain environments with a complex supply base and stringent capacity constraints (necessitating frequent make or buy decisions).

This research was based on case companies producing functional, fashion driven and innovative products. To make the findings of these cases more general, a larger number of cases need to be analyzed, considering other environments. Cases similar to Saturn's after-market spare parts and Sports Obermeyer can be considered (Cohen et al., 2000; Fisher et al., 1994). Future research can also include companies with difficulty in planning and forecasting in the presence of Big Data. This will help to draw a general conclusion on the information need in different SCs in different manufacturing environments.

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