

## The Impact of Information Technology on Coordination Mechanisms of Supply Chain

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**Abstract:** Nowadays, the effective supply chain is one of the important issues in the industrial management context. In today's world that is confronted with rapid technological changes and high competitiveness, companies are more successful that respond to the customers' needs effectively, regarding the existing opportunities and threats. Since a supply chain consists of various organizations, it can satisfy customers' needs, only when the whole of its parties become integrated and coordinated. The results showed that one of the important objectives in a supply chain is coordinating all of its parties, so such coordination mechanisms that provide coordination between various members of a supply chain, have more importance. Although recent development in information technology has affected the whole supply chain circuits, in this paper, we just argue the impact of information technology on coordination and other existing flows in supply chain. So in this paper, different kinds of coordination mechanisms were introduced and evaluated the impact of information technology on those mechanisms. These effects were shown in the form of a conceptual model. The implications provide a useful insight into managers about better coordination with their partners in a supply chain.

**Key words:** Supply chain • Coordination mechanisms • Information technology • E-commerce • Electronic supply chain

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### INTRODUCTION

A supply chain is composed of trading partners that are interconnected with financial, information and product/service flows. Effective management of these flows requires creating synergistic relationships between the supply and distribution partners with the objective of maximizing customer value and providing a profit for each supply chain member [1]. As supply chain members are often separate and independent economic entities, a key issue in SCM is to develop mechanisms that can align their objectives and coordinate their activities so as to optimize system performance [2] so when a supply chain is completely optimized that all of its parties become coordinated. Many of authors describe supply chain management as a synonym for coordination of all comprised activities. For example, Mentzer *et al.* [3] define supply chain management as “the systemic, strategic coordination of the traditional business functions across businesses within the supply chain”. Or for example, Lummus and Vokurka [4] in other research specify supply chain management as “coordination of all

activities into a seamless process”. In addition, Chandrasekhar and Scary [5] define a supply chain management as “coordination of business activities across organizational boundaries”.

As a result, Co-ordination of activities and management of supply chain relationships can be a source of competitive advantage and can bring additional value to the customer [6]. Business process management addresses organizational coordination both internally and with partners who are customers or suppliers. The design of co-ordination processes is vital for successful supply chain management and internet technologies enabled SCM processes are achieved in the best way [7].

So it can be said that, if the better coordination mechanisms used, there are more possibility to overcome its complexity and dynamisms and information technology or internet, are such tools that facilitate those mechanisms in the supply chain, so in this paper coordination mechanisms and their benefits introduced, as well as the effect of information technology on facilitating these mechanisms.

**Coordination Theory:** As it is said before, a supply chain is comprised of units (such as supplier, manufacturer and customer) and processes that flow between these units and effective coordination between processes and units leads to increasing efficiency and productivity in a supply chain.

Coordination in a supply chain means identification and classification of existing interdependencies [7]. McCann and Ferry [8] defines interdependency as “when actions taken by one referent system affect the actions or outcomes of another referent system”. The more specific the interdependency is identified, the deeper the level would be at which co-ordination strategy can be executed. Logically, there are three types of interdependencies between tasks and resources: those between tasks, those between resources and those between a task and a resource. Task/task interdependency refers to the interdependency of tasks between and internal supply chain organizations, such as order prerequisite interdependency or demand interdependency. Task/resource interdependency refers to resource requirement in realizing a task in a supply chain. It highlights the organizations, capacities and material that should be assigned to a particular task. Three task/resource interdependencies: order/organization, order/inventory and order/capacity interdependency are identified and finally, Resource/resource interdependency is the interdependency between resources such as capacity and inventory in supply chain [7]. So According to the co-ordination theory, the activities in an organization can be separated into those that are necessary to achieve the goal of the process (e.g. that directly contribute to the output of the organization) and those that serve primarily to manage various dependencies between activities and resources [9].

The organizations that have similar activities have to manage the same interdependencies, but they may choose different coordination mechanisms. Internet technologies enabled SCM processes are designed to collect real-time information and make fast and accurate supply chain decisions. Different supply chain co-ordination processes manage different types of interdependencies. Typical features of supply chain co-ordination processes include demand planning (DP), supply planning (SP), available-to-promise/capacity-to-promise (ATP/CTP), manufacturing planning, distribution planning (DP), etc. Generally, the execution of process depends on proper information management. Internet technology enabled information integration within and between organizations is critical to SCM [7].

**Coordination Functions in Supply Chain:** There are various functions for coordinating different activities in a supply chain. For example, ordering activities need complete coordination. In fact, inventory management at a single location consists of two fundamental decisions: how much to order and when to order [10]. Inventory management at a supply chain, however, consists of replenishment decisions at different firms. There are three dimensions on which the operational activities of a supply chain can be coordinated in order to maximize system profits or minimize system costs. First, order quantities that optimize individual performance are often not able to optimize system performance. This issue has long been realized. There is a vast literature on discount policies that suppliers can use to entice buyers to increase their order quantities so as to improve profits [11-13]. Second, orders can be synchronized to reduce system inventory. Consider the case of a supplier and two separate but identical buyers. Let the demand at the buyers be deterministic. If the two buyers are coordinated to place orders at the same point in time, the supplier may adopt a lot-for-lot policy and carry no inventory. If the two buyers are not coordinated on the timing of their orders, the supplier’s inventory replenishment cost is double that under the lot-for-lot policy [13-14]. Finally, accurate, timely and easily accessible information can improve decisions. In the context of SCM, a supplier is able to better match inventory supply with demand when information is available on the buyer’s inventory status [2].

Recent studies have reported significant cost savings from information sharing [7,15]. However, it is better said that the benefit of information depends on how it is used. Although this issue is obvious, it raises an important challenge: optimal policies may change with the information structure. With the existing literature, the issue is obviously no longer whether collaboration is beneficial. Rather, it is how to achieve such benefits. When the entire supply chain is under the control of a single decision maker, or the coordination benefits can be fairly distributed among the individual members by a central body, the system is referred to as a centralized system. But, when the supply chain members are separate and independent economic entities, they will act independently and opportunistically to optimize their individual benefits. In this case, an action plan has to be complemented with an incentive scheme that can allocate the benefits of coordination among the supply chain members so as to align their objectives of coordination. Such a system is regarded as a decentralized supply chain system [2].

In the next issues we point at benefits of coordination and introduce various kinds of coordination mechanisms.

**Benefits of Coordination in Supply Chain:** Researchers have shown that, under certain conditions, all members of a decentralized distribution channel can earn larger profits when all members coordinate [14], so because the environment of internet, e-commerce, or e-SC<sup>1</sup> is a decentralized one, then it is said that coordination in such environments will bring more benefits for supply chain members. Min [16] determined that Supply chain coordination provides risk reduction, access to resources and competitive advantage. In addition, Cristiaanse and Kumar [17] argue that Supply chain coordination dictates the cost improvement and value that can be gained. Jorgensen and Zaccour [18] also express that Uncoordinated decision-making creates inefficiency with the channel members' profits significantly lower for each channel member independently and collectively than what could be achieved with coordination. And finally, Cachon [19] Jeuland and Shugan [20] and McDermott, Franzak and Little [21] show that more interorganizational coordination yields lower total costs and higher profits.

So with regarding the mentioned benefits, all members of a supply chain must choose such mechanisms for coordination that maximize benefits of coordination and leads to more profitability for all members.

**Coordination Mechanism in Supply Chain:** Coordination mechanisms in supply chain are tools by which, every member of a supply chain can achieve more benefits.

Gundlach, *et al.* [22] advocate the use of norms as a coordination mechanism. Flexibility, solidarity, mutuality, harmonization of conflict, restraint in the use of power, concern for reputation and information sharing are examples of some of the norms often discussed in the coordination literature [22-31]. Norms play a key role in coordinating supply chains through team-based approaches.

The above categorizations are general approaches/organizational perspectives on classifying coordination according to style/type as opposed to specific mechanisms. A coordination mechanism, on the other hand, is a specific tool designed to address a particular coordination problem and can be applied under any of the general organizational approaches defined above. Classifying coordination mechanisms as tools requires understanding the specific coordination problem and its proposed solution. Due to the unique nature of each problem, classifying the various coordination mechanisms

is a complex and difficult task [1]. In an attempt to make progress in this area, Sahin and Robinson [32] proposed price, non-price, buy-back and returns policies, quantity flexibility and allocation rules as major categories of coordination mechanisms. Fugate *et al.* [1] have adapted their classification into three major categories: price, non-price and flow coordination mechanisms.

**Price Coordination Mechanisms:** Coordination and cooperation issues between manufacturers (suppliers) and retailers (buyers) in decentralized multi-echelon inventory/distribution systems have gained much attention in recent years due to the increasing emphasis on the significance of effective supply chain management [33].

Quantity discounts offer a method for coordinating the order quantities between a retailer and a producer. The motivation for giving quantity discounts could be either price discrimination or coordinating order quantities [34].

Of course, there are more price coordination mechanisms in addition to quantity discount [1], but our focus is on another mechanisms.

**Non-Price Coordination Mechanisms:** Non-price coordination mechanisms include quantity flexibility contracts, allocation rules; promotional allowances, cooperative advertising and exclusive dealings/territories [1]. Quantity flexibility contracts and allocation rules are the most frequently discussed forms of non-price coordination. Quantity flexibility contracts allow the buyer to obtain a different quantity than the previous estimate [35]. Suppliers often face excess demand from retailers that they cannot deliver with their current capacity levels. In these instances, the supplier establishes rules to allocate the scarce capacity among the retailers. Retailers, realizing the scarcity of capacity, distort their orders in anticipation of obtaining their desired order quantities. A variety of allocation rules have been investigated to mitigate the adversarial impact of demand distortion as the result of capacity shortage [1].

**Flow Coordination Mechanisms:** Flow coordination mechanisms are designed to manage product and information flows in supply chains. Sahin and Robinson [32] provide an extensive literature review on product flow coordination and information sharing in supply chains, classifying the literature based on the degree of information sharing and coordination.

Vendor Managed Inventory (VMI), Quick Response (QR), Collaborative Planning, Forecasting and

Replenishment (CPFR), Efficient Consumer Response (ECR) and postponement are among some of the initiatives used for product and information flows [1].

VMI allows the supplier to monitor the retailer's inventory levels and make periodic replenishment decisions involving order quantities, delivery mode and the timing of replenishments [32,36]. QR focuses on building a collaborative partnership between manufacturers and retailers by shortening the manufacturer's replenishment lead-time and giving the retailer a chance to place a small order at the beginning of the season, observe early demand and choose an optimal replenishment quantity to maximize profits based on observed demand. The manufacturer gains from the collaboration by improving forecast accuracy and revising production schedules based on early demand [32]. CPFR automates and improves sales forecasting and replenishment between trading partners, enabling participants to share improvements in inventory costs, revenue and customer service [37]. ECR decreases time and costs in the core, value-adding processes through four specific strategies: efficient store assortment, efficient replenishment, efficient promotion and efficient product introduction [38]. Postponement as a coordination mechanism attempts to reduce risk and uncertainty of operations by delaying operational commitment (form, place and time) until final customer commitments have been obtained [39]. [For more information you can see [1]. Our focus in this paper is mainly about these mechanisms.

**The Effect of Information Technology on Coordination Mechanisms:** Some tools such as information technology and information systems have the most effect on flow coordination mechanisms. These mechanisms use in order to manage information and product flows. The different companies has placed in a global supply chain, use some tools such as web or internet as a tools for better coordinationf with other members of supply chain. in addition, the existence of information technology enables companies to respond customers needs more effectively.

In fact, IT is more importantly viewed to have a role in supporting the collaboration and coordination of supply chains through information sharing and the most typical role of IT in SCM is reducing the friction in transactions between supply chain partners through cost-effective information flow. In addition, IT can be used for decision support [40].

The effect of information technology on coordination mechanisms is arguable from two aspects. One aspect is electronic supply chain and the other one is e-commerce

issue. In the next section we introduce these issues and point at some their benefits. In addition, we will show the effects of information technology on coordination in the form of a model.

**E-Supply Chain and its Benefits in Coordination:** New developments in information technology have provided a ground in which companies can program, control and manage the inputs and the outputs that flow in a supply chain.

Customization is a critical success factor in current business environment. One of the most important components that make fast and inexpensive customization possible is electronic supply chain design (e-SCD). e-SCD is a supply chain design which integrates and coordinates suppliers, manufacturers, logistic channels and customers using information technology (IT) [41]. In other word, electronic supply chain (eSC) is SCM organizations that are linked within and between their trading partners by the Internet and/or EDI to buy, sell, move products/services and cash flows [42].

The primary distinction between the eSC and the traditional supply chain is that the eSC, while structurally based on technology-enabled relationships, makes decisions based upon efficiency benefits. Because the eSC is created via electronic linkages, thereby providing low switching cost, it allows for the supply chain configuration to be very adaptable to changing trends, consumer preferences and competitive pressures. In essence the eSC is a hybrid between traditional arm's length and traditional supply chain approaches. It is relationship based but only as long as business objectives are being met. It potentially allows firms to realize the low procurement costs associated with arm's length relationships and shared risks and expertise of traditional supply chain. Moreover, eSCM can be thought of as a balancing act, causing firms to seek equilibrium between the cost benefits associated with arm's length relationships and the structural benefits of traditional supply chain management [42].

**E-Commerce and its Effects on the Coordination of Supply Chain:** E-commerce has defined simply as the use of systems and open communication channels for information exchange, commercial transactions and knowledge sharing between organizations [43]. Dolber *et al.* [44] also have defined ecommerce as the trade of goods and services that takes place electronically such as over the Internet.

For industrial marketers, e-business has triggered a growth in interest in network (rather than dyadic) levels of

activity which concentrates decision making on issues of Supply chain management optimization [43,44]. In the base of his view, primary goals of e-commerce implementation are supply chain management and integration, price pressures and cost reduction, knowledge development and learning, intellectual property and information flow control, speed of change in business, managing global customers and suppliers, development of e-procurement practices and lead time management. Totally we can say that e-business can thus be seen to impact on supply chain structures; supply chain coordination and supply chain relationships [45]. So for better understanding the effects of e-commerce, we must evaluate the e-commerce environment.

**E-Commerce Environment:** In electronic systems, there are many tools for data and information exchanges such as e-mail, web sites, funds transfer, electronic data interchange, MS outlook, Lotus notes, knowledge sharing, customer relationship, management, enterprise resource planning, computer-aided design, e-procurement, intranet, middleware, extranet, portals and global positioning systems. The most use of these tools is related to e-mail (85.9%), web sites (83.5%) and then funds transfer (83.1%) [43].

One of the important aspects of e-commerce is its high speed. In fact, it can be said that one year in e-commerce is equivalent to four years in the traditional business cycle. The speed at which business operates electronically is an attractive aspect of e-commerce, because faster execution of processes allowed companies to reduce costs, improve quality and attract the most profitable customers [46]. In fact, today, the e-commerce environment has intensified the strategic emphasis on speed, enabling further reduction of product cycle time, increased rate of new product introductions and increased speed of customer transactions [47]. E-commerce has viewed as a way to open and remove technology barriers among supply chain members and to bring everyone in the network closer. The Internet allows companies to communicate and share information across the supply chain [46].

In fact, one of the important functions of internet is that its information flows are multidirectional. This factor is very important especially for great and global supply chains, because internet application leads to more communication between members of a supply chain and therefore, coordination will increase. Today, organizations are not restricted to their physical territories and there are some companies that have no extrinsic existence, but they

have business communication with other companies and coordinate their policy with their partners.

The fast pace needed to operate in the e-commerce environment and access to new markets has impacted traditional market structures. The emergence of the electronic market space provides the opportunity for manufacturers to market directly to customers, eliminating the need for traditional channel intermediaries. At the same time, new “cybermediaries” are stepping between trading partners. In fact, internet and the e-commerce environment have decrease mediators and lead to better communication. In fact, Information visibility and dynamic market structures directly create a perception of uncertainty and in such uncertain environment, companies are more successful that focus on relationship management [46].

**The Model of Information Technology Effect on Coordination of Supply Chains:** As we said before, generally a supply chain is comprised of supplier, manufacturer and customer and whole of these members are placed in a same network. Supplier can supply raw materials directly for a manufacturer or can be a supplier for other suppliers; in addition, customer may also be a distributor, retailer or an end customer. Totally, every member has focused on a specific function. In this context, manufacturer has focused on production, supplier has focused on resourcing and finally, customer is interested to delivery.

Because these members are inevitable to communicate with each other for business proposes, they can handle their specific functions in the best way, when they can coordinate different flows (material, information and financial flows) and manage their relationships with their partners. Not only companies must coordinate their interorganizational functions, but also they must coordinate these functions with other functions in their partners' companies. As a result, this way would be profitable for all members.

Today, in information and communication age, companies are inevitable to use information technologies such as internet, in order to compete with other supply chains and also in order to reinforce their coordination with other members. So as we said before, management of information systems is very important and it leads to more coordination between members. So every member in a supply chain must analyze the whole information flows. Information analysis is one of the important functions that managers must pay a special attention about it, because the accurate analysis of information leads to better

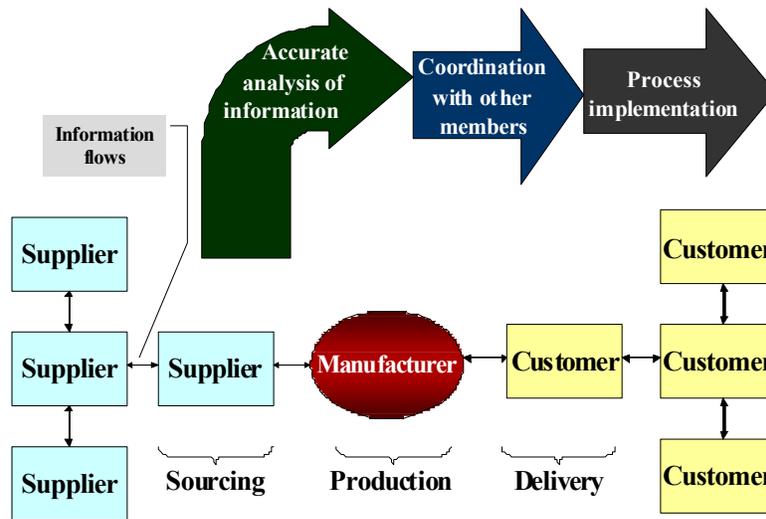


Fig. 1: The model of information technology effect on coordination and optimized implementation of processes in supply chains

comprehension about the status of other members and companies with such comprehension will have more ability to coordinate themselves with others and make the best decisions. When such coordination and alliance between companies has appeared, it is the best time to implement processes and definitely it will be accompanied with less time and cost rather than uncoordinated supply chains. This flow has been shown in Figure 1. As the figure presents, every party's managers must analyze the information flows coming to their companies and then coordinate themselves with other members in order to optimized implementation of processes.

## DISCUSSION AND CONCLUSION

Coordination between activities brings about more profitability and value added and also optimization of processes in a supply chain and in fact, one of the greatest challenges with which managers are confronted, is the function of coordinating their companies' activities with other members of supply chain. So companies must have a cooperative relationship with other members in order to effective contribution in coordination functions.

Effective coordination can lead to a reduction in lead times and costs, alignment of interdependent decision-making processes, improvement in the overall performance of each participant in the chain, as well as the supply chain itself [48].

Coordination mechanisms have been used to correct management of every flow such as financial, material and

information flow in a supply chain. Among these mechanisms, flow mechanisms that are used to management of product and information are more important. In this context, information technology has more effect on these mechanisms and optimizes their effects. The information technology issue has two aspects that can provide some opportunity in order to improve relationships and make the best decision. These aspects are e-supply chain and e-commerce that can provide better coordination between members. These technologies facilitate information accessibility in order to accurate programming and decision making. In addition, they can eliminate hierarchies and improve customer services. As a result, accurate management of information by using of new technologies, result in optimized decisions, better extrinsic and intrinsic coordination and correct implementation of processes that these factors guaranties profitability and long existence of supply chains.

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