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An Analysis of Electronic Auctions as a Mechanism for Supply Chain Management

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Abstract

The proliferation of electronic commerce venues on the Web has dramatically expanded the reach of businesses. It is now much easier for a firm to deal directly not only with its customers, but with its entire supply chain. During the past several years, business-to-business transactions have become simpler, faster, and more accurate since the advent of electronic data interchange (EDI) and the explosive growth of information technology. The Internet is introducing yet another way for businesses to electronically conduct transactions in ways that are even more far-reaching. Although this has led to some disintermediation at the brick-and-mortar level, new cybermediaries are being created to facilitate and validate the new business relationships. Internet auctions are being touted as one solution for at least some aspects of supply chain management. Attention so far has been primarily focused on the application of the technology. Although the technology facilitates the transactions and interactions of participants by increasing connectivity, other issues are also important in applying electronic auctions to supply chain management. The purpose of this paper is to identify and explore interdisciplinary issues potentially affecting the outcome of electronic business-to-business auctions in order to increase the awareness of Information Systems managers and auction participants so that effective implementation strategies can be developed.

Introduction

Electronic commerce has given businesses a new medium for conducting business. Fast and powerful computing capabilities in conjunction with the widespread availability of the Internet allow even very small businesses to compete on a level not before possible. Consumer acceptance of this new medium for researching and conducting transactions has been strong. The ability of firms to interact directly with consumers has had the effect of changing the shape of the traditional supply chain. Some intermediaries are no longer needed. Others are creating new roles for themselves to remain viable. New cybermediaries are being created. Electronic commerce is in essence a new frontier, and businesses must carefully coordinate all of their activities to consider the information-based value chain both operationally and strategically (Shaw, 1999).

However, the link from the producer to consumer is only one part of the supply chain. Traditional supply chain management involves all aspects of product creation and distribution, from procurement to the logistics of transportation and storage, to dissemination of the final product to intermediaries and consumers (Davis, 1993). Among the issues to be considered are the costs incurred at each step, internal and external quality requirements, inventory and warehousing management, product pricing, and distribution. Since buyers have unprecedented power in the new market channel, pricing and service become much more important (Andrews, 1999). Information is widely available to everyone, and the pool of available suppliers greatly increased.

The potential for business-to-business transactions via the Internet is huge. Previous barriers to trade are being removed or minimized. Global suppliers can now compete on the same level as local suppliers. Prices change hourly, as demand changes, instead of remaining relatively fixed (Bell and Staples, 1996). Procurement practices that were once time consuming and limited can now be greatly expedited. In essence, all aspects of supply chain management are affected by electronic commerce.

One venue that has been relatively unexplored until recently in the literature on business-to-business transactions is that of electronic auctions for supply chain management. Auctions have typically been used at the consumer end of the supply chain for liquidation of excess inventories. For procurement, although not traditionally called auctions, bids are frequently requested for capital purchases. In addition, governments use a sealed bid process for acquiring bids from potential contractors. Other services, such as transportation and supply acquisition, usually involve negotiation and contracts, or perhaps outright spot purchase.

Internet exchanges have been created by companies in recent years to facilitate these business-to-business transactions, many including auctions. However, recent trends suggest that activity is lagging behind expectations on these markets. This paper will look at other factors that influence a successful outcome and that may be affecting participation. The concepts of supply chain management and dynamic pricing will be explored, followed by a review of the literature on the structure and strategies involved in traditional auctions. The application

and implications of an auction strategy for supply chain management will then be discussed.

Supply Chain Management

Supply chain management is a relatively recent concept that has evolved in part from supplier partnerships established during the 1980's. Although the relationships were initially established to lower the cost of acquisition and to improve product quality, today's relationships are focused on flexibility, speed, and innovation (Magretta, 1998). Electronic data interchange (EDI) facilitated the exchange of information, while corporate intranets and extranets further expanded the possibilities for supplier relationships. A supply chain is much broader than supplier relationships. It is an entire network that includes supply, the transformation of supplies into product, and demand (Davis, 1993).

Supply chain management therefore entails the effective management of suppliers, the production facilities, and the distribution mechanisms. This includes both internal and external suppliers, processes, and customers. Companies can have multiple supply chains. The logistics involved, transportation and warehousing, are also part of the process (Kwan, 1999). The ultimate goal should be to enhance customer service and satisfaction by improving reliability and quality. By optimizing each step, time and cost can be reduced from the product delivery cycle (Magretta, 1998). Some of the goals of supply chain management are:

- ▶ reduce delays
- ▶ reduce inventories
- ▶ reduce cycle times
- ▶ reduce and control operating costs
- ▶ improve quality
- ▶ improve response to customer demand
- ▶ increase profit.

Effective business-to-business relationships consist of a shared dependence on each other to achieve mutually beneficial outcomes, target costing to encourage more efficient design and production, and personal ties and trust (Landry, 1998). Adherence to these principles will facilitate cooperation and information sharing (Landry, 1998). New information technologies enable the timely sharing of information, allowing companies to respond much more quickly to market changes than in the past (Kwan, 1999).

Davis (1993) cites uncertainty as a major problem in supply chain management. Uncertainty stems from each facet of the supply chain: suppliers, manufacturing, and customers (Davis, 1993). The supplier's ability to deliver on schedule due to unforeseen difficulties, unexpected

problems arising during the manufacturing process, and anticipated customer demand all contribute to the inability to precisely manage the supply chain.

Dynamic Pricing

Another concept that becomes more important with the new information technologies is that of dynamic pricing. Firms use price differentiation in various ways to maximize customer satisfaction (Friedman and Lewis, 1999). Although it is usually associated with perishables, equities, automobiles, and services (Bell and Staples, 1996), every product can be a candidate for dynamic pricing (Andrews, 1999). Automobile sales are the classic dynamic pricing example where each customer pays a different price determined by demand, availability, and their own negotiation skills. Dynamic pricing is a key characteristic of auctions and traditional procurement mechanisms involving negotiation or a bid process.

Auction Theory

Auctions have existed as a format for selling goods for hundreds of years. Internet auctions first came on the scene around 1995, with the advent of eBay and OnSale. Since that time, there has been an explosion in the number of online auctions.

The auction format allows for efficient price discrimination, thus ensuring that scarce resources are distributed to those who value them the most. Since an auction is basically a negotiation effort, it allows the buyers and sellers to determine market price, thus making the channel more efficient. Studies have been done to compare the various auction formats to traditional revenue-based selling mechanisms on the basis of robustness, efficiency, transaction costs, and immunity to cheating (Milgrom, 1989).

Bidding Strategies and Price Optimization

Auction strategy is based on economic theory, and more recently game theory (McAfee & McMillan, 1996). Bidding behavior and potential price expectations can be predicted based on the rules of the auction, the players involved, and other variables. In one-sided auctions, the game moves are sequential, instead of simultaneous as they are in continuous double auctions. It has been found that open bidding, as compared to sealed bids, encourages higher bids (McAfee & McMillan, 1996). Reserve prices are also an effective mechanism for generating higher expected profits (Milgram & Weber, 1982; McAfee & McMillan, 1987). The seller will select a specific auction type based on the expected behavior of the bidders. In

contrast, each bidder must assign a personal value to the item being bid, then attempt to guess how other bidders will value the item.

People will tend to bid their valuations, and focus on maximizing profits. Milgrom (1989) says that returns in bidding come from cost and information advantages. This implies that bidders must understand the importance of their strategy in relation to their anticipated costs and use of the item.

The bidder’s goal is to acquire the item at the lowest possible price, usually below their valuation. In many cases, the items being auctioned do not have a fixed market value, or the exact value is unknown. In all cases, the bidder strives to avoid the winner’s curse: paying too much for an item. This usually means that the winner made a larger error in valuation, and profits are decreased. In competitive bidding, the reverse is also true. For contractors bidding on a project, the winning bidder is the one with the lowest estimate of project costs, and the winner’s costs will tend to be too low (Milgrom, 1989). Milgrom advises that to make a profit, the bidder should increase the bid to account for underestimation of costs, and to include a profit margin.

The seller and the bidder are striving for equilibrium - ideally the best outcome for both. The intersection of the best response functions will result in Nash Equilibrium.

For the seller, it is always beneficial to disclose as much information as possible about the item. This will help to decrease uncertainty, and distribute the knowledge about the item evenly, thus eliminating any asymmetries.

Game Theory views competition as a process of strategic decision making that is performed under uncertainty, and helps sellers price items when the buyers’ willingness to pay is unknown (McAfee & McMillan, 1996). According to McAfee and McMillan (1996), competition leads to higher prices, while economizing on knowledge, computation, and commitment. This provides the framework that will allow us to determine an optimal equilibrium strategy for the game (auction).

Internet Auctions - Similarities and Differences

While there are some differences between Internet auctions and traditional auctions, there are also many similarities. In both cases, the consumer (buyer) benefits from having complete control over the price paid, and from the spirit of competition. The seller also benefits because excess inventory is moved, although it may be at a loss. However, because of the nature of the medium, new challenges arise. There is a need to generate trust and

value when dealing with unfamiliar buyers and sellers. No one is quite sure what combination of strategies will emerge as dominant in the long run.

Classification of Internet Auction Formats

Electronic auctions follow all of the formats of the traditional auctions, plus some hybrids of their own. Due to the lack of standardization in terminology in Internet auctions, as well as traditional auctions, it can be difficult to identify specific auction formats by name alone. Buyers need to carefully research the auction rules at each site. Terminologies differ not only from those used in traditional auctions, but also among each other.

In addition, most auction sites also factor in other conditions to determine winning bids, such as quantity of items desired and the time of the initial bid or last bid. Not only do these differences affect the total revenue generated, but they also necessitate that bidders employ different strategies, depending on the auction rules.

A common terminology is needed to reduce confusion for both buyers and sellers. This will enable some consistency, while still allowing for individual differences. Some terms are continued from the traditional auction format, while others are introduced.

Sealed-bid auction types are not included in this classification scheme. Even though the technology easily supports the hiding of competitors’ bids, as used in the traditional sealed bid auctions, the research (Milgrom & Weber, 1982; McAfee & McMillan, 1987) indicates that bids tend to be higher when additional information, including competitors’ bid prices, is known.

Table 1. Classification of Internet Auctions

AuctionFormat	Auction Type	Characteristics
Ascending Price	English	<ul style="list-style-type: none"> single item high bid wins
	Yankee	<ul style="list-style-type: none"> multiple items each winner pays own bid price
	Vickrey	<ul style="list-style-type: none"> multiple items each winner pays second highest price or some variation
Descending Price	Dutch	<ul style="list-style-type: none"> one or multiple items each winner pays own bid price
	Reverse	<ul style="list-style-type: none"> Sellers bidding against each other.

The first-hand experience of the Commonwealth of Pennsylvania and others with FreeMarkets suggests that the same theory should hold true with reverse auctions used for procurement (www.freemarkets.com). Bids will tend to be lower when competitor bids are known, thus saving the buyer an estimated 15-20%.

Business-to-Business Electronic Auctions

To date, most Internet auctions have been business-to-consumer (B2C) or consumer-to-consumer (C2C). Although this certainly changes the structure of the supply chain, it is only the tip of the iceberg. Auctions are a multi-billion dollar industry. They are also very efficient as a mechanism for allocating resources and extracting the optimal market price. The sheer volume of the B2B market is lucrative.

For the business-to-business sector, electronic auctions have several potential benefits. In addition to leveraging the power of the Internet by bringing buyers and sellers together in one marketplace, an electronic auction format facilitates the efficient distribution of scarce resources. However even there, the accessibility and availability of the Internet is changing the concept of scarcity in some areas (Andrews, 1999).

Benefits for Sellers

The use of online auctions to introduce new items has a two-fold benefit to the producer. First, it provides a fairly accurate gauge of public interest in the product, and second, it establishes the market price (Andrews, 1999). An auction format helps sellers to set prices for new goods and services whose value may otherwise be difficult to determine. Some items could benefit from being initially introduced at auction. This would allow the manufacturer to maximize profit while the item is at its prime and commanding a premium price, and to more easily recognize when interest is waning. Dynamic pricing during the natural product life cycle will enable producers to better manage inventory and warehousing. An Internet auction has the additional benefit of opening the sale to a global market.

Electronic auctions enable sellers to develop new markets for low-margin items in areas that may otherwise be constrained by location or some other factor. Because of the unique attributes of the Internet, sellers can reach markets that would be too expensive otherwise. Products with a short shelf-life can be more efficiently distributed. This would have the effect of reducing the need to discard leftover products with zero profit. Likewise, the seller is able to maximize the value of obsolete items or scrap

materials, or manage excess capacity by offering these items at auction.

Auctions have already been determined to be an efficient mechanism for uncovering the precise value of scarce, in-demand items. They provide sellers with a way to test price-volume relationships. Internet technology makes it relatively simple to monitor buyer behavior without incurring the costs of extensive marketing studies.

By registering as a supplier for online auctions, a seller is able to break down existing barriers to market entry, thus extending the business' reach. They can also easily compare bids from multiple buyers, enabling them to further analyze their pricing strategies.

Benefits to Buyers

Buyers also enjoy several benefits to using Internet auctions. The global nature of the Internet enhances the ability of buyers to identify new sources of supply. There is no longer a need to be restricted to a particular geographic region. They can easily search for new suppliers and establish long term global relationships. Auctions can be either open to all suppliers who wish to participate, or they can be limited to qualified parties.

The Internet is a great disseminator of information. For the buyer, this means that product information can easily be located and comparisons done. Often product information from current users of a product or service is also available. Buyers can list their procurement specifications exactly, based on their research and the experience of others. By soliciting bids in an auction format, the buyer is assured of competitive terms and reduced purchased costs that might not otherwise be possible.

Business Models

There are many ways that Internet auctions can be classified:

- ▶ *who* is initiating the auction
- ▶ *what* type of product is being sold
- ▶ *how* (format) auction is conducted
- ▶ *where* auction is held
- ▶ *when* auction is held

Four clear business models are emerging for business-to-business auction transactions: procurement (buyer) auctions, supply (seller) auctions, proprietary auctions added to a company's e-commerce site, and auctions hosted by a cybermediary. In some cases, buyer auctions and seller auctions co-exist within one auction site. Within these models, a variety of formats can be effective. Virtually

every type of product or service can be a candidate for dynamic pricing. In all cases, precise description of items is required in order to increase bidding and maximize profits. It is important to note that other criteria are also important to buyers.

Procurement Auctions

Procurement auctions are initiated when a firm has a need to acquire a product or service. These are typically reverse auctions. There are several considerations that must be addressed by the buyer:

- Criteria that will be used to evaluate and certify suppliers
- Demand uncertainty
- Frequency of order
- Quantity to be ordered
- Warehouse requirements and constraints
- Transportation
- Time constraints
- Customer satisfaction

As in the old business model, a Request for Proposal (RFP) is issued. However, by posting it on an auction site, the buyer can attract a larger audience of suppliers than they could get otherwise. The inefficiencies inherent in the sealed-bid process are eliminated.

FreeMarkets (www.freemarkets.com), located in Pittsburgh, Pennsylvania, was established in 1995 to facilitate procurement. They offer a wide range of services to facilitate the procurement process, including an expertise in developing RFP's and conducting in-depth research for clients. They serve diverse markets such as industrial parts, commodities, raw materials, and services. Customers include DaimlerChrysler, Giant Eagle, Caterpillar, First Energy of Ohio, and the Commonwealth of Pennsylvania.

Supply Auctions

Supply auctions are used by firms wanting to liquidate inventories, manage excess capacity, accelerate time to market, enter new markets, and aid in production planning. Some of the benefits sellers can hope to realize include convenience, speed, extended market reach, volume orders, and obtain new accounts.

Firms such as FreeMarkets qualify suppliers, provide training, and provide communications services in 30 languages to assist global interactions (www.freemarkets.com). Other firms conducting supply auctions include JC Penney, Dell, Microsoft bCentral, and transportation carriers selling excess cargo space.

Table 2. Advantages of Electronic Auctions for Supply Chain Management

Procurement (Buyer)	Supply (Seller)
<ul style="list-style-type: none"> • Identify new sources of supply • Manage changes in demand through spot purchases • Easily search and compare products from multiple suppliers • Competitive terms • Reduce purchase costs • Establish global relationships with suppliers • Manage inventory 	<ul style="list-style-type: none"> • Compare bids from multiple buyers • Manage excess capacity • Maximize value of obsolete items or scrap materials • Access new markets • Accelerate time to market • Reduce the cost of retaining existing customers and obtaining new customers • Break down barriers to market entry and extend reach <ul style="list-style-type: none"> ▶ aid in production planning ▶ minimize losses

Proprietary Auctions

In some cases, manufacturers and distributors are establishing their own auctions as an extension to their existing e-commerce site. This can be accomplished in one of three ways: adding the auction to an existing Internet site, using an extranet to limit participants, or by using an intranet for internal suppliers and customers. The automobile manufacturers have been quick to recognize the value of online supply chain management. Each of the U.S. automakers has independently established on-line supply chain mechanisms that incorporate thousands of suppliers into one network that includes auctions. The forthcoming joint venture between Ford Motor Company, General Motors Corporation, and DaimlerChrysler to establish an integrated supplier exchange illustrates the added benefits that can be obtained.

Cybermediary Auctions

Auction sites hosted by cybermediaries can potentially attract a larger audience of suppliers than might otherwise be found on a single company's site. For the supplier, this reduces the need to register on multiple sites.

In order to be successful, a cybermediary must address issues other than price and hosting of the web site. In addition to allowing for expanded market reach, cybermediaries can provide a multitude of services to assist the buyer, and reduce procurement costs.

These might include assisting with RFP development, or arranging for transportation and delivery. The cybermediary can also assist with many global issues that might otherwise be an impediment, such as tariffs, customs requirements, and compliance with export/import regulations. A value-added service that cybermediaries can provide is supplier certification to ensure suppliers actually have the ability to deliver. This could reduce some of the

uncertainty involved in dealing with unknown suppliers cited by Klein and O'Keefe (1999).

Conclusion

Many new partnerships are being formed to create new business-to-business marketplaces. The goal is an integrated e-commerce platform that will integrate a network of buyers and sellers. A key to success is integration and shared information. Participants only need to integrate once to the common standards established by the exchange, instead of with each entity with which they do business.

That participation in these markets is below expectations indicates that other issues are involved. Managing supply chains with electronic auctions represents a new venue, and it can be difficult for organizations to change. Large organizations and bureaucracies require longer time frames to implement new procedures. Also, the new mechanisms are largely untested and unproven. Changes of this magnitude are disruptive to existing processes, and require a great deal of planning.

Academia can help by documenting the problems and proposing techniques for change management. We can also look for critical success/failure factors in exchanges that do/don't work as expected, i.e., the effect of strong management support.

Additional study is needed in several areas. Research to determine the effectiveness of using Internet auctions for supply chain management, and the benefits/effectiveness of the various auction mechanisms, i.e., proprietary vs. cybermediary, will enable businesses to plan their strategies. Also, research is needed to assess who benefits from dynamic pricing in supply chain management, and whether traditional bidding strategies still apply. A strategy of using agent technology or other artificial intelligence as a supply chain management strategy should also be explored.

No industry is immune. The Internet simply represents a new mechanism for managing the supply chain.

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