Internet-enabled coordination in the supply chain

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Abstract

The Internet fosters the integration of business processes across the supply chain by facilitating the information flows necessary for coordinating business activities. However, the Internet also supports the use of market mechanisms, such as auctions, that foster price competition. Using market mechanisms is less likely to generate a sustainable competitive advantage, but they might offer the opportunity to purchase some items at a lower price. Managers have the challenge of selecting the Internet-enabled coordination mechanism that best fits the needs of a variety of business situations in the supply chain. The authors present a framework to assist managers with this decision.

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Much has been said about how the business landscape has changed as a result of the Internet. Managers may use a variety of coordination mechanisms available through the Internet. Using the appropriate coordination mechanisms offers the potential to help managers improve business performance, increase revenues, reduce costs and reach new markets. However, for these to happen, management practices must be adapted to the new environment. The Internet facilitates the implementation of a variety of coordination mechanisms, such as information sharing, auctions, and electronic agents, for connecting members of the supply chain. The challenge that managers face is to select the mechanism that best fits each situation.

The Internet is a standard computer communication network. Before its development, linking information systems across the supply chain was expensive and technically challenging. In this sense, the Internet empowers managers to extend the practice of supply chain management (SCM). The ability to integrate business activities with customers and suppliers leads to a competitive advantage, differentiating top performing firms. However, the Internet also enables managers to reduce acquisition costs by fostering price competition among suppliers using market mechanisms such as auctions.

The purpose of this paper is to identify how the Internet can be used to improve business practices in the supply chain. From literature in marketing, logistics, SCM, economics and management information systems, we develop a framework with six dimensions and identify seven Internet-enabled coordination mechanisms. Then, we evaluate each mechanism on the six dimensions in the framework. We expect the framework will help managers identify the right coordination mechanism for each of a variety of business situations.

1. Supply chain management

The Internet offers several cost reduction and service improvement opportunities to managers involved in SCM. These opportunities include the ability to integrate business processes electronically with other supply chain members, the ability to provide worldwide customer service, the ability to track systems status of third-party service providers, and the ability to reduce service costs and response time [1]. However, there is a lack of agreement among educators, consultants and practitioners on the precise definition of SCM. In fact, many use the term interchangeably with logistics or operations management. We believe that SCM refers to the integration of key business processes...
across key members of the supply chain and accept the definition provided by The Global Supply Chain Forum:

Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders. [2]

The Forum members’ view of SCM is summarized in Fig. 1. Since, at the time the framework was developed, most of the Forum members where manufacturers, Fig. 1 assumes the perspective of the manufacturer positioned in the middle of the supply chain. However, the framework can be readily applied to a retailer or to an original supplier.

The Forum members identified eight key business processes that are implemented within the supply chain cutting across functional silos and organizational boundaries. The key business processes are [3,4]:

- customer relationship management
- customer service management
- demand management
- order fulfillment
- manufacturing flow management
- supplier relationship management
- product development and commercialization
- returns management

The integration of business processes with other supply chain members requires considerable management attention.

The SCM business processes will be integrated with key supply chain members. This integration is supported by the linking of information systems. Competitive market mechanisms will be used with other members with whom business is conducted in a transaction-by-transaction basis. Managers need to choose the appropriate level of integration for particular relationships in the supply chain and the appropriate degree of information sharing.

Integrating the SCM processes or doing business on a transaction-by-transaction basis requires information sharing and the Internet facilitates information sharing. Information such as forecasts and delivery schedules is continuously shared to coordinate activities in close business relationships. Transactional data are shared in those relationships in which business is done repetitively. The Internet is also used to share data between the customer and potential suppliers to purchase an item on a one-time basis. The SCM framework suggests that information flows link all supply chain members (Fig. 1). However, little research has been done to explore these information flows. In this article, we describe how Internet-enabled coordination mechanisms support the information flow among supply chain members.

2. Cost of coordination

The study of the effect of information technology (IT) on the firm [5] and the economy [6] has received considerable attention. Transaction costs economics (TCE) provides a framework to explain how firms are affected by IT. In this

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Fig. 1. Supply chain management: integrating and managing business processes across the supply chain.

Originally developed by Coase [7] and extended by Williamson [8–10], TCE is used to describe the dynamics of markets or hierarchies based on the cost of transactions. Transaction costs are the costs of searching for the right alternative, and negotiating and enforcing a contract. In a market, also characterized as one-time relationships [11], “autonomous contracting...is ubiquitous” [8]. In other words, each time a buyer has a requirement it is necessary to search the market to find the best offer that matches the requirement, and to agree on the price and other conditions with the seller.

A market is coordinated by price. Price is adapted to changing conditions of time and place, functioning as a coordination mechanism [12]. The firm is a hierarchical structure created to reduce the cost of transactions [13]. A hierarchy refers to the situation in which a set of separable tasks is placed under common direction [8]. This type of organization has been referred to as vertical integration in the marketing literature [14].

2.1. Cost of coordination and IT

Based on research that dealt with the effect of IT on coordination costs, we suggest the use of six dimensions to evaluate each Internet-enabled coordination mechanism. The dimensions are:

- complexity of product description
- asset specificity
- transaction risk
- operational performance risk
- frequency
- item value

2.1.1. Complexity of product description

Malone et al. [15] used TCE to analyze the effects of IT on the structure of markets and hierarchies using two dimensions: complexity of product description and asset specificity. Complexity of product description refers to the amount of information needed to specify the product characteristics in enough detail for potential buyers [or sellers] to make a selection. The higher the complexity of product description, the higher the searching costs. Using IT fosters the standardization of product description because to implement an information system data should be structured.

2.1.2. Asset specificity

Asset specificity refers to assets that cannot be readily used outside the relationship. Specific assets increase the switching costs to another relationship. The need for assets specific to a relationship increases transaction risk and, ultimately, transaction cost. Malone et al. anticipated that IT would increase the proportion of transactions coordinated by markets because IT reduces the level of specific assets needed to maintain a relationship in the supply chain and the cost of searching for supply options.

2.1.3. Transaction risk

Clemons and Row [16] separated transaction costs into explicit coordination costs and transaction risk. Explicit coordination costs are the direct costs of tailoring decisions for a relationship. Transaction risk is the risk associated with the other side of the relationship behaving opportunistically. Opportunistic behavior is, for example, one side trying to renegotiate a contract after some commitment have been made by the other side. The closer the relationship, the higher the transaction risk associated with the relationship.

2.1.4. Operational performance risk

In a follow-up publication, Clemons et al. [17] further disaggregated transaction costs into: coordination costs, transaction risk and operational risk. They related operational risk to the difficulty to specify the rights and responsibilities of each party of the relationship. In a close relationship, managers find that it is more difficult to specify rights and responsibilities and perceive a higher operational risk.

Clemons and Row related operational risk to possible misalignment of objectives. Nonetheless, even when both firms agree on the objectives, one might fail to perform as expected which also has been called operational performance risk [18]. Operational performance risk is associated with the loss of control over the management of the activity. If the other party in the relationship fails to fulfill a request and the impact on the firm’s efficiency is high, then operational performance risk is high. Conversely, if the other party in the relationship fails on a commitment and the disruption to the firm is minor, operational performance risk is low.

2.1.5. Frequency

The frequency with which a transaction occurs influences transaction costs [10]. IT has high setup costs and low marginal costs, which provides economies of scale. Consequently, the higher the frequency (or transaction volume) the more likely efforts to standardize the format of transactions will pay off.

2.1.6. Item value

The value of the item involved in the transaction might influence the selection of the coordination mechanism. Buyers might find it easier to reduce costs on high value items than on low value items. The potential cost reduction is traded-off with, for example, the incremental searching costs associated with finding new supply options. Low value items are less likely to offer room for cost reductions.
Now that we have described the six dimensions for evaluating coordination mechanisms, we will use these dimensions to evaluate seven coordination mechanisms available through the Internet.

### 3. Internet-enabled coordination mechanisms

Several coordination mechanisms use the Internet as the computer communication network. Some existed before the Internet, but now are less costly and reach a greater number of users; others are under development.

The Internet-enabled mechanisms can be classified into:\n- **Market mechanisms** and **coordination flows**. A market mechanism is used to conduct a business transaction, to purchase something at a given price. Frequently, market mechanisms are used to foster price competition among potential suppliers. Therefore, market transactions are often one-time transactions because a different supplier can be selected for each transaction. The information that is shared using market mechanisms is generally limited to the conditions of the transaction, delivery information and payment, in addition to the bidding processes. We identified six Internet-enabled market mechanisms: auctions, multidimensional auctions, closed auctions, purchasing groups, electronic purchasing aids and electronic agents.

In contrast, in coordination flows, purchasing decisions have been made and information is shared to coordinate the flow of products. Coordination flows are implemented when managers do not need to search the market and evaluate alternatives for each transaction. Information is shared in a seamless fashion and it is used, for example, for planning production and distribution, developing products and handling special orders. Coordination flows usually have a greater impact on the organization that market transactions and, therefore, are suitable for more stable relationships.

Table 1 contains a framework that can be used to evaluate Internet-enabled coordination mechanisms. It also includes a brief definition of the dimensions used in the analysis.

### 3.1. Market mechanisms

An array of market mechanisms may be used in a business. The key for managers willing to use Internet-enabled mechanisms is to identify which one best fits each of the firm’s needs. Usually, market mechanisms, such as auctions, will not provide a sustainable competitive advantage to a firm. Nonetheless, they tend to be simple to use and frequently offer the opportunity to purchase some items at a lower price, making them popular.

Six market mechanisms are evaluated using the six dimensions previously reviewed: asset specificity, complexity of product description, transaction risk, operational performance risk, frequency and item value.

### 3.1.1. Auctions

An auction is a market mechanism in which the buyers and seller agree on the item to be auctioned, and on payment and delivery conditions. Each auction can be regarded as a one-time transaction because the bidding process can output a different winner each time.

There are many types of auctions. The most popular is the progressive auction [19]. In progressive auctions, also called English or standard, “...bids are freely made and announced until no purchaser wishes to make any further higher bid” [20]. In a Dutch auction, the auctioneer announces lower prices in succession until a bidder bids [21]. In second-price auction, the winner is the one who bids the highest but pays the second highest bid [22].

Auctions have been categorized as consumer-to-consumer, business-to-consumer and business-to-business (B2B) [21]. Our focus is on B2B auctions. Reverse auctions are particularly popular in B2B. In reverse auctions, a firm sells a contract for the provision of an item and suppliers bid for the contract. The dynamics of a reverse auction might be confusing because the flow of products and payments are reversed and the objective is to bid for the lowest price rather than for the highest. That is, the suppliers bid on the lowest price at which products will be sold and the buyer pays the winner of the auction (the selected supplier) for the provision of the products specified in the contract being auctioned.

In the case of a reverse auction, the supplier is unknown until the end of the bidding process. Additionally, all suppliers are considered equal in terms of, for example, product and service quality, and reliability. Since all conditions of an auction need to be clear to both parties, the complexity of product description needs to be low [23].

Three parties participate in an auction: the buyer, the seller, and the auctioneer. Usually, no relationship-specific assets between buyer and seller are needed in an on-line auction on the Internet. Additionally, sellers and bidders require little assets that are specific to the relationship with the auctioneer. Online auctions are a good example of how the Internet changed the business environment. Before the Internet, specific assets were necessary to participate in on-line auctions; that is, when private computer communication networks were needed for connecting the seller, bidders and auctioneer. For example, AUCNET is a used car auction system created in Japan in 1984. The implementation of AUCNET required the development of a private computer communication network and proprietary personal computers [24]. Both sellers and bidders needed assets specific to the relationship with the auctioneer, “locking them in” the relationship with the auctioneer.

Because auctions are one-time transactions, the transaction risk associated with the closeness of the relationship is low. The operational performance risk for auctions can be high and might be the highest of all mechanisms reviewed here. The conditions of the transaction are standard for all bidders. The bidding process considers all suppliers equal.
<table>
<thead>
<tr>
<th>Coordination mechanism</th>
<th>Dimension for evaluation</th>
<th>Complexity of product description</th>
<th>Asset specificity</th>
<th>Transaction risk</th>
<th>Operational performance risk</th>
<th>Frequency of purchase</th>
<th>Item value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auctions</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Multidimensional auctions</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Closed auctions</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Low to medium</td>
<td>High</td>
</tr>
<tr>
<td>Purchasing groups</td>
<td>Low to medium</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low to medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Electronic purchasing aids</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Medium to high</td>
<td>High</td>
</tr>
<tr>
<td>Electronic agents</td>
<td>Low to high</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low to high</td>
</tr>
</tbody>
</table>

Example of how to read the table: Auctions are appropriate for products with low complexity of product description. Using auctions requires a low level of assets specific to the relationship with the other side of the transaction. The use of auctions has low transaction risk. Auctions have high operational performance risk. They are more appropriate for low frequency of purchase. Finally, auctions are more appropriate for medium value items.
Thus, operational performance risk is high because, for example, delivery and transportation time could be uncertain and delays negatively affect performance of the firm’s operation.

Since the preparation for and the participation in an auction is time consuming, the frequency of transaction needs to be low. Higher frequency might make other coordination mechanisms preferable. To reduce frequency of transactions, management could choose to auction a contract. For example, instead of auctioning the transportation of a truckload between two cities, the item in a reverse auction can be the provision of the transportation service during a year. In this case, complexity of describing the item (the contract) is increased to reduce frequency of transactions.

A reverse auction fosters price competition among potential suppliers promising lower unit cost to the buyer. Higher value products offer more cost reduction potential, making them appealing to auction-type mechanisms. Auctions are usually appropriate for items with at least medium value. The key is to use auctions in those situations in which the cost savings are higher than the additional costs for conducting the auction.

### 3.1.2. Multidimensional auctions

In standard auctions, sellers and bidders only coordinate the price of the item. Multidimensional auctions (also called multiple-attribute auctions) “…automate multilateral negotiations on multiple attributes of a deal” [25]. For example, price and quality have been used to investigate the use of two-dimensional auctions [26,27].

A multidimensional auction can be based on any set of attributes, for example, price and delivery date could help the seller to smooth peaks and declines in demand. With this type of auction, a customer needing the products during a peak in demand will pay more than another willing to wait. In general, multidimensional auctions can be used to implement price discrimination strategies [28].

With standard reverse auctions, buyers only consider price when making a purchasing decision. Using this type of auction might hinder long-term relationships with suppliers [29]. However, the use of multidimensional auctions could be effective in matching buyers’ needs and sellers’ availability. A laboratory study, comparing standard and multidimensional auctions, shows multidimensional auctions achieve a higher overall utility than standard auctions [30].

In general, multidimensional auctions are more complicated to implement than standard auctions. The seller of the contract (i.e., the buyer) has to determine weights for each dimension [25] to allow an algorithm to find the “best” bid. If the process for finding the best bid is automated, the buyer and suppliers need a thorough understanding of their business to develop the appropriate decision rules and dimension weights. Accurate information is essential including capacity available at any point of time, acceptable delivery dates, and manufacturing and logistics costs. Sometimes, after the competitive bid on the many dimensions ends, managers make the decision manually with subjective criteria such as preferred suppliers. This conclusive step makes the process less objective, but facilitates its implementation.

Products that are easy to describe fit better with multidimensional auctions because the product being auctioned has to be clearly described to all suppliers. However, standard auctions require item homogeneity, while multidimensional auctions do not. For example, in a reverse standard auction, suppliers only bid on price whereas in a reverse multidimensional auction, suppliers bid on price and delivery date. The multidimensionality of this type of auction adjusts for product differences and, ultimately, reflects differences in the price.

As with standard auctions, the need for specific assets is low since only bidding software is needed to participate in the auction. Transaction risk is low because these auctions are one-time transactions with no closeness between buyer and seller. For the same reason, operational performance risk is high.

Multidimensional auctions need to be used with medium frequency because they are more difficult to implement than standard auctions. If there is a high frequency of transactions, other mechanisms offer better solutions. Lastly, high value items offer higher chances to skim benefits in the form of cost reduction or marginal sales.

### 3.1.3. Closed auctions

Closed auctions differ from standard auctions in that the bidders are prequalified and invited to participate. Closed auctions avoid some drawbacks of standard auctions by preparing the transaction that will end in a competitive bid. Many closed auctions take the form of reverse auctions, where a firm auctions a contract to many suppliers.

In a closed auction, the auctioneer (or agent) plays a more active role than only facilitating the final bid. The auctioneer prepares the transaction by helping the firm selling the contract (the buyer) to develop the product description and write the contract. The auctioneer also works with the bidders (suppliers) to identify those who are capable of supplying the item as requested. Lastly, the auctioneer leads the bidding process [31]. The increased interaction among the three parties enables the auctioning of products that are complex to describe such as a custom-built piece of manufacturing equipment.

Asset specificity is considered medium because assets required for a particular closed auction are higher than those for a standard auction. Usually, the buyer does not need assets specific to the bidders, but closed auctions require some investments by the buyer, suppliers and auctioneer before the bidding process starts in the form of money and management time.

First, the auctioneer works as a consultant during the preparation stage. This requires investments by the buyer and auctioneer. Second, the suppliers work with the auctioneer to prequalify. After the preparation stage, the marginal cost to continue with the auction process for the buyer
and the potential suppliers is low; they do not want to leave the relationship at this point. Last, the buyer and the suppliers might need to implement a proprietary information system to participate in the competitive bid.

The transaction risk is medium. Despite greater closeness between the buyer and the selected supplier, the preparation stage works as a risk attenuator by identifying unreliable suppliers. Thus, transaction risk is higher than with standard auctions.

A priori, operational performance risk can be regarded as high as in a standard auction. Nevertheless, setup efforts limit the kind of items suitable for this mechanism. Most probably, complex and high value items fit best with closed auctions. Thus, operational performance risk is regarded as medium since it is lower than in the case of standard auctions, but for critical products or services, it might be more appropriate to implement coordination flows.

Setup efforts restrict the use of closed auctions to infrequent transactions. Similarly, item value must be high to offer the buyer room for cost reductions. Auctioning a yearlong contract makes item value higher and frequency lower, allowing the auctioning process to produce sufficient savings for the auctioneer to get its fee while still generating cost reductions.

3.1.4. Purchasing groups

A group of buyers can agree on pooling their individual purchasing volumes and let the group management negotiate on their behalf. However, buyers need to accept the rules of the purchasing group. For example, the group management charges a fee. However, the increased purchasing power promises a better price to the group members and the fee can be contingent upon cost reductions. Additionally, the members have to standardize their purchasing needs and batch their requirements. Standardizing and batching requirements might cause disruptions to some organizations; however, many have already done this to leverage their purchasing volume internally.

In purchasing groups, complexity of product description needs to be medium to low. The product does not have to be a commodity, but its features and quality have to be easy to assess. No specific assets are needed for joining a purchasing group. Transaction risk is low because using a purchasing group is similar to a one-time transaction and no barrier restricts a firm’s management from purchasing independently from the group. The firm is not “locked in” the relationship with the suppliers, nor with the management of the group itself. Many purchasing groups for hospital supplies work this way.

Operational performance risk is as high as conducting a one-time transaction because the group management may decide, for instance, to change suppliers without notice. For office supplies, this might not present a problem, but changing suppliers for manufacturing materials needs careful consideration. In addition, the firm cannot place orders at any time, but has to follow the group’s procedures. These constraints add uncertainty to and make purchasing less flexible.

High frequency of purchase might indicate that a closer relationship with some suppliers is needed. Therefore, low to medium frequency is appropriate for using a purchasing group. Medium value items, such as computers, fit well with purchasing groups. Other mechanisms might be preferable for high value items. On the other hand, low value items might not provide room for the group management to charge its fee, unless volumes are high enough.

3.1.5. Electronic purchasing aids

Electronic purchasing aids are pieces of software that assist a buyer in finding the right product at the best price available. Empirical studies show that the use of electronic purchasing aids help buyers to “detect products that are overpriced or otherwise dominated by competing alternatives, thus, increasing market efficiency” [32].

Electronic catalogs, price search engines, recommendation agents and comparison matrices are examples of electronic purchasing aids. Electronic catalogs support product representation, search and classification by presenting information to the customer in a structured and customized manner [33]. A price search engine will find the lowest published price of those products that fit with the input description. Higher degree of standardization in the product description leads to higher accuracy in finding the lowest published price. Recommendation agents use self-reported information of the user to recommend the product that fits the buyer’s needs. Comparison matrices are used to compare the product features side-by-side on a single page.

Price search engines are extensively used in business-to-consumer e-commerce for products such as computer components, books, music and movies [34]. These items’ descriptions are standardized by a model number or by an identification code such as the ISBN for books. Their use in a business-to-business setting is restricted by the ease of product description. Low complexity of product description increases the efficiency of this decision aid.

No specific asset is needed to use decision aids since they are generally a service provided by a third party charging a transaction fee or interested in capturing on-line traffic. As in other one-time transactions, transaction risk is low and operational performance risk is high.

A purchasing representative will use a decision aid to evaluate products and price alternatives. This is time consuming in contrast to placing an order with a known supplier. Thus, frequency of purchase has to be low because the cost associated with searching for the lowest price might outweigh the price reduction. Still, a decision aid can be used to find the supplier offering the lowest price or the most appropriate product and this information can be used to negotiate a supply contract. Similarly, the value of the items should be at least medium, high enough to offer savings potential.
3.1.6. Electronic agents

Electronic agents applied to electronic commerce are semi-autonomous pieces of software that are constantly searching for business opportunities based on a set of rules; they link business goals and customer interests [35]. Agents can be used to automate time-consuming stages of the purchasing process reducing the transaction cost for buyers and sellers. “Buying agents automatically collect information on vendors and products that may fit the need of the company, evaluate the various offers, make a decision on which merchants and products to investigate, negotiate the terms of transactions with these merchants, and finally place orders and make automated payments” [36]. A sales agent used by a manufacturer searches for potential buyers, promotes sales, prioritizes orders received, analyzes manufacturing constraints and negotiates conditions [37].

Today, electronic agents are used primarily for perishables, commodities and surplus products. As technology matures and product standards are adopted, agents might transform some aspects of the way firms do business [36]. The implementation of electronic agents requires low complexity of product description. Products can be identified by an identification code (for example the UPC code) or by the product’s features. When technology develops, agents might handle ambiguous content, complex goals and changing environments [36].

Electronic agents are part of the IT infrastructure since they are used for doing business with all possible customers or suppliers. There are no relationship-specific assets. Further, automated transactions are one-time transactions, which makes the transaction risk low. For the same reason, operational performance risk is considered medium to high. In the case of a buying agent, operational performance risk is considered high since the agent might select a different supplier each time.

For agents to work appropriately, products should be unmistakably identified, purchasing needs should be clear in terms of delivery dates and other conditions, and purchasing decision rules should be in place. This demands considerable management effort to standardize products and the purchasing process. Thus, frequency needs to be high enough to make these efforts worthwhile.

Item value needs to be medium since low value items might not offer an appropriate return for the implementation efforts. In contrast, dealing with high value items might demand closer attention than an automated process can offer.

3.2. Coordination flows

Coordination flows are implemented for ongoing relationships, that is, business is not conducted on a transaction-by-transaction basis. Business relationships must be stable to justify the set-up efforts. Furthermore, using coordination flows effectively is more complex than using a market mechanism. The focus of using a market mechanism is on a transaction. Whereas, managers implement coordination flows to manage their businesses more effectively by focusing on the relationships with other supply chain members rather than on individual transactions.

Coordination flows are not new to the Internet-era. For example, electronic data interchange (EDI) has been used in business since the 1970s to share transactional data. However, the Internet offers lower implementation cost and fosters standardization of data formats because it makes data sharing economically feasible to more firms. Then, managers work to standardize data with other supply chain members or become compliant with the industry standard. Implementing coordination flows using the Internet is considerably less expensive than traditional EDI settings. For example, it has been estimated that Internet-based EDI can be up to 90% cheaper and 300 times faster than traditional EDI [38].

From the TCE point of view, complexity of product description and unit value of the item are less relevant to assess whether coordination flows are appropriate. When coordination flows are implemented, purchasing decisions have been made; information is shared to coordinate business activities. Standardization made investments in IT part of the firm’s infrastructure (i.e., hardware, software and supporting services) rather than being specific to a relationship. Whereas, a traditional EDI link has little value outside the relationship, a link to the Internet is used with many supply chain members at the same time. Implementing coordination flows requires medium asset specificity, which is lower than implementing an EDI link, but it is higher than implementing other market mechanisms.

Transaction risk due to closeness of the relationship is high given that coordination flows are generally implemented with key members of the supply chain. The objectives of the various members of the supply chain need to be aligned by developing partnerships [39], or product and service agreements [4]. Nevertheless, this is a challenge that technology will not solve by itself. Managers need to implement appropriate monitoring systems and supply chain metrics to manage the relationship [40].

Systematically sharing information reduces operational performance risk because it makes processes easier to monitor by substituting information for inventory [41] and excess resources [42]. Operational performance risk is low since management may implement coordination flows to actively manage the relationship and, ultimately, to reduce risk of operational failure. Implementing and capitalizing on coordination flows is demanding from an economic and a managerial point of view because management practices have to be adapted to work closely with the other side of the relationship. This might include adjusting the way tasks are performed internally to plan and manage jointly the business processes. Implementation efforts, in terms of technology and management practices, will only be cost-effective with high transactional volume. However, transactional volume does not need to be as high as using traditional EDI.
4. Effect of the internet on coordination

Many researchers agree that IT reduces the cost of coordination [15,16,43–45]. Lack of coordination will result in the supply chain holding inefficiencies in the form of inventory buffers, underutilized capacity, obsolescence of products or lost sales.

The degree to which two activities are coordinated is limited by the cost of coordinating the activities [16]. In other words, if the cost of coordination is higher than the cost of the inefficiencies, the firm is better off not coordinating. The trade-off between cost of coordination and cost of inefficiencies in the system determines the extent to which activities in the supply chain are coordinated.

Since we are concerned with the effects of the Internet on business practices, we need to identify how the present environment differs from the pre-Internet era. Much effort has been spent implementing EDI. EDI’s high cost made it viable only in those relationships in which the transaction volume was very high. This meant that sharing data through EDI was restricted to large firms and their largest customers and/or suppliers.

Fig. 2 illustrates the volume of transactions needed to make coordination economically feasible using traditional EDI and the Internet. The cost of inefficiencies is considered a step function. The steps represent increases in fixed cost components as a result of adding capacity. The solid line represents the cost of coordination using EDI. It shows high setup cost and low variable transaction cost since computer and communication systems are largely fixed cost elements. Fig. 2 suggests that, using traditional EDI, activities will be coordinated when the volume of transactions is greater than “P.” The dashed line shows the cost of coordination using the Internet, which also has relatively high setup costs and low marginal costs. Nevertheless, the setup costs are lower than those experienced with EDI. The lower coordination cost reduces the minimum volume of transactions needed to breakeven. This is shown in Fig. 2 as “Q,” which suggests that all else being equal, inefficiencies in the supply chain will decrease as coordination flows are implemented.

Another factor that fosters coordination is a “network effect.” The power of a network increases exponentially with the number of users [46]. EDI networks work like closed groups. Traditionally, the channel captain would set the technology standard and encourage suppliers to become EDI-compliant using a de facto data standard. A small fraction of this development could be used with other members of the supply chain. In contrast, IT infrastructure for sharing information through the Internet is used with many members. Developing the IT infrastructure might include becoming compliant with industry standards or implementing software packages.

In sum, the extent to which business activities were coordinated in the past was limited, in part, by IT. State-of-the-art IT releases many of these constraints, enabling managers to increase the level of coordination in the supply chain. Now, it seems that coordination is constrained by management’s willingness and capabilities to integrate business activities with key supply chain members.

5. Implementing coordination flows

Coordination flows can take many forms ranging from private information hubs to “Public Information Hubs” and “Electronic Marketplaces.” In a private information hub, the Internet is used as the data communication network to implement the coordination flows. This setting has been called an “information transfer model” and is considered a natural evolution of EDI networks [41]. Participation in a private information hub is generally restricted to the channel captain and its key customers and suppliers.

The objective of a public information hub or an electronic marketplace is to connect as many participants as possible. They are usually independent organizations that charge membership or service fees. Some are independent startups; others started with the support of the biggest
players in an industry. For example, Transora was funded by companies that are member of the Grocery Manufacturers of America [47] and the World Wide Retail Exchange was formed by 17 international retailers [48].

Sometimes the term “electronic marketplace” is used to describe the role of information hubs [49,50]. However, their role is not the same. Broadly, a marketplace is a governance mechanism [15]. In particular, an electronic marketplace is an information system that allows buyer and sellers to exchange information about prices and product offerings, and the firm operating the electronic marketplace is an intermediary [51]. In other words, the main objective of an electronic marketplace is to facilitate trade: buying and selling. For example, ChemConnect supports “...buying and selling chemicals and plastics” [52].

In contrast, an information hub is an information system that supply chain members use to share data. It provides a single data communication point enabling information sharing and facilitating coordination in the supply chain. Business transactions take place outside the hub. This model has been described as “information hub model” or “third-party model” in the academic literature [41]. Confusion between the role of public information hubs and marketplaces might stem from the fact that most information hubs have matchmaking mechanisms in their service offering. In this role, information hubs and electronic marketplaces overlap.

The much advertised benefits from joining a public information hub remain to be seen [53]. Managers are still looking for the role of public information hubs within a supply chain, while some public information hubs have changed their original focus to become electronic procurement systems (electronic marketplace) [54]. In addition, consolidation has taken place [55] and more is expected [53].

There are several managerial challenges that exist for those wanting to use public information hubs. First, information asymmetries can lead to exploitation [41]. That is, the firm that has data that are not available to other members can use the data to reap profits from other members of the supply chain. Empirical studies have found that IT can change the power structure in the channel by creating or eliminating information asymmetries [56,57]. Second, sharing information with a supplier that is also a competitor can jeopardize confidentiality. Even though it is stated frequently that supply chains will compete against each other, this may not be the case. Therefore, this statement is a simplification; relationships in the supply chain are more complex. Third, many managers are not ready to share information with other supply chain members [59]. Fourth, in many firms, management has not achieved internal integration of information systems and business processes. Internal integration is needed for achieving external integration.

A fifth issue is that competition among public information hubs prevents end-to-end information sharing from taking place. For example, there are at least three public information hubs operating in the packaged goods industry: GlobalNetXchange, Worldwide Retail Exchange and Transora. All three hubs intend to service the needs of retailers and manufacturers. In addition, Wal-Mart has decided to build its own information hub [60]. Similarly, six OEM car manufacturers are members of Covisint but many others are not; will these outstanding manufacturers join Covisint or will they pursue other options?

Last, competition for traffic leads to competition for setting data format standards. Public information hubs provide connectivity to their members, but how will interfaces with other information hubs be implemented? Once a public information hub has gained critical mass by attracting the key players in an industry, standards could be used as a competitive weapon. If two manufacturers who purchase from the same supplier use different information hubs, will the supplier be able to integrate data from both?

In Section 6, we will show how the coordination mechanisms fit in the information flow of the SCM framework.

6. SCM information flows

The seven coordination mechanisms analyzed are grouped into market mechanisms and coordination flows. Coordination flows support the integration of business activities through information sharing. Therefore, they will tend to expand to many tiers in the supply chain. Market mechanisms will be mostly used for purchasing; thus, they must be implemented at each buyer and seller linkage in the supply chain. Fig. 3 shows the span of public and private information hubs, and public marketplaces as they relate to the supply chain members and information flows identified in Fig. 1.

Initially, public information hubs will expand to a few tiers until their role in the supply chain is strengthened. Their aim is to extend to the whole supply chain, but at present, the majority of them reach two or three tiers at the most. For example, the initial vision for Transora was that it would enable end-to-end supply chain visibility. However, a review of its website reveals that Transora’s service offering is focused on the dyad and include purchasing tools such as electronic catalogs and auctions, collaborative planning forecasting and replenishment (CPFR), and matchmaking for transportation services. In general, managers are having difficulty finding genuine value propositions associated with the use of public information hubs. Many managers are now shifting their attention to private information hubs to implement coordination flows [61].

Private information hubs usually start small and grow slowly, but every improvement has sizable potential to benefit participants. Since the channel captain leads the development of the information hub, its best interest may be to include as many supply chain members as possible. Additionally, the private information hub is tailored to the strategy of a supply chain and its services might reach the
end customer through electronic commerce. For example, a running shoe manufacturer offers customers the option to monogram their shoes when bought on-line. The customers’ orders could be shared throughout the supply chain to make shoes to order, thereby fostering efficiency throughout the supply chain.

Public marketplaces implement market mechanisms such as auctions. The main objective of public marketplaces is matchmaking and facilitating the bidding process. In contrast to coordination flows, market mechanisms extend a dyad: the sellers and the buyers (Fig. 3). There is no need for information to flow beyond the trading parties. Generally, market mechanisms fit better near-commodity products or “vanilla services.” This is more likely to happen closer to the original supplier. As products move downstream in the supply chain, and service and innovation becomes a differentiator, stable relationships will be preferred over spot markets. However, public marketplaces used in transportation, for example, are available to firms positioned anywhere in the supply chain.

Market mechanisms also can be implemented downstream in the supply chain in business-to-consumer settings. Auctions, purchasing aids and electronic agents are being used successfully as marketing tools, but some purchasing groups, for example, have not proven successful.

7. Conclusion

Managers need to choose the Internet-enabled coordination mechanism that best fits each business situation in the supply chain. A framework has been presented to assist managers in this decision. Seven coordination mechanisms available through the Internet were described and the framework was used to evaluate them. These mechanisms can be used to increase coordination on close business relationships or to increase competition for one-time transactions. The issue of whether the Internet fosters coordination or competition has captured considerable attention from scholars. For example, some authors believe that competitive bidding makes the relationship with other supply chain members grow stronger [62]. Others assert that the present environment in which information is ubiquitous is too complex for a single firm to succeed and that activities should be integrated with other supply chain members [18]. Being able to share accurate data from a wide range of operating areas is considered a key success factor in SCM [1]. While managers will seek to increase competition among suppliers in some situations, not all relationships will be replaced by one-time transactions. Managers still need to achieve integration of business processes by fostering coordination to make the supply chain responsive to market changes [63].

It is unlikely that the Internet will change the reasons why firms maintain close relationships with other supply chain members. The need for integrating business activities in the supply chain does not lie in the state of the art of IT. However, IT can constrain management practices. What managers can do is limited by the support tools they have available. The Internet, together with other IT advancements, reduces communication costs and fosters standardization of infrastructure and data formats. This progress releases some constraints on how management can coordinate activities in the supply chain. The challenge managers...
have is to capitalize on the state of the art of IT to improve performance of their businesses. Choosing the coordination mechanism that best fits each type of relationship in the supply chain is part of this challenge.

Using a coordination mechanism that does not fit well with a relationship will lead to confusion and disappointment. In an interview, an executive of a manufacturer of private label consumer packaged goods mentioned that one of his customers highlighted how important the partnership with the manufacturer was to them. The following week, the manufacturer was notified that the retailer would hold a reverse auction on the Internet and have suppliers bid for the business. The manufacturer was very disappointed with the relationship. The manufacturer thought they had a long-term relationship with this customer. However, it seemed that the customer is focused on getting short-term benefits by reducing acquisition costs working in a transaction-by-transaction basis.

The Internet has the potential to facilitate—or enable—the integration of business processes across the supply chain. For instance, a retailer can use the Internet to integrate its activities with the manufacturer’s business processes. This integration will affect the role of the retailer. For example, traditionally, a golf club retailer offers product selection and availability to the end-customer. However, by integrating the information systems of the retailer and manufacturer, the retailer can work as an extension of the manufacturer and become a “golf club consultant.” When a customer walks into a golf store, the retailer—consultant measures the customer’s height, length of arms, strength and so on; and the consumer tries different clubs to determine the best fit. The retailer uses the Internet to input the order in the information system of the manufacturer. At the manufacturer’s plant, the golf clubs are customized and shipped directly to the consumer. The Internet enables this kind of integration, functioning as a low-cost communication network.

The Internet is an enabler in both these scenarios, having the suppliers compete on price in a reverse auction as in the example of the packaged consumer goods manufacturer, and integrating activities in the supply chain as in the example of the golf club retailer. However, the resulting relationships are very different. When a reverse auction is used, the supplier can be different every time an auction is held. The resulting relationship is focused on the one-time transaction. On the other hand, the golf club retailer works as an extension of the golf club manufacturer, the relationship is close and long-term focused. Managers need to choose the form of coordination that is most appropriate for their business needs.

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