

Coordination Mechanisms for Supply Chain: A Review

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ABSTRACT

Today, globalisation, outsourcing, and continuous innovations in information technology result in increased dependency among supply chain (SC) members. As this dependency increases, the extent of risk and uncertainty also increase. This situation requires effective coordination among SC members to meet these challenges. Therefore, for better understanding of the coordination in supply chain and methodologies to achieve it, a systematic literature review is presented to elaborate the term coordination, and enlist the important coordination mechanisms.

Keywords: Supply Chain Management, Coordination, Supply Chain Coordination, Coordination Mechanism

INTRODUCTION

Supply chain management is management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole (Christopher, 1992, Singh & Gupta, 2014). In supply chain management, different areas of an organisation like, material, men, money, and information are managed by strategic and systematic efforts of different business activities within and outside the organisation to improve long run performances of business for achieving maximum benefits and to maximise customer satisfaction to make competitive effectiveness (Singhal, Agarwal, & Sharma, 2016). A supply chain can be visualised as comprising inter-dependent members who depend on each other for managing various resources such as money, inventory, and information. Generally, supply chains are complex due to number of activities spread over multiple functions as well as organisations. It becomes difficult for supply chain members to compete as independent members. Therefore, to improve the performance of supply chain, all the members of supply chain must act as a part of an inter-dependent system. In this way, the term “coordination” comes at focal point as it is visualised as managing the dependencies among activities.

Malone and Crowston (1994) define coordination as the management of dependencies between activities, whereas interdependency is the extent of influence on one referent

system by the actions of another referent system (McCann & Ferry, 1979) or the degree to which one process depends on the other to achieve the overall value creation processes (Simatupang, Wright, & Sridharan, 2002). It means that coordination comes into picture wherever there is existence of dependency and supply chain witnesses dependency among various activities within the organisation as well as across the organisation. The performance of a supply chain depends critically on how its members coordinate their decisions (Gour, Singh, & Sohani, 2013). Therefore, it drags the attention to get an insight of coordination in supply chain to improve performance.

Coordination mechanism is a certain set of methodologies that is applied to manage various dependencies among the activities. Dependencies in supply chain can be managed by coordination mechanisms and thus better performance of supply chain can be obtained. Coordination mechanisms are widely applicable in industry as they eliminate barriers of supply chain performance (Stern, El-Ansary, & Coughlan, 1996) and help in attaining the desirable performance (Kumar & Seth, 1998).

Coordination requires observing the process then identifying various activities, interdependencies among them, and performers with their roles and responsibilities. Further analysis leads to specify methodologies or coordination mechanisms to manage the dependency to resolve conflicts and enhance cooperation in order to bring

benefits to supply chain members.

On the basis of requirement of coordination between supply chain processes such as procurement-production, distribution-production, inventory-distribution, different models of coordination in supply chain are presented by researchers, whereas some researchers addressed barriers in supply chain coordination such as opportunistic behaviour, different interests, outdated policies, misalignment of performance measures. Researchers have also given a significant contribution in identifying various coordination mechanisms focusing on coordination issues in supply chains such as logistics synchronisation, information sharing, decision making, incentive alignment, information technology (IT), trust among members, and supply chain partnerships. Researchers of this area emphasise on multiple benefits resulting from effective coordination of the supply chain such as efficient product developments efforts, increase in customer retention,

eliminating excess inventory, reducing lead times, increase in sales, improvement in customer service, reduction in manufacturing costs, revenue enhancements.

REVIEW OF LITERATURE

In this section, the efforts of various researchers on supply chain coordination are consolidated by identifying approaches of coordination and explanation of various mechanisms designed to solve specific problems of coordination.

Simatupang et al. (2002) presented four coordination modes in his taxonomy of coordination based on mutuality and focus perspective which should exist simultaneously to attain better performance. These are information sharing, incentive alignment, logistics synchronisation and collective learning.

Table 1: Taxonomy of Coordination

		Mutuality of Coordination	
		Complementarity	Coherency
Focus of Coordination	Operational Linkages	Logistics Synchronisation (objects: products/ services and logistics process)	Information Sharing (object: information)
	Organisational Linkages	Incentive Alignment (object: benefits and risks)	Collective Learning (object: knowledge and capability)

Source: Simatupang et al. (2002)

Every coordination mode holds different contexts and associates different cognitive processes. Logistics synchronisation attempts to ensure alignment between logistics process activities (Fisher, 1997). Information sharing aims at realising the coherency of information (Lee, 2000).

Incentive alignment endeavours to distribute associated benefits and risks with logistics functions (Lee, 2000; Simatupang et al., 2002). Collective learning provides the support to tackle the coherency problem of initiation and flow of knowledge across borders (Senge, 1990; Sawhney & Prandelli, 2000).

Arshinder and Deshmukh (2006) reviewed that supply chain contracts, information sharing, information technology, collaborative decision-making, meetings with supply chain members, and technical support are important

coordination mechanisms to manage dependencies in the supply chain (Cachon & Fisher, 2000; Disney & Towill, 2003).

Arshinder and Deshmukh (2007) analysed the coordination issues in supply chain in a case study of XYZ company by applying SAP-LAP (Situation-Actor-Process-Learning-Action-Performance) framework. They found joint decision making, information sharing, information technology, and flexibility as some important coordination mechanisms to bring coordination in supply chain.

Coordination mechanisms are tools designed to address coordination problems of supply chains, and coordination in supply chain deals with managing dependencies among activities of supply chain. Therefore, it becomes interesting and challenging to classify various coordination mechanisms. Sahin and Robinson (2002) suggested price,

non-price, quantity flexibility, buy-back, and returns policies and allocation rules as major categories of coordination mechanisms which are further categorised by Fugate, Sahin, and Mentzer (2006) as price, non-price, and flow coordination mechanisms.

Price Coordination Mechanisms

Fugate et al. (2006) reviewed Bergen, Dutta, and Walker (1992); Coughlan (1985); Gerstner and Hess (1995); Heide (1994); Jeuland and Shugan (1983, 1988); Jorgensen and Zaccour (2003) to conclude that quantity discount pricing schemes are frequently studied mechanisms in the area of price coordination. They further concluded from Spengler's (1950) "double marginalisation," that quantity discounts should be offered to motivate retailer to increase purchase quantity which will result in increased profit margins of suppliers. It was Crowther (1964) who first focused on an interfacing of the buyer and supplier interests in quantity discounting. He discussed that available quantity discounts help cost reduction for buyer and supplier both. This joint effort is referred to as a joint economic lot sizing problem (JELS). Goyal (1989) supported price discounts to buyer for increasing the lot size. In contrary, Lee and Rosenblatt (1986) asserted the constraint on the discount amount. In investigating the impact of the buyer's lot size changes on both parties' costs, Banerjee (1986) also concluded that a supplier may offer price discounts to the buyer if he wants to entice the buyer to increase the order size.

The study by Tsay and Agrawal (2000), and Chen, Fedurgruen, and Zheng (2001) explores the quantity discount pricing under various dimensions using asymmetric and symmetric information among the members of supply chain that covers the objective of ensuring manufacturer's pricing strategy aligns retailer's benefits to optimise the system. Mahajan, Radas, and Vakaharia (2002) investigated the implications of price coordination mechanism on distribution strategy of supplier and retailer's inventory decisions in presence of limited and unlimited capacity.

A two-part tariff, another price coordination mechanism suggested by Fugate et al. (2006). They concluded after reviewing Bergen, Dutta, and Walker (1992); Lal (1990); McGuire and Staelin (1986); Moorthy (1987); Weng (1995), that in two-part tariff price coordination mechanism, a supplier offers a constant unit wholesale price and a fixed fee, then depending upon the internal cost structure, the fixed fee offered in the contract, and wholesale price, buyer can select the order quantity.

Non-price Coordination Mechanisms

From the study by Anderson and Weitz (1992); Bergen and John (1997); Dutta, Heide, and Bergen (1999); Frazier (1999); Mathewson and Winter (1985, 1984); Rey and Tirole (1986), it can be concluded that non-price coordination mechanisms are different coordination mechanisms than price coordination mechanisms which include quantity flexibility contract, promotional allowances, exclusive dealings, allocation rules, and cooperative advertising (Fugate et al., 2006).

There are some agreements between buyers and suppliers which introduce a factor of flexibility can be collectively termed as quantity flexibility contracts. Fugate et al. (2006) concluded from Lariviere (1999) that quantity flexibility contracts enables buyer to opt different size than previously estimated, and from Eppen and Iyer (1997) that backup agreements provide flexibility in terms that buyer is allowed to switch to a higher but limited quantity than initial ordered quantity. Bassok and Anupindi (1997) suggested minimum purchase quantity contracts, different form of quantity flexibility contract sets up the terms, where the buyer needs to purchase a minimum quantity and the supplier requires to supply up to a certain quantity as the demand exceeds the forecast (Tsay, 1999; Fugate et al., 2006).

Flow Coordination Mechanisms

Fugate et al. (2006) concluded from Angulo, Nachtmann, and Waller (2004); Bowersox, Closs, and Stank (1999); Brown and Bukovinsky (2001); Daugherty, Myers, and Autry (1999); Frohlich (2002); McCarthy and Golicic (2001); Pagh and Cooper (1998); Waller, Johnson, M. E., & Davis (1999), that there are various flow coordination mechanisms such as Efficient Consumer Response (ECR), Collaborative Planning Forecasting and Replenishment (CPFR), Vendor Managed Inventory (VMI), Quick Response (QR), and postponement which are found to be helpful for managing product and information flows across supply chains.

Table 2: List of Studies on Flow Coordination Mechanisms by Different Authors

Flow Coordination Mechanisms	Description	Authors
Collaborative Planning Forecasting and Replenishment (CPFR)	Helps supply chain trading partners to get multidimensional benefits; it brings improvements in revenue, customer service, reduction in inventory costs, improvements in sales forecasting and replenishment	Esper and Williams (2003); Fugate et al. (2006); Haghighat. (2008)
	Synchronised forecasts help in determining the production and replenishment processes	Larsen, Thernoe, and Anderson (2003)
	Higher service levels, faster order response time, lower product inventories, faster cycle times, reduced capacity requirements, reduced number of stocking points as some more benefits of CPFR	Arshinder and Deshmukh (2008)
Vendor Managed Inventory (VMI)	Enables suppliers to access the retailer's inventory level information to anticipate order quantities, modes of delivery, and the timing of replenishments	Sahin and Robinson (2002); Fugate et al. (2006); Haghighat (2008)
	For products with high demand variance and high outsourcing costs vendor managed inventory can specially be beneficial	Cheung and Lee (2002)
Quick Response (QR)	Emphasises on bringing manufacturers and retailers together in a collaborative partnership that reduces the manufacturer's lead-time of replenishment and provides the retailer a chance for placing a small order at the start of the season. It helps manufacturer to improve accuracy of forecasts and adjusting production schedules	Sahin and Robinson (2002); Fugate et al. (2006); Haghighat (2008)
Efficient Consumer Response (ECR)	Adds value in the process through efficient store assortment, efficient promotion, efficient replenishment, and efficient product introduction which result in decreased time and costs	Lohtia, Xie, and Subramaniam (2004); Fugate et al. (2006); Haghighat (2008)
Postponement	Emphasises on to reduce the risk and uncertainty in operations, involves delay in operational commitment regarding form, place, and time until the final customer commitments are achieved	Pagh and Cooper (1998); Fugate et al. (2006); Haghighat (2008)

Arshinder and Deshmukh (2008) discussed supply chain contracts, information sharing, information technology, and joint decision making as four coordination mechanisms to manage the various interdependencies in supply chain.

Supply Chain Contracts

The term contract encompasses the parameters like quality, price, quantity within which a buyer places orders and a supplier fulfills it. The supply chain contracts hold the objective of increasing the total supply chain profit, reducing inventory costs and sharing the risks among the supply chain members (Tsay, 1999). The contracts counter double marginalisation that is by decreasing the costs of all supply chain members and total supply chain costs when they coordinate as against the costs incurred when

the supply chain members act independently (Arshinder & Deshmukh, 2008). In the process of selecting the ideal supplier, contract terms are created and negotiations take place. These terms often include payment type, consequences for inability to perform, terms of the contract and so on (Skoumpopoulou, Dewaele, & Vlachos, 2014). In the revenue-sharing contracts, partners choose optimal order quantity for whole supply chain as the supplier offers the buyer a low wholesale price when the retailer shares a part of his revenue with supplier (Giannoccaro & Pontrandolfo, 2004; Cachon & Lariviere, 2005). In quantity flexibility contracts, inventory and stockout costs burdens are shared by the supplier and the buyer. For effective supply chain coordination through contracts some extensions are reported in literature such as flexible returns policies in three-level supply chain (Ding & Chen, 2008)

and two period supply contract model for decentralised assembly system (Zou, Pokharel, & Piplani, 2008).

Table 3: List of Studies on Supply Chain Contracts by Different Authors

Supply Chain Contracts	Description	Authors
Buy Back	At the end of the selling season the manufacturer buys back unsold items from retailer at pre-decided prices	Mantrala and Raman (1999); Hau and Li (2008)
Revenue Sharing	the buyer shares some of his revenues with the seller, in return for a discount on the whole sale price	Yao and Chiou (2008); Zhou and Wang (2009)
Sales Rebate	The sales rebate provides a direct incentive to the retailer to increase sales by means of a rebate paid by the supplier for any item sold above a certain quantity	Wong et al. (2009)
Quantity Flexibility	It couples the customer's commitment to purchase no less than a certain percentage below the forecast with the supplier's guarantee to deliver up to a certain percentage above	Tsay (1999)
Reservation policy	This policy offers discounts to the products reserved and the products which are not reserved are sold at retail price	Chen and Chen (2009)
Trade Policy	This policy deals with how the total profit is shared among supply chain entities	Ding and Chen (2008)

Source: Arshinder, Kanda, and Deshmukh (2011)

Information Technology

Arshinder, Kanda, and Deshmukh (2011) mentioned that advances in Information Technology such as Internet,

ERP (enterprise resource planning), EDI (electronic data interchange), e-business allow firms to rapidly exchange products, information, and funds and utilise collaborative methods to optimise supply chain operations.

Table 4: List of Studies on Role of IT in Supply Chain Coordination by Different Authors

Role of IT in Supply Chain Coordination	Authors
For improving coordination across organisation boundaries Information Technology (IT) is very useful	McAfee (2002); Sanders (2008); Arshinder et al., (2011)
Inter-organisational coordination has positive impact on select firm performance measures, such as lead time, customer service, and production costs.	Vickery, Jayaram, Droge, and Calantone (2003); Arshinder et al. (2011)
IT helps to integrate the point of manufacturing with the point of purchase or delivery, It provides real time data for planning, tracking and estimating the lead times	Singh (2011)
Review of past and current performance becomes easy by enhanced communication with Internet and web which helps supply chain members to manage workflow system.	Liu, Zhang, and Hu (2005); Arshinder et al. (2011)
E-business strategy describes how internet tools are chosen and used for integration with other organisational and managerial tools.	Soliman and Youssef (2001); Arshinder et al. (2011)
Identifying potential suppliers is both costly and time consuming, as it requires a lot of attention to detail. Therefore, with a preferred vendors list, companies can expedite their selection process and minimises costs through the usage of e-procurement.	Skoumpopoulou et al. (2014)

Information Sharing

Simatupang et al. (2002) define Information sharing as the act of disseminating common understanding among participating members. Sharing information is the most basic form of coordination in supply chain. There are a

number of new emerging technologies available to connect the members of a supply chain to support information sharing (Gour et al., 2013). Supply chain members may share information related to demand, inventory, orders, point of sale (POS) data, etc. to coordinate the supply chains (Arshinder et al., 2011).

Table 5: List of Studies on Role of Information Sharing in Supply Chain Coordination by Different Authors

Role of Information Sharing in Supply Chain Coordination	Authors
Timely available information about demand and advanced commitments from customer can be viewed as substitute for inventory and lead times as it helps in reducing the inventory costs by offering price discounts.	Reddy and Rajendran (2005); Arshinder et al. (2011)
Information sharing with supply chain partner increases the service level, demand variability, supplier-holding costs, and offset time, and decreases the length of the order cycle.	Bourland, Powell, and Pyke (1996); Chen, Drezner, Ryan, and Levi (2000); Arshinder et al. (2011)
Sharing of point of sales (POS) data helps supplier for anticipating future orders of the retailers and reducing the bullwhip effect.	Dejonckheere, Disney, Lambrecht, and Towill (2004); Arshinder et al. (2011)
Information sharing about inventory of retailer helps the supplier to optimally allocate the stock to retailers.	Moinzadeh (2002); Arshinder et al. (2011)

The importance of information sharing can be seen as undesired results produced in absence of proper information exchange. Fugate et al. (2006) reviewed in a study of industrial dynamics in a four level supply chain; Forrester (1958) discussed how rational decision-makers acting independently could bring inefficient asset utilisation, inaccurate forecasts, and poor customer service. Thoughts of Lee et al. (1997) also strengthened the same

stream by coining the term bullwhip effect resulting from ineffective information flow.

Joint Decision Making

Joint decision making can be taken for the following issues to improve the performance of a supply chain.

Table 6: List of Studies on Concern for Joint Decision Making by Different Authors

Concern for Joint Decision Making	Authors
Replenishment	Yao and Chiou (2004); Chen and Chen (2005)
Collaborative planning	Aviv (2001)
Costs of different processes	Haq and Kannan (2006)
Frequency of orders	Yang and Wee (2002); Barron (2007)
Batch size	Pyke and Cohen (1993); Boyaci and Gallego (2002)
Product development	Kim and Oh (2005)
Resolving conflicts	Arshinder et al. (2011)

Source: Arshinder et al. (2011)

Arshinder et al. (2011) made an attempt to quantify coordination by calculating coordination index, they also proposed a framework based on the usage of coordination mechanisms information sharing, information technology, supply chain contracts and joint decision making and

their importance in resolving various kinds of conflicting problems in coordination.

In Table 7, a summarised view of different categories of coordination mechanisms with their types is presented:

Table 7: Different Categories of Coordination Mechanism and their Types

Coordination mechanism	Description
Logistics Synchronisation	Alignment between logistics process activities
Incentive Alignment	Distribute benefits and risks associated with logistics functions
Collective Learning	Support to tackle the coherency problem of initiation and flow of knowledge across borders in supply chain
Price	
(Quantity discount pricing schemes, Buy-back and returns policies, Two-part tariff)	Use of pricing different pricing strategies to coordinate
Non-Price	
(Quantity flexibility contracts, Promotional allowances, Allocation rules, Exclusive dealings)	Vendor and buyer may coordinate using mechanisms other than price
Flow Coordination	
(Collaborative Planning, Forecasting and Replenishment (CPFR), Vendor Managed Inventory (VMI), Quick Response (QR), Efficient Consumer Response (ECR), Postponement)	Manages product and information flows across supply chains.
Supply chain contracts	
(Buyback, revenue sharing, quantity flexibility and quantity discounts)	Parameters (like quantity, price, time, and quality) within which a buyer places orders and a supplier is obliged to fulfil them.
Information sharing	
(Advanced order information, Inventory level, Sales data, Sales forecast, Order status, Production schedule, Capacity and lead time)	The information regarding supply chain operations may be shared among supply chain members to plan and timely schedule various activities of supply chain
Information Technology	
(Internet, email, EDI, ERP)	The supply chain members may communicate with each other through fast and flexible information systems
Joint decision making	
(Joint forecasting, joint replenishment and joint ordering resulting in joint profit sharing)	The supply chain members may encourage joint decision making to face any future exceptions and to attain a coherent supply chain.

CONCLUSION

In the era of global competition, the rapid innovations in the field of science and technology, there are several issues and challenges that are to be addressed by supply chain management. Reduction in lead times, minimisation of uncertainty, improvement of flexibility, minimisation of inventory, improvement in process quality etc. may be the issues are to be addressed by supply chain management. Logistics synchronisation, incentive alignment, collective learning, price, non-price, flow coordination, supply chain contracts, information sharing, information technology, and joint decision making are found as some prominent

coordination mechanisms to improve performance of supply chain. This categorisation of coordination mechanisms puts an effort to encompass all the coordination mechanisms in a comprehensive manner, however further analysis is required to form more categories to avert the overlapping.

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