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Supply Chain Coordination Models: A Literature Review

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Abstract

Background/Objectives: The objective of the work carried out in this paper is to present the literature based on different Supply Chain (SC) coordination mechanisms. Also, it is intended to explore various coordination models proposed by various researchers from the literature. **Methods/Statistical Analysis:** The literature is reviewed by considering 142 articles published from 2000 to till date and classified as two-level models and three-level models. All these articles are further discussed based on few coordination mechanisms such as trade credit, quantity discounts, revenue sharing contract and information sharing. In addition, the literature is reviewed on Vendor Managed Inventory and price dependent demand variations and the coordination issues are discussed. **Findings**: From the findings of this research, it is observed that sufficient volume of papers reported the coordination mechanism in a two-level SC. The number of papers discussing three-level SC coordination is few in number. Especially, in the perspective of trade credit and quantity discount option, very few articles are reported discussing coordination in a three-level SC. Further, it is also found that most of the articles addressed the coordination mechanism incorporating ordering and carrying costs. Very few articles addressed the implications of transportation cost in SC coordination mechanism. **Application/Improvement:** From the outcomes of this work, it is observed that study of the effect of space cost and advertisement cost on SC performance is highly significant. The use of simulation is highly emphasized as the activities of SC are becoming highly dynamic and challenging with the ever growing global competition.

Keywords: Coordination Mechanisms, Global Competition, Inventory, Three-Level Models, Two-Level Models

1. Introduction

The post liberalization era characterizes severe competition among the business organizations. Due to globalization of markets and ever rising customer expectations, business enterprises have been forced to concentrate their SCs for effective and efficient management of business operations. Also, ever rising technological advancement in E-Business, E-Commerce and E-Logistics have motivated the evolution of the Supply Chain Management (SCM) concept. Thus, SCM has become significant research area which can provide the companies with an effective tool to build an advantage over their competition. Further, it is a fact that both academicians and research experts have shown much attention towards SCM[1]. To utilize the various opportunities evolving due to globalization and to withstand the acute competition, researchers and practitioners are designing Supply Chain (SC) as a system.

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SCM is the process of coordinating various activities like production, inventory, transportation etc., amongst the members of the SC in order to achieve the efficiency and effectiveness in serving the market[2]. Main aim of the SCM is to increase the sale of the products to the end user and at the same time reducing both inventory and operating expenses. It is the trade-off between responsiveness and efficiency with the optimum spread of the inventory in the SC. The practice of implementing SCM concept leads to significant improvement in company's revenue and reduced cost. Further, the goals of the SC members are completely different from each other. Also, these goals are said to be conflict from each other and are mutually dependent. Each level of the SC has its own impulse and circumstances. A SC consists of several entities involved in satisfying the buyer request, directly/indirectly.

Moreover, the performance of the SC is determined in terms of inventory decisions, transportation decisions, facilities etc. In some of the manufacturing industries, nearly 60 to 70 % of total capital investment is to be spent for the purchase of raw-material only. Hence, a small portion of reduction in the cost of inventory results in significant rise in profits. The efficiency and responsiveness of the SC is very much influenced by the variations in inventory policy. Large inventory increases responsiveness, but also increases retailers cost and thus leads to less efficiency. Reduced inventory increases efficiency, but lowers responsiveness. Hence, inventory management can be a difficult task for industries with thousands of raw materials located in various locations. Thus, inventory management becomes a major issue in SCM that addresses SC issues under an integrated perspective[3,4].

The remaining portion of the work in this paper is divided into three sections. In Section 2, a detailed discussion on the importance of Supply Chain coordination under various mechanisms is carried out. In Section 3, discussion on two-level SC models based on trade credit, quantity discounts, information sharing and revenue sharing contract is carried out. Section 4 carries the discussion on three-level models based on trade credit and quantity discounts is carried out. Section 5 discusses coordination issues in Vendor Managed Inventory systems. Section 6 carries the review on SC coordination mechanism with price dependent demand. Section 7 presents some observations and concluding remarks.

2. Supply Chain Coordination

All the participants of the SC have understood that the SC of one organization has to compete with the SC of other organizations rather than having the competition amongst the echelons of the same SC. Further, it is a fact that the echelons of the SC cannot perform individually. Hence, coordination between the members of the SC has become a challenging issue for efficient and effective SCM. Thus, the SC coordination has beecome significant in order to maintain the stiff competion in business environmment. The mechanism of developing SC coordination has also become inevitable, since it enables all entities in a SC to collaborate and enhance the benefits of the total SC. The most important task involved in SCM is to encourage each participant of the SC and to synchronise and direct their efforts[5]. Naturally, the SC coordination is achieved by integrating the inventory models of respective players in the SC.

While planning a coordination mechanism, all the entities of the chain are assumed to be neutralists customarily with respect to issues and challenges of the SC. Each participant of the SC puts effort to decrease his cost or increase his profit. The mechanism of SC coordination stimulates each participant so as to modify its objective in the line of SC goal. Paper[6] suggested to integrate business practices and the main participants of the SC, since the structure of industrial activities, within and amongst the firms, are said to be significant in order to derive maximum cost-effectiveness and attractiveness. In paper[7] proposed an innovative non-radial network Data Envelopment Analysis model to evaluate the performance of SC. In paper[8] studied the influence of RFID on pharmaceutical SCs with a focus on India, China, France and the UK.

2.1 Coordination Mechanisms

Managing effective and efficient SC coordination mechanism among different entities of chain is really challenging and became an appropriate research area in the present day scenario of globalization. In general, the process of coordination in SC is based on integrated and dispersed decision making practices. Channel coordination is a combined decision making strategy attained by an agreement between the members of the SC to decrease

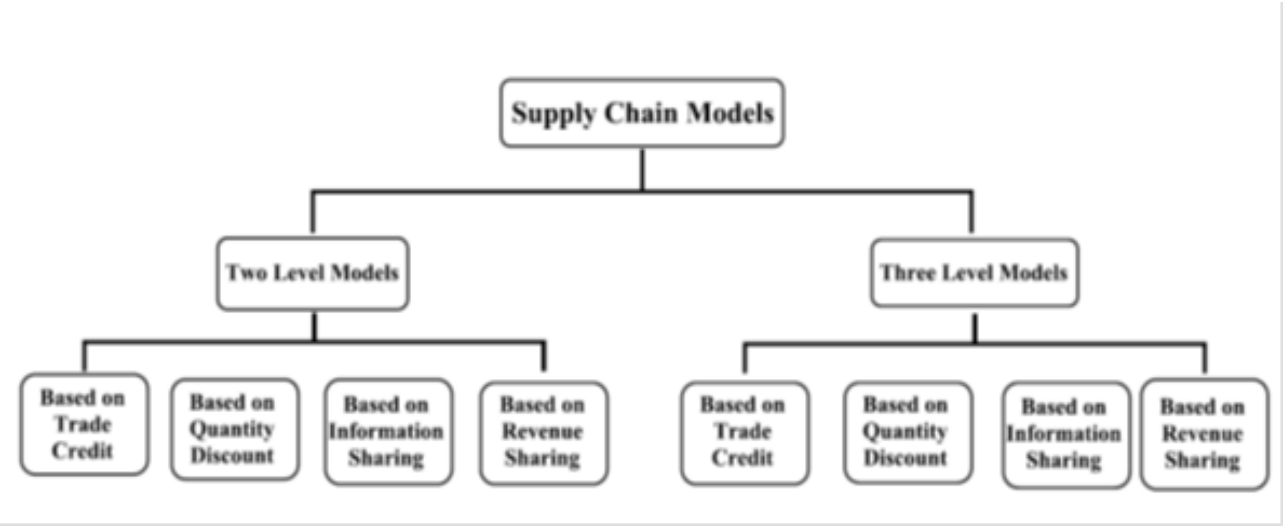

Figure 1. Classification of Supply Chain models.

(increase) the total relevant cost (net revenue). In order to have the successful coordination mechanism, several inventory models are developed by various authors for joint optimal inventory decisions of both the buyer and vendor. Both the participants of the SC negotiate in order to derive the mechanism of sharing the revenue savings. These models provide a frame work for evaluating strategic investment decisions quantitatively.

Based on the literature, various mechanisms have been proposed to achieve effective SC coordination; such as quantity discounts, trade credit, price discounts, volume discounts, common replenishment periods.

From all available multi-echelon inventory models, up to four echelons are considered, i.e., tier-1 vendor, tier-2 vendor, manufacturer and retailer. In majority of the models, two-level SC coordination mechanism is investigated with varying assumptions. The decision making process in a SC is either centralized or de-centralized. In a centralized SC, the decisions are taken jointly together by all the entities of the chain. In a de-centralized SC, the decisions are taken independently by the entities of the SC who have conflicting objectives. As it is demonstrated in Figure 1 in this paper, the articles dealing with SC coordination are collected from 2000 to till date. In turn, they are classified as two-level models and three-level models based on few coordination mechanisms.

3. Two-Level Supply Chain Models

From last two decades, majority of the authors have focused their attention in developing two-level models with a single-vendor and single-buyer for effective SC coordination. Initially, the process of SC coordination mechanism was originated by considering inventory lot size. In deriving the coordination among the members of the SC, the replenishment batch size at the upper echelon is an integer multiple of ordering quantity at the lower echelon. The total variable cost of the SC is reduced through the joint determination of inventory replenishment decisions and shipment policies. Sufficient volume of work is evident from the literature dealing with SC coordination, especially, in terms of lot size inventory.

Papers reporting Supply Chain coordination through lot sizing decisions for a single-supplier (may be a vendor) and single-retailer (may be a buyer) include[9–12]. In particular, buyer-vendor coordination model to find the reorder level, replenishment quantity and shipment frequency in a two-level SC under stochastic lead time and allowable shortages is presented in paper[9]. In paper[10] presented a joint inventory model for two-stage SC with a vendor and retailer for joint inventory replenishment and shipment delivery planning in which product demand

pattern follows the Poisson distribution. Mathematical model for optimal replenishment decisions in a two-level pharmaceutical SC comprising of a single-warehouse and one-retailer is studied in paper[11]. Authors of the paper assumed that product demand is stable and turnover rate is high. Coordination mechanism for profit maximization in a two-stage SC with single-vendor and single-buyer is derived in paper[12]. The SC coordination through optimal consignment policy generates higher profit to the manufacturer than the traditional system[13]. In paper[14] carried out an extensive review on SC coordination mechanisms and categorized the research papers based on analytical and simulations approaches.

Joint optimal inventory policy with manufacturing setup cost reduction is addressed in paper[15]. An extensive literature on mathematical models for inventory optimization of a closed loop SCs is reviewed in paper[16]. The role of human factors on the two-level SC performance is addressed in paper[17]. An analytical approach to examine the effectiveness of a serial multi-stage SC through a decomposition approach is presented in paper[18]. Integrated marketing-inventory model involving discount promotion and customer behavior is developed in paper[19] for a two-echelon SC to determine economic ordering, pricing and shipping quantities simultaneously.

Integrated inventory model for optimal inventory level and vehicle routing of a multi-vendor and single-manufacturer system with just in time delivery is addressed in paper[20]. Dual-channel SC coordination with variation in product demand pattern as well as cost of the production is achieved in paper[21]. In paper[22] developed a multi-objective model using mixed integer programming approach to locate the facilities as well as design the forward and reverse network. Also, authors of the paper determined the long-term solutions to optimize net present value of the cash flows of the total SC. Mathematical model for profit maximization of centralized and decentralized two-level SC under price dependent demand and controllable lead time is studied in paper[23]. Authors of the paper found that even though the retailer's selling price decreases with lead time reduction, the profit of the SC increases significantly. In paper[24] proposed a joint production inventory model for the buyer and vendor by considering ramp type demand. Authors of the paper included Weibull rate of deterioration, inflation and variable holding cost for model development.

Though, many of the inventory models dealt with single-retailer and single-supplier coordination mechanism, few researchers have discussed the joint inventory models for a single-supplier and multi-retailer. In paper[25] proposed a heuristic approach for a single-vendor and multi-buyer problem. The use of negotiation-based collaborative planning process to synchronize plans in a two-level SC with a single-supplier and multi-buyers is described in paper[26]. Order timing preferences in a single-supplier and multi-retailer SC system are studied in paper[27]. Centralised and decentralised two-level SC with a single-vendor and multi retailer for optimal ordering and pricing decisions is studied in paper[28].

A two-level inventory model with a single-vendor and multiple buyers for optimal operational decisions and vehicle routing is studied in paper[29]. Paper[30] studied the influence of bullwhip effect in E-Business of an automotive industry. In paper[31] examined the coordination mechanism for SC comprising of a single-manufacturer and multi retailers under the variation in market demand as well as production cost. In paper[32] developed a mathematical model for centralized and de-centralized two level inventory system by incorporating the concept of recycling in manufacturing system. Coordinated inventory model to find out the quantity of the production, pricing and inventory decisions under optimal discount policy in a two-stage SC comprising of a single-buyer and several suppliers is proposed in paper[33].

3.1 Supply Chain Models with Information Sharing

From the literature, it is evident that the mechanism of the revenue sharing has become popularized in establishing coordination among the entities of the SC. It is one type of mechanism used to increase the efficiency or to attain the better coordination of the chain. In this type of mechanism, vendor sells the product to the buyer at a wholesale price, which is said to be less than the unit production cost, based on the agreement of sharing a portion of the retailer's revenue earned on the products sold[34]. Some of the works addressing the revenue sharing contract in

SC coordination include[35–39]. In particular, coordination policy for a two-level SC comprising of a single-producer and single-buyer is explored through revenue-sharing contract, where the product quality is assured[35].

In paper[36] examined dynamic joint decisions for optimal revenue sharing allocation, ordering quantity, retail price and wholesale price for a single-manufacturer and single-retailer SC coordination problem with deteriorating items under vendor managed inventory. Dual-channel SC coordination models are developed for optimal pricing and production decisions under demand disruption management through a revenue sharing contract[37]. Multi-stage SC coordination under the contract of revenue-sharing with budget constraints is studied in paper[38]. Paper[39] demonstrated that the combined mechanism of revenue sharing contract and payback period improves the SC coordination process. Authors of the paper proved that the payback period mechanism corrects the problem of producing under quantity by supplier's and through the mechanism of revenue sharing, the problem of ordering excess quantity by retailers' is rectified.

3.2 Supply Chain Models with Information Sharing

Due to ever growing technological advancement, the phenomena of information sharing has become an important contract in achieving effective Supply Chain coordination. It includes sharing of various details of production and transportation costs, costs of inventory, quantity discounts, stock levels, available facilities with capacities, product demand information and planned promotional strategies of all members of the chain. Information sharing provides three major advantages to the SC members: Information distribution throughout the chain, closeness between the senders and receivers of the information and quick responsiveness of Supply Chain members[40,41]. Articles reporting the SC coordination based on information sharing include[42–45].

In paper[42] presented the broader review on information sharing on SC coordination process and categorized the literature. Also, authors of the paper highlighted the gaps in the current literature and identified thrust areas for further research. In paper[43] studied the influence of the capacity of sharing information on retailer-supplier relationships and firm performance. In paper[44] demonstrated the impact of sharing information and the effectiveness of coordination mechanism in make-to-order SC. Authors of the paper formulated five SC strategies mathematically, on the basis of different stages of information sharing and the mechanism of SC coordination. In paper[45] presented a simulation study to investigate the influence of information sharing in a SC and showed that, from the viewpoint of both inventory levels and back ordering quantities, the wholesalers and distributors gain considerably through information sharing. In paper[46] studied the problem of determining the optimum level of sharing information to maximize the profit of a two-echelon SC. De-centralized capacitated planning for the tactical level of two-level SC through optimal level of sharing information is modelled in paper[47]. Information sharing does not influence the SC performance directly, but influences the SC performance indirectly, through the SC collaboration[48].

3.3 Supply Chain Models with Trade Credit

In the traditional system of integrated inventory models, retailer pays the vendor as soon as goods are received. But, in the ever growing global competition, it has become customary of providing credit period to entice the buyers. Trade credit is a loan to the buyer offered by the vendor for a short period of time. In the SC coordination through trade credit mechanism, vendor allows the buyer to delay payment of the invoice of the goods supplied. The buyer pays no interest during the permissible delay period. However, the buyer pays the interest for the time period beyond the permissible period. So, trade credit is a tool to compete and generate sales. Vendor can gain competitive advantage through trade credit to the considerable extent.

As trade credit develops long term healthy relationship amongst the vendor and retailer, this mechanism gained the interest of several researchers. Some of the relevant works considering trade credit as a SC coordination mechanism include[49–54]. In particular paper[49] demonstrated a coordinated model for a two-stage SC having vendor and buyer to synchronize their inventory replenishment orders towards the optimization of the cost of individual entities and SC. In their model, the concept of trade credit is implemented as a mechanism of managing the replenishment quantity. In paper[50] discussed a

coordination mechanism for profit sharing amongst the producer and a retailer based on credit choice. In paper[51] proposed coordinated SC model for the purpose of finding replenishment quantity and reorder level under credit choice. An integrated inventory replenishment model for deteriorating products under the influence of order cost reduction and trade credit incentives, in a two-stage SC with a single-vendor and a single-buyer is presented in paper[52]. Mathematical model with variable lead time and trade credit policy for optimal replenishment quantity, lead time, process quality and shipment frequency is presented in paper[53].

Dynamic two-stage SC model comprising of a single-supplier and multiple retailers is investigated in paper[54]. An integrated model under trade credit option to find out the inventory and shipment decisions in a two-stage SC with a single-supplier delivering a single type of item to a single-purchaser is proposed and discussed in paper[55]. An integrated supplier-retailer inventory replenishment model for optimal ordering, pricing, shipping and payment strategy under bipartite trade credit phenomena is proposed in paper[56]. The coordination mechanism of a single-supplier and several heterogeneous buyers with trade credit option is investigated in paper[57]. Vendor-buyer coordination model by considering imperfect quality of items and credit period option is studied in paper[58]. SC coordination model through trade credit mechanism is discussed in paper[59]. Single-supplier and single-retailer coordination model for defective items to determine replenishment decisions and shipment frequency through trade credit and allowable shortages is developed in paper[60].

SC coordination issues in a two-echelon inventory system using trade credit and wholesale price discount option is studied in paper[61]. An inventory replenishment policy for optimal cycle time of the retailer under two-level trade credit phenomena is studied in paper[62]. Centralized and de-centralized two-level SC for optimal inventory decisions and length of the permissible delay period through trade credit option is studied in paper[63]. Authors assumed that storage space of the retailer is limited and he faces inventory-dependent demand. A note on two-level SC coordination mechanism for optimal replenishment quantity and re-order point under trade credit is presented in paper[64]. The process of coordination mechanism in a two-stage SC with a single-producer supplying a single kind of item to a single-retailer under the phenomena of stock-dependent demand rate and trade credit option is studied in paper[65]. SC coordination process in a two-stage inventory system under credit period and quantity discount option is studied in paper[66].

3.4 Supply Chain Models with Quantity Discounts

From the extant of literature, it is a fact that the popularity of SC coordination through quantity discounts influences the purchasing behavior of the buyers. Also, it is demonstrated that the application of quantity discounts mechanism reduces the inventory replenishment cost of the purchaser and increases the supplier's profit simultaneously. Under asymmetric information, paper[67] presented the optimum quantity discount method and compared the same with the situation in which the vendor has complete information. In paper[68] the consideration of convex decreasing function of retailer's selling price for the product demand and time-dependent function of backlogging rate were made. In this paper, authors developed an inventory replenishment model for deteriorating products and quantity discount.

Inventory models with quantity discounts and lead time-based discounts are compared to coordinate the efforts of an inter-organizational SC using simulation[69]. Further, authors demonstrated that the use of these two discount systems makes a significant difference in the gross profit of the SC members. In paper[70] proposed a quantity discount pricing model for a two-echelon SC with a supplier and a buyer. Also, the authors of the paper resolved the practical difficulties associated in implementing the quantity discount strategies between a supplier and a buyer. In paper[71] investigated quantity discount schedule set by the supplier to influence the stocking decisions at the buyer facing stochastic demand. In paper[72] presented a two-level SC coordination model for a fixed lifetime components under quantity discount incentive scheme.

In paper[73] proposed a multi-objective nonlinear inventory coordination model with mixed integers for single-retailer and multi-vendor SC under the strategy of providing quantity discounts for all-units. Paper[74] studied

the SC coordination mechanism for false failure returns using quantity discounts strategy. In paper[75] studied a SC coordination mechanism with quantity discounts in which the buyer interacts with supplier for multiple times before the product is sold in the end-consumer market. In paper[76] studied coordination models for the fashion SC under quantity discounts with uncertain yields. Two-echelon SC coordination for single-manufacturer and several buyers are achieved with the use of quantity discount contract for profit maximization[77]. The problem of optimal coordination between transportation and quantity discount decisions in a three-party SC is studied in paper[78]. The advantage of quantity discounts approach in deriving the coordination mechanism in a two-stage SC with single retailer and several suppliers is discussed for the allocation of order quantities[79].

4. Three-Level Supply Chain Models

In spite of several researchers focusing on two-echelon inventory models, few of the SC authors have made an effort on deriving a coordination mechanism for a three-level SC. In particular, a three-level inventory model with multi-entities at each level was studied in paper[80]. The author of the paper assumed that the entire lot is to be manufactured before the delivery of the batch of the goods. In paper[81] studied a three-level inventory system comprising of a single producer and multiple distributors and retailers. In paper[82] discussed a three-level coordinated SC model with flexible returning policies for short life cycle products by setting the rules of pricing. In paper[83] studied a three-level SC composing of a single-supplier, a single-producer and a buyer who faces stochastic demand. In paper[84] proposed a joint inventory production policy for a three layer SC.

In paper[85] investigated coordination of replenishment quantities in a three-layer SC with a joint decision making process. In paper[86] proposed a three-level SC model by considering setup time of the producer as a bottleneck constraint for the SC. Author of the paper found that the set up time and the rate of utilization are inversely related for optimal savings of the producer in the coordination channel. Mathematical model to compute the lead time of the retailer in a three-level SC comprising of two warehouses and multiple-retailers is proposed in paper[87]. In paper[88] investigated a three-layer SC in which manufacturing operations are continuously improved using learning curve theory. Coordinated model for production-inventory system with the consideration of defective and non-defective items in a three-level SC comprising of a supplier, manufacturer and retailer is proposed in paper[89].

In paper[90] studied joint economic inventory replenishment decisions in a three-level SC with a single supplier, single producer and multi-buyers. A three-level model for evaluation and configuration of network in a closed-loop SC network under uncertain demand is proposed in paper[91]. A nonlinear mathematical model for a three-level SC comprising of a single-manufacturer, one warehouse and two-buyers is proposed in paper[92]. An integrated inventory model for a three-echelon SC with several vendors, various manufacturing plants and multiple retailers is proposed in paper[93].

Most recently, three-level SC coordination under stochastic demand and random yield is discussed in paper[94]. The production lot sizing model for both defective and non-defective items in a three-layer SC with several suppliers, producers and retailers is studied in paper[95]. A three-stage mathematical model based on IoT (Internet of Things) technology for the optimal procurement, production and product recovery and acquisition is proposed in paper[96]. Coordination and effective profit distribution mechanism in a public responsible three-level SC comprising of a single-producer, single-distributor and single-buyer is studied in paper[97].

In addition, paper[98] demonstrated the optimality of replenishment choices and shipment strategies in a three-level SC by considering price dependent demand function which in turn is expressed in terms of ordering quantity and dependence factor. Coordinated and non-coordinated three-stage SC model with linear price dependent demand for optimal inventory decisions and shipment policies is presented in paper[99].

4.1 Supply Chain Models with Revenue Sharing Contract

From the paper[100] it is evident that the use of revenue sharing contract increased the Blockbuster's market

share of video rentals from 24% in 1997 to 40% in 2002. Also, paper[101] reported that the trade of revenue sharing mechanism increased the total net revenue of the industry by 7%. This has led to the increased scope of research in developing Supply Chain coordination models with revenue sharing contract. However, the volume of the literature addressing the mechanism of the revenue sharing contract in a three-level SC coordination mechanism is not enormous. Few authors have studied the coordination mechanism under revenue sharing contract by considering different aspects like price dependent demand, random demand, stochastic demand, risk preference, demand disruption, product loss, sales effort etc. Paper[102] discussed a coordinated inventory replenishment model for a three-stage SC with a single-producer delivering a single type of item to a single-wholesaler and then to a single-purchaser is developed under revenue sharing mechanism with the consideration of price and random demand. In paper[103] studied the coordination mechanism between the manufacturer, wholesaler and retailer in a three-level SC under demand uncertainty. The authors of the paper assumed that the wholesaler has buyback contract with the retailer whereas the manufacturer has profit sharing contract with the wholesaler. In paper[104] developed a three-level SC model and studied the coordination mechanism through revenue sharing contract. Also, authors of the paper discussed the mechanism of distributing the SC's profit among the members of the chain and setting up of sharing coefficients to achieve overall coordination. In paper[105] discussed the mechanism of revenue sharing contract in a three level Supply Chain under risk preference. Further, authors of the paper proposed the interval of the revenue sharing coefficient.

In paper[106] discussed a coordination process in a three-level SC consisting of a single- manufacturer, single-distributor and a single-retailer under stochastic demand. Also, authors of the paper proposed an optimal strategy to deal with demand disruption and to improve the revenue sharing contract. Further, they studied the disruption of profit among the entities of the SC. In paper[107] discussed the mechanism of three-level SC coordination between the producer, distributor and retailer for fresh and live agrarian products under revenue sharing contracts. Authors of the paper determined the optimal profits of the SC for three different decision making situations by considering product loss, product freshness and stocking factor. In the recent past, the coordination mechanism in a three-level SC comprising of a single-manufacturer, a single-distributor and a single-retailer under revenue sharing contract is studied[108]. Authors have assumed that the product demand at the purchaser point is stochastic in nature and depends upon the sales effort. Also, authors studied the SC coordination mechanism under the impact of sales effort.

4.2 Supply Chain Models with Information Sharing Contract

In the current day phenomena of ever growing technological advancement, the role of information sharing contract has become an essential approach in developing SC coordination mechanism. From the literature, though considerable amount of work has been reported in two-echelon inventory models, very few articles are evident in three-echelon inventory systems with information sharing contract. In paper[109] presented the architecture of the multi-echelon SC integration and variety of methodologies for information sharing. Paper[110] quantified the influence of information sharing contract on the replenishment quantity and expected cost in a three-stage SC under the common end demand process. Also, authors of the paper showed that the replenishment level of inventory and total relevant cost at the distributor and producer points decreases with respect to the increased level of information sharing in a three-level SC. In paper[111] studied the mechanism of three-level SC comprising of a producer, wholesaler and buyer with a focus on allocating cost savings through demand information sharing. Authors developed a cooperative game in the form of characteristic function and determined the appropriate allocation scheme to allocate expected cost savings. In paper[112] studied a three-echelon SC system and investigated the mechanism to provide the incentive to buyer by upstream partner to implement information sharing. Also, authors of the paper studied the issues involved while aligning the incentive scheme amongst the manufacturer, distributors and retailers and quantified the benefits generated in terms of inventory reduction through information sharing.

4.3 Supply Chain Models with Trade Credit

Many of the researchers have focussed on incorporating credit period as a SC coordination mechanism in two-level SC models. However, articles reporting coordination mechanism in a three stage SC with trade credit are few from the literature. Most recently, coordinated production-inventory model in a three-stage SC consisting of a producer, wholesaler and buyer for deteriorating products under two-stage credit period financing and quadratic demand is studied in paper[113].

4.4 Supply Chain Models with Quantity Discounts

Based on the literature in very few articles, the process of three level Supply Chain coordination mechanism is reported. In particular, paper[114] proposed the mechanism of SC coordination in a three-echelon inventory system under quantity discounts. Authors of the paper showed that incorporation of quantity discounts at both ends of the SC decrease the cost significantly rather than concentrating at the lower end. In the recent past, a joint production-inventory model for three-level SC of imperfect quality products is presented[115].

5. Vendor Managed Inventory Models

In Vendor Managed Inventory (VMI) system, supplier takes the full control of inventory control and replenishment decision policies for retailers. Under VMI policy, retailer provides the inventory information to the vendor and the vendor uses this information to monitor inventory orders. Several researchers have focused on deriving the potential benefits of VMI in a SC management[116–124]. In paper[122] studied a VMI SC for deteriorating items by considering common replenishment cycle time and shipment frequency as decision variables. In paper[124] proposed a VMI model for optimal selection of buyers for a vendor and showed that the optimal selection of buyer increases the vendor's profit up to 90%.

Mathematical model for relating the performance of traditional inventory system and VMI system in a two-level SC is presented in paper[125]. In paper[126] proposed an analytical model to identify various SC parameters that influence the percentage of cost savings realized from the mechanism of VMI. In paper[127] reviewed the literature on Vendor Managed Inventory and presented it into three categories and six dimensions. Consignment and VMI policies in a SC with single-supplier and several buyers for deterministic demand are modeled in paper[128]. Vendor Managed Inventory scheme for SC coordination is proposed in paper[129], where the buyer imposes a penalty to the vendor when the shipment quantity exceeds an upper limit.

6. Supply Chain Models with Price Dependent Demand

Further in the perspective of inventory management in a SC, demand happens to be the vital component. Hence, few researchers have drawn the attention towards the development of coordination models. In particular, paper[130] assumed infinite replenishment rate and arithmetically progressing successive replenishment cycle lengths. Also, authors of the paper developed a deterministic inventory replenishment model for a single item under linearly increasing time-dependent demand with two separate storage facilities. Paper[131] considered seller's unit selling price and span of credit period as policy variables for the seller in two-level SC, in which the end product is price sensitive. Paper[132] used different expressions for the demand-curve functions in an inventory replenishment model as an alternative to the linear demand function. In paper[133] developed an inventory model for a coordinated SC through pricing discount. The model was developed for optimal inventory replenishment strategy and pricing procedure under the change of demand linearly with price. In paper[134] studied the market demand disruption in a SC consisting of one supplier and one vendor. In paper[135] quantified the relationship between the seller and buyer in a coordinated and non-coordinated two-level SC in which the product demand is sensitive to both price and promotional strategies. The seasonal demand pattern in which the demand function is expressed in terms of price and time was observed in paper[136].

In the recent past, uncertainty with demand and supply in a multi-echelon SC was studied in paper[137]. The

effect of reduced wholesale price index and increased consumer price index on the gross profit of a two-level SC, when the product demand is reliant on selling price was investigated in paper[138]. Two linear and non-linear regression models of a two-stage inventory replenishment system were developed in paper[139]. In paper[140] developed two-stage inventory replenishment model with a producer and a buyer under exponential price dependent demand. A two-level SC comprising of a single-producer and a single-buyer under the condition of quadratic price dependent demand is modeled in paper[141]. Most recently, coordinated and non-coordinated two-level SC with price dependent demand is presented in paper[142]. Authors of the paper considered that the product demand dependent on retailer's unit selling price, which in turn is expressed as a function of retailer's ordering quantity influenced by the dependence factor.

7. Conclusions

In this paper, an attempt is made to present the extant of literature on various aspects of Supply Chain coordination. Research papers dealing with SC coordination mechanism have been collected and classified into two categories: 1. Two-level models and 2. Three-level models. Further, two-level models are classified based on trade credit, quantity discounts, information sharing and revenue sharing; whereas, three-level models are classified based on revenue sharing, information sharing, trade credit and quantity discounts. Further, the literature is reviewed on Vendor Managed Inventory models and also the discussion is carried out on SC coordination under price dependent demand. From the background of this literature, it is observed that coordination development among the members of the SC is critical. Due to ever rising competition with technological advancement in manufacturing and business firms, SC coordination has become a challenging task.

Also, it is observed that sufficient volume of papers reported the SC coordination in a two-stage inventory system. The number of papers discussing three-level Supply Chain coordination is few in number. Especially, in the perspective of trade credit and quantity discount option, very few articles are reported discussing coordination in a three-level chain.

Further, it is also observed that most of the articles addressed the coordination mechanism incorporating ordering and carrying costs. Very few articles addressed the implications of transportation cost in SC coordination mechanism. In the current day global competition, study of the effect of space cost and advertisement cost in coordination mechanism is highly significant. The use of simulation in developing SC coordination is highly emphasized as the activities of the chain are becoming highly dynamic and challenging.

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