A REVIEW OF RECENT DEVELOPMENTS IN SUPPLY CHAIN COORDINATION

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Abstract: One of the emerging trends in the supply chain management is the realization that long term strategic and operational partnerships among the players in the supply chain (SC) through combination of various appropriate coordination mechanisms are very essential for improving the performance, responsiveness and also to achieve satisfaction among members of the SC. In this paper, various issues and coordination mechanisms in the different areas of SC coordination presented in the recent works are reviewed. These issues dealt in the earlier works are related to operations, pricing, information sharing, technology, and disruptions. Each issue can be classified into various sub issues or different categories. We have done the same and tried to analyze its importance from literature. Finally, the summary of findings as well as the areas of future research to be focused is also provided.

Keywords: Supply chain Coordination, Mechanism, Operation, Pricing, Information sharing, Technology, Disruptions

1. INTRODUCTION

According to professionals of supply chain management (SCM), a supply chain (SC) is a system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer. It performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers at minimum cost. Most of the times, many different organizations are involved in different stages and they need to work together to create value and improve SC performance. Managing all functions in different stages along the whole chain – from the supplier’s supplier to the customer’s customer – requires a great deal of coordination among the players in the chain. The objective of every SC is to maximize the performance of the SC. Supply chain performance measures may be classified into two types (qualitative and quantitative). SC profit/cost, service level etc comes under quantitative category and the satisfaction of customers and players comes under the qualitative category. Supply chains are generally complex and are characterized by numerous activities spread over multiple functions and organizations, which pose interesting challenges for effective SC coordination.

A generally accepted goal for a SC is to maximize SC surplus. For this in a SC consisting of many firms with different ownership/management linked to each other, close coordination is very essential. The goal is total SC optimization and not individual firm optimization to obtain a win-win situation for all members in a SC. The decision taken by any SC member will affect the performance of the other members and finally the SC. This shows the significance and necessity of the need to study coordination in SC.

The remainder of this paper describes the classification of SC coordination issues and related studies followed by concluding remarks and further research directions.

2. CLASSIFICATION OF SC COORDINATION

SC coordination issues may be classified into five categories namely (1) operations (2) pricing (3) information sharing (4) disruptions (5) technology. These issues may be again classified into various sub categories. Different issues in SCC are identified as shown in figure 1.

In the section below, the first category of issues dealing with operations and its sub categories are discussed.
2.1. Operation

It is one of the most important areas of SC coordination which may be again classified into different subcategories such as order quantity, fuzziness, capacity, replenishment, and inventory. The recent works related to all these subcategories including coordination mechanisms are explained in the following sections.

2.1.1. Order Quantity

Order quantity is linked to production batch size, price, inventory, transportation etc. Therefore it forms a key variable to be decided between two adjacent members in a SC. Various mechanisms are used to coordinate the order quantity in a SC system under different context. Most of the studies in the literature are based on a two level SC system as it is the basic structure of any SC. In such a system where the demand and lead time is fixed, a mechanism called delay in payments is used to coordinate order quantity (M.Y. Jaber et al., 2006) and thereby to minimize the local costs and that of the chain. Coordination using a quantity discount policy under multi period and probabilistic customer demand with shortage cost allowed (Jianli Li, et al. 2006) is also available in the literature. Profit sharing mechanism of some nature is found in almost all studies to ensure equal rate of return on investment for each player. S. P. Sharma, et al. (2007) developed a coordination mechanism through credit option and discount policy such that both parties can divide the surplus equitably after satisfying their own profit targets and also proved that financially stronger player prefer credit policy and weaker selects discount policy for coordination. Numerical and empirical analysis of influencing factors such as annual demand, ordering cost, carrying cost, receiving cost, cost rate of losing flexibility, production rate and fixed set up cost on ordering and shipment policy (Peter Kelle et al. 2007) available in literature is useful for taking optimal decisions for managers in actual practice.

Ping – Hui Hsu et al. (2008) did a work on SC dealing with short lifecycle products & variable selling price and developed an integrated strategy consists of
proper information sharing and a compensation mechanism. According to M. Y. Jaber, et al. (2009), coordination of a four-level SC consists of multiple buyers, a vendor (manufacturer), multiple tier-1 suppliers, and multiple tier-2 suppliers with a common and optimal cycle time for all non identical retailers and also through compensation by offering quantity discounts to entice the retailer to order more than EOQ. Coordination for a SC which deals with newsvendor-type-products is another issue found in this area. Young-wu Zhou, et al. (2009) investigates such a system with two ordering opportunities and partial backorders in which excess demand after the first order is partially backlogged. In this case two policies are proposed for coordination (1) a two-part-tariff policy when the buyer pays all the manufacturing cost (2) a revised revenue sharing contract when two parties share the cost. Joint decision making regarding order quantity and reorder point is very important in a SC. For this purpose, S.Kamal Chaharsooghi et al. (2010) developed an incentive scheme based on credit option in which buyer can use it with the condition of jointly agreed order quantity and reorder point.

2.1.2. Effect of Fuzziness of Demand on Coordination

Fuzziness is a complex issue in SC coordination and studies regarding this issue are comparatively less in literature. The effect of fuzziness of demand can spread over the different stages of SC and reduces its efficiency and responsiveness. Dorbila Petrovic, et al. (2008) considered a single product inventory control in a Distribution Supply Chain (DSC) which operates in the presence of uncertainty in customer demands. In this study, demands are described by imprecise linguistic expressions and modeled by discrete fuzzy sets and inventories at each facility within the DSC are replenished by applying periodic review policies with optimal order up-to-quantities. An iterative coordination mechanism was proposed for changing the review periods and order up-to-quantities for each retailer and the warehouse to minimize the cost. Ruoning Xu et al. (2009) also did a work on the fuzziness aspect of demand uncertainty. Fuzzy numbers were used to depict customer demand in this study and investigate the optimization of the vertically integrated two-stage SC under perfect coordination and non-coordination case. In the absence of a clear command and control structure, a key challenge in SC management is the coordination and alignment of SC members. Kwangyeol Ryu et al. (2010) used a newsvendor model and a fuzzy approach to quantify the cost of this misalignment and to assess the impact of various coordination policies.

2.1.3. Influence of Capacity of Facilities on Coordination

Production capacity and its utilization is a key issue in SCM. Chang Hwan Le et al. (2007) examined return policy in a newsboy frame work under the assumption that both the supplier and retailer have limited and stochastic salvage capacities. To handle this issue, three mechanisms are proposed: (i) The manufacturer’s buy back with early salvage capacity (BES) - compensating the retailer for all the retained leftovers after buy back; (ii) Buy back with price protection (BPP) - compensating for the fraction of the retained leftovers that the retailer salvages after buy back; (iii) Buyback with final salvage subsidy (BFS) - compensating for the remaining leftovers after the retailer’s salvage. Insufficient production capacity is another problem for coordination. Santanu Sinha et al. (2007) developed a mathematical model to analyze the situation of the lost sales when the supplier’s production capacity is less than the annual demand of the retailer. Here, the supplier can procure from external source and satisfy the requirements of retailer. Jianli Li et al. (2008) developed an extended newsboy model in which the retailer can place a second order to avoid the stock out where manufactures reserve capacity for the retailer’s second order is limited. They designed a coordination mechanism and a profit allocation policy (price discount and profit allocating factor) to get more SC profit and allocate the same properly among players. Coordination is also possible for a SC in which manufacturer’s operations undergoes learning based continuous improvement (Mohamad Y.jaber et al. 2010). It is characterized by enhancing capacity utilization, reduction in set-up time and improved product quality.

2.1.4. Replenishment Policy based Coordination

The issue ‘replenishment’ consists of deciding order quantity, lead time and reorder point. Joint decision making is a suitable mechanism to manage this issue. Chun Jen Chung et al. (2007) developed an optimal replenishment policy using a simple algebraic method to solve a three stage SC inventory problem with backorder considering JIT delivery. A procedure for coordinating the inventory replenishment, production and shipping decisions for a single product in a SC
(Avijith Banerjee, 2007) consisting of a single producer with multiple retailers and suppliers is also suggested in the literature. Such coordination is achieved by linking the inventories at the different echelons of the chain through integrated decision making. Liang – Hsuan Chen et al. (2007) developed the integrated models with the permissible delay in payments for determining the optimal replenishment time interval and replenishment frequency. SC models for trade credit issues in the existing literature always assume the items produced as perfect. But, Liang – Hsuan Chen et al. (2010) developed integrated vendor–buyer models that consider a permissible delay in payment and products of imperfect quality to determine the optimal solutions of the buyer’s order quantity and the frequency for each vendor’s production run.

2.1.5. Importance of Inventory on Coordination

Management of inventory is actually a separate topic of study and it is very important in any SC system as it causes the storage cost and holding cost. Jianwen Luo (2007) proposed a vendor – buyer with a single product to analyze the benefit of coordinating SC inventories through the use of credit period. Under this strategy, the vendor requests the buyer to alter his current order size through a proper compensation and also though order size dependent credit period mechanism such that the vendor can benefit from lower setup, ordering and inventory holding costs. Hojung Shin et al. (2007) conducted a study in this area and developed a quantity discount model (buyer’s risk adjustment model) which allows the supplier to offer discounts that capitalize on the original economic lot sizes and share the buyer’s risk of temporary overstocking under uncertain demand.

W. K. Wong et al. (2009) detailed how a sales rebate contract helps to achieve SC coordination. This study proposes a model for a SC consists of single supplier serving multiple retailers in a VMI partnership which facilitate the application of sales rebate contract. The proposed model demonstrates that the supplier gains more profit with competing retailers (with a demand function depending on all retailer’s prices) than without (with a demand function sensitive only to their own price) as competition among the retailers lowers the prices and thus stimulates demand. The study conducted by Peter Kelle et al. (2009) focused on the inventory related costs that can be influenced by adjusting the ordering, setup, and delivery policy to the random yield which is still prevailing in several industries. This study showed that not the average yield but the yield uncertainty plays the critical role mainly in providing an appropriate service level but also in finding the optimal shipment and setup policy.

2.2. Pricing

It is another important issue of SC coordination which can also be divided in to subcategories. They are price dependent demand, pricing and contracts, uncertainty and pricing schemes. It is actually a key issue as it normally decides the customer demand. Studies related to these are discussed in section below.

2.2.1. Price Dependent Demand

Price elasticity of demand is a very fundamental principle of economics and is widely discussed. Price dependent demand is a significant issue in SCC. The solution is to find out the optimal price discount and selling price to increase the profit. In the literature, for a three-level SC model with price dependent demand, an all unit price discounts scheme is used to coordinate order quantities (Mohammad Y Jaber et al. 2006) and thereby to maximize the SC profit. Chung-Chi Hsieh et al. (2010) also analyzed the coordination of ordering and pricing decisions in a two stage distribution system with price sensitive demand through short-term discounting under two types of demand; linear demand in price and constant elasticity demand in price. They found that for homogeneous retailers, the players profits have similar characteristics under both the cases of demand but have different trends for heterogeneous retailers.

Another study found in the literature is the coordination of cooperative advertisement in a manufacturer-retailer SC with price sensitive demand (Jinfeng Yue, et al. 2006) and the manufacturer offers price deduction to customers. Game theory was used for analysis and the optimal price deductions are determined. Xiangtong Qi (2007) also studied a SC with price sensitive demand but with multiple capacitated suppliers to maximize the profit by determining an optimal selling price. It is proved that the problem is NP-complete, and proposed a heuristic algorithm and a dynamic programming algorithm and tested by computational experiments.

Many more inventory models under different context with price sensitive demand is reported in literature. A finite time horizon inventory model for deteriorating items with price and time dependent
demand under permissible demand (Yu-chung Tsao et al. 2008) is developed. The analysis found the optimal price, promotional effort and replenishment quantities throughout a multi-cycle planning horizon to maximize the net profit. Chia-Huei Ho et al. (2008) formulated an integrated supplier-buyer inventory model with the assumption that the market demand is sensitive to the retail price and the supplier offers two payment options: trade credit and early payments with discount price to the buyer. By analyzing the total channel profit function, they developed a solution algorithm to determine the best payment period, optimal retail price, order quantity and the number of shipment per production run from the supplier to the buyer.

2.2.2. Pricing and Contracts

Coordination of various parameters using different contracts with certain rules of pricing under multilevel structures and dynamic operating conditions of a SC system is found in the literature. There is a combination of coordination mechanisms consisting of quantity discount (QD) and handling – charge reduction (HCR) schemes used in literature for a manufacturer supplying numerous heterogeneous retailers (Amy Hing Ling Lau, et al., 2008) and the analytical and numerical analysis reveals the following (i) an optimal QD scheme will have a high enough price break such that extremely few retailers will be big enough to get a ‘free’ discount and (ii) an optimal HCR scheme produces practically the same magnitude of expected total gains as an optimal QD scheme. Revenue sharing contract is also a good contract for coordinating a SC comprising one manufacturer and two competing retailers (Z. Yao, et al. 2008) that faces a stochastic demand before the selling season. In this case, the retailers determines order quantity and retail price and manufacturer designs revenue sharing contract. Adopting the classic news vendor problem model framework and using numerical methods, this study found that provision of revenue sharing in the contract can obtain better performance than a price-only contract. Ding Ding et al. (2008) studied how to fully coordinate a three level SC with the so-called flexible return policy by setting the rules of pricing. With this contract, unsold products or used modules disassembled from the unsold products are returned level by level from the retailer to the upstream firms and each firm’s shares the loss due to the overstock.

Cooperative advertising is another good contract in practice by which advertisement cost has to be shared by both manufacturer and retailer. Jinxing Xie et al. (2009) addressed channel coordination by seeking optimal cooperative advertising strategies and equilibrium pricing in a two-member distribution channel. In this study also, a game theoretic approach is used for modeling and analysis. Integration of consumer return policy and manufacturer buy back policy with in a modeling frame work is a new approach in the literature. Tiaojun Xiao et al. (2010) investigated coordination of a two stage SC facing consumer return using a buyback/markdown money contract under partial refund policy and found that it plays an important role in the decisions and profitability of the players.

2.2.3. Uncertainty and Pricing Schemes

There are number of cases in the literature where uncertainty and pricing schemes plays an important role in the SC coordination. In the recent literature, instead of simple price discount, pricing schemes/pricing schedules are used to coordinate a SC as the degree of uncertainty and dynamism has become very high. Amy Hing Ling Lau et al. (2007) examined how a dominant retailer should operate when his knowledge of manufacturing cost is imperfect. They derived optimal decisions to be taken by retailer and a reverse quantity discount scheme that a dominant retailer can offer to the manufacture. They showed that it is effective when nature of demand is linear and ineffective when iso-elastic. Chang Hwan Lee (2007) designed and tested a model to study the effects of manufacturer and a discount outlet coordination in SC stocking, pricing and promotional markdown operations (product sold in normal sales period and subsequent leftovers markdown sale period). The study provided a numerical analysis to learn how and when coordination helps to increase profits and indicates that the centralized approach outperforms the decentralized one on every occasion.

Uncertainty and competition is very common in business. So the study on the impact of price discount contracts and pricing schemes on the dual channel SC competition (Gangshu Cai et al. 2009) in an online direct channel is very significant. Coordination through simple discount policy may not be an efficient solution when the system contains high degree of uncertainty. So, in such cases, multi pricing schedules to adopt global optimal policy (Santanu Sinha et al. 2010) is suggested in the literature.
2.3. Information Sharing

It is unavoidable and very prominent issue of SC coordination which connects various stages of SC to achieve better performance. This issue may also be subdivided in to different groups like integration of information sharing and SC practice, inventory and information sharing, information asymmetry, value of information sharing, and vertical information sharing. Each category is discussed below.

2.3.1. Information Asymmetry

Information asymmetry is a common issue in almost all cases of SC. Some of the cases are found in literature. A critical assumption made throughout in SC literature in this area is that the supplier has complete knowledge about the buyer’s cost structure. Eric Sucky (2006) provided a bargaining model with asymmetric information about the buyer’s cost structure assuming that the buyer has the power to impose its individual policy. Xin Xu Hao Zan (2009) studied and analyzed the principle-agent problem under fuzzy information asymmetry condition using the theory of principal-agent (enterprise–seller) and incentive mechanism assuming that the demand depend upon the agent’s effort level and the fuzzy market condition and derived a optimal contract for coordination. M.Esmaeili et al. (2010) also did a work on asymmetric information structure in which the seller’s setup/purchase cost is unknown to the buyer and the buyer withholds certain information related to market demand. In this study, sharing of marketing expenditure is used as an incentive strategy to reveal information and modeled using game theory.

2.3.2. Integration of Information Sharing and SC Practice

Effective integration of information sharing (IS) is very essential to improve the performance in a SC. Proper inter-organizational information sharing (IIS) improves SC performance; but it is very difficult task to set up a supply network (SN) with the appropriate level of IIS as SNs tend to evolve over time, and are usually not the result of a master plan by any firm. Therefore firms need guidance to effectively utilize resources and implement IIS capabilities properly so that the performance of the individual firms and the whole SC improves a lot. Subhashish Samaddar et al. (2006) focused on network configuration and partner goal congruence and their potential influence on IIS.


2.3.3. Value of Information Sharing

It is very important to analyze the value of information sharing in SCM under various situations for proper implementation. S. Viswanathan et al. (2007) investigated and compared the value of various information exchange mechanisms in a four-echelon supply chain under a MRP frame work through a simulation study. They found that among all the demand information exchange mechanisms, planning inventories based on the planned downstream order schedules resulted in the lowest average inventory level for the entire SC and use of end-user demand history to forecast and plan inventories at all echelons resulted in the lowest total cost when compared to a policy where each echelon plan inventories based on actual demand form its downstream customer. Muthuswamy Ganesh et al. (2008) also did a study on the value of information sharing in a multi-product SC with product substitution in which products may be substitutable in the sense that a customer may be willing to buy an alternate product when the customers preferred product is out of stock. This study showed that substitutability among products generally reduces the value of information sharing and that the reduction is increasing in the degree of substitution.

2.3.4. Vertical Information Sharing

The significance and effects of vertical information sharing in the SCC is also found in the literature. Dong-Qing Yao et al. (2008) considered a SC consisting of one supplier and two Value-adding heterogeneous retailers and each retailer has full knowledge about his own value-added cost structure that is unknown to the supplier and the other retailer. Under the assumption that there is no horizontal information sharing between two retailers, they modeled SC with a three –stage theoretic frame work in which each retailer decides to vertically disclose his private cost information first and the supplier announces the wholesale price to the retailers in the second stage and finally the retailers optimize their own retail prices and the values added to the product. They obtained the conditions under which both retailers have incentives to reveal their cost.
information with the supplier and for not sharing their private information. The first attempt to incorporate buyer’s expectations in to SCC problem is by Selek Karabati et al. (2008) in which they addressed the coordination problem in a single-supplier/multiple-buyer SC with vertical information sharing. They modeled each buyer’s net savings expectations based on her limited view of the entire SC which consist of herself and the supplier only, and then incorporated these expectations in to the modeling of the SC conducted by the supplier. They have considered both price discriminatory and non-price discriminatory approaches to design the quantity discount schemes that achieve time coordination without any additional requirement for buyers to comply with the supplier’s replenishment period in choosing their order quantities.

2.3.5. Inventory and Information Sharing
Literature also deals with how proper information sharing helps to coordinate under different inventory policies. Srinagesh Gavirneni (2006) considered a SC consisting of one supplier with finite production capacity and a retailer facing independent and identically distributed demands (iid) from end-customers. Their study showed that SC performance can be improved by the supplier offering fluctuating prices and proper information sharing. Studies to reduce average ordering and inventory related cost under the centralized decision making paradigm where there is a single decision maker and complete information of the system are available in literature. Chi-Leung Chu et al. (2008) conducted a different study to analyze, the problem of coordinating a single-warehouse multi-buyer inventory system with private information, and found a replenishment policy for each facility in the system, such that the total average ordering and inventory-related cost of the entire system is minimized. Modified Power of-two inventory theory is used to develop a heuristic for coordinating the above inventory system under private information.

2.4. Disruptions
SC systems however well designed in operations will face disruptions. Disruption management is comparatively new and challenging field. There are many disruptive accidents in the SC operations system such as demand disruptions, production cost disruptions, supply disruptions and other general/multiple simultaneous disruptions which are explained briefly in this study.

2.4.1. Demand Disruptions
Demand forecasting methods are available in plenty. But, the actual end customer demand may vary from the forecasted one and this will cause demand disruptions at different stages of the chain. Demand disruption results in losses in different ways for each player in a chain. Tiaojun Xiao et al. (2007) investigated the coordination of a SC with one manufacturer and two competing retailers when the demands are disturbed. They analyzed the effects of the changed amount of market scales on the coordination mechanism and the optimal decision making. Apart from the case of competing retailers, coordination of SC under demand disruption with a dominant retailer (Kebing Chen et al. 2009) is also available in literature. This SC model with one manufacturer and dominant retailer under demand disruption incorporated the deviation cost that affects the objective functions of the SC members. The analysis showed that linear quantity discount schedule is better when production cost is sufficiently low and when it is high, wholesale price schedule is better.

2.4.2. Production Cost Disruptions
Production cost disruptions may occur due to change in the cost of tools, technology, materials, variation in salaries & wages, production quantity, quality requirements etc. Minghui Xu et al. (2006) studied a SC coordination problem under production cost disruptions. In this study, a single product is considered which requires two major operations and it was assumed that during the second operation, anticipated production cost has changed. In their study, modeling the production cost disruptions and their impacts, design coordination schemes under disruptions are discussed and developed expressions for optimal values of retail price, production quantity and optimal SC profit. Another study in this area is the coordination of two-level SC with production interruptions (Ahmed M.A EI Saadany et al. 2008) to restore process quality. Three cases that describe the behavior of the manufacturer’s inventory level were considered in this study. These are: (1) restore the production process after delivering a lot to the retailer (2) restore the production process before delivering a lot to the retailer and (3) restore the production process at any time during production. This study suggested that order in smaller lots more frequently is better when production is imperfect.
2.4.3. Supply Disruptions

It needs earliest and immediate attention as it is the starting point of any SC and without solving this issue properly, the system cannot move further. Hui Yu Caihong Sun Jian Chen (2007) studied how the disruptive accidents affect the coordinated SC. Based on the SC coordinated by the negative incentive mechanism, they analyzed the impacts of supply disruption on the SC system by using simulation approach where two different distribution function of random variable were used to express the supply disruption. They compared these two simulation results and suggested a possible coordination mechanism for handling supply disruption. It is very important to analyze that how sourcing can be done in the presence of SC disruption risks. Haisheng Yu et al. (2009) examined the complexity of the sourcing decision in the presence of SC disruptions; in particular, the famous debate between single sourcing and dual sourcing is revisited by taking supply disruption risks in to account under price sensitive demand and the market sale increases when a supply disruption occurs. This study indicates that sourcing decision depends on the magnitude of the disruption probability and also provides the closed form solutions and critical values to help the decision making process under disruption. Determination of optimal size of supply base considering the risk of supply disruption is a very significant issue. Ashutosh Sarkar et al. (2009) determined the optimal size of supply base. They analyzed the risks of supply disruptions due to occurrence of super, semi super and unique events and formulated a model in a decision tree–like structure to determine the optimal size of supply base. The study of buyer’s perceptions of supply disruption risks (Scott C. Ellis et al. 2010) is also found in the literature. In this study, the validation of buyers perceptions of magnitude of disruptions, probability of disruptions, and overall supply disruption risk facilitate the translation of situation to decision.

2.4.4. General / simultaneous Disruptions

There are general or common disruptions and some of which can be recognized initially itself and solve the same so that it will be easier to solve the major disruption comes in between the various operations or stages. Christopher S. Tang (2006) presented certain robust strategies to enable SC to manage the inherent fluctuations efficiently regardless of the occurrence of major disruptions and to make a SC become more resilient in the face of major disruptions. The proposed strategies are postponement, strategic stock, flexible supply base, make- and - buy, economic supply incentives, flexible transportation, revenue management, dynamic assortment, silent product rollover.

Multiple disruptions are also discussed in the literature. Tiaojun Xiao et al. (2008) analyzed the coordination of a SC consists of one manufacturer and two competing retailers with price competition, cost and demand disruptions and analyzed that how disruption cost affects the two coordination mechanisms: all unit quantity discount and incremental quantity discount. Thus, strategies are formulated to handle both cost and demand disruptions. The effect of operational slack, diversification and vertical relatedness on the stock market reaction (Kevin B. Hendricks et al. 2009) to SC disruptions is another useful study found in the literature. This study used a sample of 307 SC disruptions announced by publicly traded firms during 1987-1998 to analyze the effect of various strategies on the stock market reaction to SC disruptions. Their analysis showed that more slack in the SC and high degree of vertical relatedness experience less negative stock market reaction and business diversification has no significant effect on the stock market reaction. But, geographically diversified firms experience a more negative stock market reaction. These findings surely influence the design and operation of SCs to mitigate the negative effect of SC disruptions.

Case studies related to management of disruption are also available in literature. Adegoke Oke et al. (2009) conducted a case study of a US retail SC and categorized various risks in to inherent or high frequent risks and disruption or infrequent risks. Finally, they found out some generic and specific strategies for handling various types of risks. Joehp B. Skipper et al. (2009) also examined the use of strategic approach to minimize the risk exposure to SC disruption. Based on the sample used in this survey, top management support, resource alignment, information technology and external collaboration enhances the flexibility in the system and found that this flexibility can reduce disruptions.

2.5. Technology

SC coordination without proper technology is extremely difficult in a competitive and dynamic business environment. Information technology is a key issue to be considered in a SC as without which the three main flows (product flow information flow, fund
flow) in a SC are not possible in an optimal manner. This issue can also be viewed as different groups which are internet, SC collaboration with new technologies, and impact of IT on SC process.

2.5.1. Internet

It is clear from the literature that internet can be utilized for the coordination in different ways among SC members as it is the fastest and cheapest way for communication & source of information and economical. Internet companies extensively use the practice of drop-shipping. Serguei Netessine, Nils Rudi (2006), developed a dual strategy whereby the retailer uses local inventory as a primary source (in which retailer stocks and owns the inventory) and relies on drop-shipping (in which the wholesaler stocks and owns the inventory and ships products directly to customers at retailer’s request) as a back-up and model it as a non cooperative game among the retailers and wholesaler. They analyzed this model and obtained insights to the structural properties of the equilibrium solution to facilitate the development of recommendations for practicing managers. Now, regarding SC for construction industry, a qualitative study is there in literature regarding coordination mechanisms for construction supply chain management (CSC) (Xiaolong Xue et al. 2007) in the internet environment. This study defined the concepts of construction supply chain (CSC) and CSC management and also the inter–organization problems that affect CSC coordination. They presented two types of internet-enabled coordination mechanisms: market mechanism, such as auction contracting and coordination flow, including information hub and electronic market place, for improving construction performance and to accelerate the innovations in the construction industry.

2.5.2. SC Collaboration with New Technologies

In the SC coordination, quick response, timing, accuracy are very important which necessitates the SC collaboration with new technologies. In the literature, there is a statistical study on the impact of ERP II. S. C. L. Koh et al. (2008) built a set of clear business benefits and impediments, hindrances to success through an extension of pertinent literature on ERP and through logical deduction (cause and effect) of the current literature on ERP II. The research identified three collaborative structures suitable to aid information exchange in a real-time collaborative scenario, namely joint ventures, networks and Japanese–style ‘purchasing partnership’. Another methodology/technique for SCC is distributed optimization. Jonathan Gaudreault et al. (2009) studied the case of a SC made up of autonomous facilities (represented by software agents) that need to coordinate their manufacturing operations. The coordination problem represented as a tree by considering the entire coordination space (by generalizing the coordination mechanisms) can be optimized using a distributed tree search algorithm (e.g.SyncBB). This allowed for the exploration of alternative solutions by the agents while maintaining current business relationships, responsibilities and local decision making algorithms. This study found that SyncBB improved the quality of the solution compared to the current practice. The main contribution of this study is multi agent concurrent discrepancy search (MacDs) that uses the concept of discrepancy and permits the agents to find the optimal solution.

Radio Frequency Identification (RFID) features high storage capacity, remote access, excellent data security and multiple - tag reading. Katerina Pramatari (2007) provides an overview of SC collaboration practices and the way the underlying enabling technologies have evolved, from the classical EDI (Electronic Data Interchange) approach, to web-based and RFID-enabled collaboration. They derived interesting lessons regarding the suitability and criticality of the technological approach used to support collaboration, especially regarding the use of a centralized web-platform as compared to the EDI approach and to a decentralized solution based on web services. L. C. Lin (2009) constructed an integrated framework for the development of RFID technology in the logistics and SCM which includes the hierarchy of factors, structural procedure, and sequence of adoption.

2.5.3. Impact of IT on SC Process

Analysis on the impact of IT on SCM is very much needed to take corrective measures for further improvement. Drawing from the resource-based view, Fang Wu et al. (2006) proposed that IT-enabled SC capabilities are firm –specific and hard –to copy across organizations. This study provided a new perspective in evaluating IT investment in the SC process. The implications of the different types of institutional isomorphism, namely coercion, mimesis and norms, are explored from both the perspectives of firms that have taken the initiatives to adopt IT and those that have followed their SC partners to adopt IT. Study on institutional isomorphism and the adoption of IT for SCM is very important topic. Kee-hung Lai et al.
Ambilikumar C. K. and M. Bhasi (2006) analyzed and discussed the implications of institutional isomorphism on the adoption of IT for SC management in their study. Byoungho Fin (2006) empirically investigated the moderating effects of firm size on the relationship between the level of IT adoption and three performance levels: operational, financial and strategic, for an apparel SC and found that firm size was a significant moderator variable for operational (lead time), but not strategic and financial performance.

Drawing from organizational theories of learning, Nada R Sanders (2008) proposed a model that evaluated how two patterns of IT use by suppliers (exploitation and exploration) impacts on two specific types of coordination activities with their buyers (operational and strategic coordination). Using data from 241 first tier OEM suppliers in the computer industry, they found that each pattern of IT use directly promotes a specific type of coordination activity and to achieve a complete set of benefits, suppliers must ultimately use IT for both exploration and exploitation.

3. CONCLUDING REMARKS AND SUMMARY OF FURTHER RESEARCH DIRECTIONS

Coordination within a SC is related to strategic and technological issues among the players within the chain. Though essential, it is very difficult to achieve coordination among various processes and members of a SC. There are number of coordination issues found in the area of operations, pricing, information sharing, technology and disruptions. Mechanisms such as quantity discounts, delay in payments, joint decision making, Information sharing of various details, information technology, and other new strategies have been used in the literature to achieve coordination. Coordination schemes are generally based on centralized and decentralized decision making process and other operating conditions. The mechanisms for coordination need to be studied in detail. To coordinate the whole SC, the study on the impact of all coordination mechanisms on the performance of SC is required. Various combinations of mechanisms can be explored with the help of simulation.

3.1. Mechanisms Vs Stages and Flows in Supply Chain

A coordination mechanism is a set of strategic approaches, rules, contracts or technologies used to improve and manage the interdependence between outside and inside the organizations and thereby to enhance the overall performance. Based on this literature review, the different stages during the life of a SC may be divided in to design, operations and disruptions. Different mechanisms used in literature at different stages of a SC for ensuring the smooth and efficient flow of product, fund and information in an optimal manner to improve the performance of the system are summarized in table 1.

3.2. Policies and Risks in a Supply Chain

The different policies & Influencing factors as well as its risks and decision option available in a supply chain are briefly depicted in figure 2.

Table 1
Mechanisms Corresponding to Different Stages (S) Vs Flows (F) in a Supply Chain

<table>
<thead>
<tr>
<th>S</th>
<th>F</th>
<th>DESIGN</th>
<th>OPERATIONS</th>
<th>DISRUPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>*Joint market survey</td>
<td>*Joint forecasting, ordering and replenishment policies</td>
<td>*Information technology</td>
<td>*Robust strategies such as postponement, strategic stock, flexibility enhancement, make-and-buy, flexible transportation, assortment planning, etc</td>
</tr>
<tr>
<td></td>
<td>*Joint product design</td>
<td>*Joint contracts like buyback, quantity flexibility, quantity discount</td>
<td>*Cost sharing</td>
<td>*Robust strategies such as economic supply incentives, revenue management via dynamic pricing and promotion, make-and-buy</td>
</tr>
<tr>
<td></td>
<td>*Joint product policies &amp; strategies such as market, promotion techniques</td>
<td>*Learning based continuous improvement</td>
<td>*Joint pricing schemes</td>
<td>*Joint decision on profit sharing methodology</td>
</tr>
<tr>
<td></td>
<td>*Joint decision on technology for fund transaction</td>
<td>*Joint price contracts such as quantity discount, price discount, delay in payment</td>
<td>*Cost sharing</td>
<td>*Joint decision on technology for fund transaction</td>
</tr>
<tr>
<td>Fund</td>
<td>*Joint trade credit policies</td>
<td>*Joint information sharing on demand ,inventory lead time production schedule, capacity etc</td>
<td>*Incentive schemes for information sharing</td>
<td>*Joint decision on technological investment for information sharing</td>
</tr>
<tr>
<td></td>
<td>*Joint decision on trade off between cost and quality</td>
<td>*Information sharing tools like ERP, MRP, Email, EDI, RFID</td>
<td>*Joint decision contract, Joint decision making, information technology</td>
<td>*Centralized/decentralized structure</td>
</tr>
<tr>
<td></td>
<td>*Joint decision on technology for fund transaction</td>
<td>*Joint order and production policy</td>
<td>*Risk categorization and Risk mitigation strategy formulation</td>
<td>*Design of supply network and inter organizational information sharing</td>
</tr>
</tbody>
</table>
Figure 2: Influencing Factors – Policies – Risks - Decision Option Available in a Supply Chain
Table 2
Supply Chain Coordination – Future Research Directions

<table>
<thead>
<tr>
<th>Operations</th>
<th>Pricing</th>
<th>Is</th>
<th>Disruptions</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Coordination of order quantity in a multi echelon supply chains with uncertainty and competing retailers especially for SLC and multiple products</td>
<td>1) Price dependent demand in a multi echelon with price discount at different times in replenishment cycle in a multi period case, time dependent partial backlogging. Quality, delivery, time and after sales service dependent demand</td>
<td>1) Information asymmetry of demand, lead time, production schedule, capacity</td>
<td>1) Sharing of deviation cost, dominant retailer competing in price and asymmetric fringe retailers</td>
<td>1) Opportunities and threats in the internet for a SC.</td>
</tr>
<tr>
<td>2) Fuzziness aspect of various parameters in a realistic SC system and its causes and effects</td>
<td>2) Quantitative studies on information asymmetry and value of IS in a realistic system</td>
<td>Study of negative aspects due to horizontal IS</td>
<td>3) Supply disruptions under limited supplier capacity, multi source situation and joint sourcing decisions, Effect of disruption in one firm on others in a SC</td>
<td>3) A quantitative study of the impact of IT implementation in the area of SCC</td>
</tr>
<tr>
<td>3) Managing capacity related to production storage, transportation, out sourcing, subcontracting in a dynamic SC</td>
<td>2) Probabilistic demand and pricing schemes with several price breaks, nonlinear price sensitive demand, competing retailers</td>
<td>3) IS in a fuzzy or uncertain environment among competing retailers for a multi stage SC</td>
<td>4) how to achieve perfect truthful IS and analyze proper mechanism for the same</td>
<td>4) Research on new technology suitable to variety of SC</td>
</tr>
<tr>
<td>4) Non stationary stochastic demand in multi periods with different inventory policies</td>
<td>3) Use combination of mechanism/contracts in a more complex dynamic system</td>
<td>4) combination of multiple and simultaneous disruptions</td>
<td>4) Sharing of expenses at different levels of SC</td>
<td>4) Sharing of expenses at different levels of SC</td>
</tr>
</tbody>
</table>

Table 3
Structure Vs Issues of the Papers Reviewed showing Reference Sl. No

<table>
<thead>
<tr>
<th>Structure</th>
<th>Two stage supply chain</th>
<th>Two stage with multiple up or down stream players</th>
<th>Three stage supply chain</th>
<th>General SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPERATIONS</td>
<td>Order quantity</td>
<td>27,30,36,51,72</td>
<td>28,53,57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity</td>
<td>9,29</td>
<td>48</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Fuzziness</td>
<td>54</td>
<td></td>
<td>18,42</td>
</tr>
<tr>
<td></td>
<td>replenishment</td>
<td>44,45</td>
<td>6,15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inventory</td>
<td>24,31,52</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>PRICING</td>
<td>Price dependent demand</td>
<td>11,14,32</td>
<td>69</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Pricing and contracts</td>
<td>33</td>
<td>4,16</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Uncertainty &amp; pricing schemes</td>
<td>3,10</td>
<td>56</td>
<td>22</td>
</tr>
<tr>
<td>INFORMATION SHARING</td>
<td>Information asymmetry</td>
<td>19,20,70</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>TECH.</td>
<td>Integration of IS and SC practice</td>
<td></td>
<td></td>
<td>7,25,62</td>
</tr>
<tr>
<td></td>
<td>Value of IS</td>
<td></td>
<td></td>
<td>49,66</td>
</tr>
<tr>
<td></td>
<td>Vertical IS</td>
<td></td>
<td></td>
<td>17,59</td>
</tr>
<tr>
<td></td>
<td>Inventory and IS</td>
<td>61</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internet</td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>SC collaboration with new tech.</td>
<td></td>
<td></td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Impact of IT on SC</td>
<td>50</td>
<td>34,37,41,43</td>
<td>8,21,39</td>
</tr>
<tr>
<td>DISRUPTIONS</td>
<td>Demand</td>
<td>64</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Production</td>
<td>2</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply</td>
<td>58</td>
<td>5,26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>General disruptions</td>
<td>65</td>
<td>1,13,23,35,40</td>
<td></td>
</tr>
</tbody>
</table>
3.3. Future Research Directions
Some of the future research directions under different issues in the area of supply chain coordination (SCC) are provided in table 2.

3.4. Structure Vs Issues and Reference Serial No
The models dealt with in the references with regard to unknowingly. It is essential to study different coordination, it is clear that coordination in a SC is very important. Organizations follow some principles of supply chain management knowingly or unknowingly. It is essential to study different coordination mechanisms and finds areas where they are effective, so that knowledge for conscious selection of coordination mechanism is created for users. There has been a lot of work in the area of SC coordination and bridging the gap between models with rigid assumptions and reality will be a constant challenge to researchers in this area.

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