E-Commerce for Healthcare Supply Procurement

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1. Introduction

In the recent years, healthcare analysts and advocates of the Internet have raised our expectations for gaining significant cost savings from applying e-commerce to healthcare supply procurement. First, the Efficient Healthcare Consumer Report estimates that “the healthcare products industry could significantly improve its ability to deliver quality healthcare products and services to consumers and save as much as $23 billion in supply chain costs.” Next, more than 60 ventures have capitalized on this opportunity offering various e-commerce approaches trying to save these costs. Third, Millenium Research Group indicates in its report that “The average US hospital currently transacts 2.6% of total procurement online.”

However, not one of the GPOs, distributors, and medical equipment providers that have started using e-commerce, has reported sustained contribution to their bottom line in the form of cost savings or higher revenues. Neither have any of the ventures reported profitability. Nevertheless, according to Millennium Research Group “In as little as one year, procurement managers predict this percentage will increase to 26.4%, indicating a ten-fold increase in online procurement. By 2003, procurement managers expect that 64% of their total procurement will be done through e-commerce, indicating an aggressive desire to migrate online.”

This article offers a taxonomy for e-marketplace classification, analyzes the discrepancy between the expectations and the real delivery abilities of different e-commerce models, exposes objective reasons for failing approaches and offers a generalized model for developing a successful e-commerce platform in today’s rapidly changing business environment. The key thesis of this article is that a successful B2B e-commerce must address system complexity first before accumulating market liquidity.

The 61 competitors in the healthcare supply chain e-commerce arena include e-GPOs, consortiums, and independent players. Roughly 30 percent of the hospital supply chain e-market is channeled through one of the leading e-GPOs namely Neoforma (partners with Novation,) Medibuy (partners with Premier), Broadlane and Promedix (partners with Tenet and Amerinet), and EmpactHealth.com (partners with Columbia/HCAHealthcare.) The two consortiums bring together Baxter, Johnson & Johnson, Abbott Laboratories, Medtronic, and GE Medical Systems; or McKesson, Cardinal, AmeriSource Health, Owens & Minor, and Fisher Scientific. The competition for the remaining share of the market is fierce, and the anticipated growth of the B2B trade of drug supplies and equipment wholesale to $124 billion by 2004 markedly raises the bar for entering this market, and accelerates the race for the e-healthcare ‘killer-app’.

Luring procurement executives and decision makers to use the Internet for their supply chain needs proves to be an intricate process that involves what marketing executives refer to as ‘breaking habits’: getting customers to unlearn existing procurement practices and adopt a new way of doing business. This is especially difficult because much of the EHR estimated $23 billion in savings would come not from the trade process but from workforce reduction and payroll savings. Thus, opting to use a supply chain e-commerce solution requires procurement executives to radically restructure their operations in the long run. Next, the novelty of e-commerce still deters the healthcare supply chain industry, and while most procurement managers are optimistic about future benefits, they are hesitant to take the plunge into e-commerce and are currently using healthcare sites mainly for research.

Furthermore, breaking habits is not a panacea. The restructuring of the healthcare supply chain further necessitates the reevaluation of legacy systems that are now becoming obsolete. Phasing out these trusted yet dated and insufficient legacy systems presents the industry with tough technical and financial barriers that entail connectivity challenges, data transferring procedures, and considerable start up costs. Moreover, hospitals and GPOs have to consider state regulatory policies which have yet to incorporate online procurement into hospital purchasing schemes.

Despite the difficulties inherent in the transition of the healthcare supply chain into e-commerce, it is predicted that by 2004 the majority of hospitals, GPOs, manufacturers and distributors of medical equipment will make the leap and fully integrate their ordering and purchasing systems. Such a shift is
expected to mend current inefficiencies that stem from the arcane ordering procedures, multi-vendor negotiations, complex discount pricing contracts, market fragmentation, and expensive sales cycles. In summary, the success of an industry-wide implementation of e-commerce is hinged upon its ability to present a viable solution for current inefficiencies while making the transition as painless as possible.

2. A Qualitative Analysis of Exchange Systems

An offline exchange in a traditional (fragmented) marketplace depends on the personal contacts made through a network of service centers and distributors. Such an exchange lacks a system to directly coordinate available inventory with buyers’ needs. In addition to being inconvenient, a traditional market is inefficient because of large networks of middlemen, and a lack of updated information among its members. In general these inefficiencies work to the disadvantage, of both the buyer and seller.

The goal of off-line auctions and other open-exchange marketplaces is to solve these problems while reducing the time and expense associated with selling complex goods. However, these exchanges ignore the time and expense of the buyer; buyers in an off-line auction need to be present at the auction and must participate in a sequential bidding process one item and one bid at a time. Worse, when trading complex items that require the negotiation and agreement between multiple participants, the buyers must complete each stage sequentially, usually starting with the seller and then proceeding to other associated service providers, such as financing, shipping, or warranty maintenance.

Within the last three years, the Internet has revolutionized the traditional auction from a travel-intensive, infrequent, slow-moving and expensive occurrence to a dynamic, exciting event, attracting millions of participants worldwide and creating a new multi-billion dollar market. In this new high-productivity culture, hundreds of eBay replicas allow users to conveniently bid in hundreds of simultaneous auctions around the world. These exchanges can be divided into three categories: seller-driven, buyer-driven, and symmetric.

On-line Seller-Driven Exchanges

The traditional seller-driven system permits sellers to post detailed specification of an item for sale and permits buyers to browse or search the posted inventory to locate items filling specific needs. The seller-driven system binds the seller to his offer and allows the buyer to choose the best price. A buyer may bid on part or all of an item posted and the seller may accept or reject any bid. Most systems today, including auctions, are seller-driven.

Figure 1 offers a three-dimensional illustration of the differences in technological platforms. Its five cubes are formed with three criteria in mind: Vendors, Buyers or Orders, and Interaction between Buyers and vendors. Each of the criteria is divided into two values, namely, single, and multiple. Specifically, vendors may act separately or cooperate on a single deal involving multiple aspects, such as shipping or financing. Similarly, buyers may act separately or cooperate to aggregate orders and negotiate discounts from vendors in exchange for higher purchase volume guarantees. Finally, the buyers and the vendors may negotiate one aspect of the deal, namely, price, or they may negotiate arbitrary aspects, such as quality, proximity, maintenance, etc.
While hundreds of e-marketplaces compete in the consumer space, driven by single-order-single-vendor interaction along a single criterion, namely, price, none of the e-marketplaces address the hardcore B2B procurement that requires simultaneous order aggregation and negotiations with multiple vendors along arbitrary criteria.

Cube A represents the single vendor single order milieu. Most of the consumer-to-consumer marketplaces operate in this realm. The system is asymmetric as it remembers the vendor’s items but not the buyer’s needs. Thus, the buyer must actively search the marketplace for items of interest every time he returns to the site. The seller-driven systems in Cube A have multiple shortcomings, including lack of buyer or seller cooperation and single-criteria bidding mechanism.

Traditional auction systems focus on the transaction itself and overlook related deals. Such related deals may happen by creating cooperation opportunities among the sellers and among the buyers. The opportunities for vendor cooperation arise in complex deals where various auxiliary services, such as leasing, inspection, shipping, and installation may be required before the buyer can use the item. Similarly, the opportunities for buyer-driven cooperation arise when the purchase price is too high for individual buyer and the buyers decide to band together and submit a joint bid.

In some on-line markets the individual bidders enter bids from remote terminals and the current highest bid and eventual winning bid are displayed in real-time on the remote terminals. To win an auction, each bidder must personally have sufficient funds to cover a winning bid. Thus, although such a system solves the problem restricting auction participation, it still limits participation to those individuals who can personally afford the entire purchase price of the item for sale.

Complex markets, such as healthcare markets, pre-negotiate discounts on retail items, and then apply those discounts on groups of items. Traditional online auction systems cannot accommodate such special arrangements since all negotiations are based on the item for sale. Since pre-negotiated contracts are associated with the buyer and not just the item for sale, traditional systems have no facility for applying discounts individually. In addition, traditional auction cannot offer a discount to the highest bidder since that may reduce the winning bid. Because of the single-dimensionality of traditional online auctions, multi-level discounts cannot be accommodated.

The bidding phase of traditional auctions allows each potential buyer to offer a higher bid than the previous bidder. As a result, the only indicator of the offer is the offering price. This one-dimensional view of auctions is often inadequate for real-world markets where the appeal of offer may depend on other factors.
Most current systems also treat each listing as a fixed item, providing the customer with the option to bid on the item or pass up the deal. This limitation precludes online configuration of complex equipment with multiple options.

**On-line Buyer-Driven Exchanges**

When searching for vendor or for the item becomes prohibitively expensive, the buyers create a buyer-driven marketplace, illustrated in Cube B. It provides the buyer with the ability to negotiate single order with multiple vendors. Cube B represents a typical Request-For-Proposal (RFP) model.

The RFP model is also asymmetric as it remembers only the buyers needs but does not memorize the vendors supply. Thus the vendor must search the site every time he enters it.

**Aggregate Orders for Buyer-Driven Exchanges**

Sometimes the buyers cooperate to negotiate discounts in exchange for larger order volumes. Cube C represents the aggregated orders single vendor technology. This platform allows for volume discounts based on multiple buyers and a single supplier.

Medical equipment exchange is an example of a complex market where a deal requires the agreement of several participants (e.g., buyer, seller, inspector, financier, and shipper) along multiple deal attributes (e.g., price, quality, location, weight, model year, timing, and availability of local support). Single dimensional price-only oriented auctions are ill suited for complex market making and variations such as bartering, exploding offers, and early auction closing. Because of such limitation, their Internet extensions have so far received little attention from the healthcare community.

Both exchange models (cubes A, B, and C in figure 1) improve upon the traditional (off-line) market, however, neither can facilitate complex deals because they do not provide basic B2B exchange functionality, which includes order aggregation, multi-party deal, and multi-criteria negotiation. Further, current on-line exchanges impede the purchase process of complex products and services by placing the search burden on the buyer (or seller), ignoring multiple aspects of the deal beyond the price, and excluding ancillary service providers.

**A Successful (Liquid) Marketplace for Complex Exchanges**

An ideal e-marketplace must:

1. Recognize returning users
2. Support complicated negotiations
3. Support complex product configuration
4. Match requests for products and services automatically
5. Compute and apply pre-negotiated, multi-level discounts
6. Support arrangements for ancillary services (e.g., inspection, delivery, maintenance, credit terms)
7. Execute these services in a timely manner

**On-line Symmetric Exchanges**

The requirements for such a marketplace call for a symmetric exchange, represented in Cube D. Unlike conventional catalogues, auction, or reverse auction systems, both buy and sell requests are dynamically indexed and automatically matched. Automated matching eliminates time-consuming manual searches and
efficiently supports both order aggregation and multi-participant trade. Cube E represents a general\textit{ized symmetric exchange}, where users can negotiate over arbitrary criteria (not just price).

The generalized symmetric exchange model is robust. All actions (buy, sell, ancillary service) are handled uniformly as requests. The system is thus robust enough to provide, match, and support negotiation for a full gamut of services including financing (payment processing, receivables management, and credit analysis), logistics (shipping, warehousing, and inspection), risk mitigation (escrow and warranties) and synergies with other functional e-markets, dramatically simplifying system interaction. In addition, uniformity allows the model to be easily extended to handle custom configuration of orders with complex options, pre-negotiated multi-level discounts, and dynamic multi-tier discounts. These requests are dynamically indexed without specially pre-selected keywords. Finally, automated matching brings all participants together enabling multi-dimensionality and convenient aggregation of all relevant information for each deal. Generalized symmetric exchange has the added benefit of convenient closing; participants can accept deals at any time, instead of waiting for an arbitrary closing date. Generalized symmetric exchange solves fundamental B2B market complexities by creating proprietary technologies that include a comprehensive order-matching engine capable of aggregating buy orders, requesting quotes from multiple vendors simultaneously, and negotiating along multiple criteria. Most automated auctions are in fact restricted instances of this more general model.

By implementing one-on-one negotiations instead of traditional, single-dimension auctions, the symmetric exchange model allows pre-negotiated, multi-level discounts. A discount schedule can be described and associated with a group of requests. Subsequent matches are checked against the discount schedule to determine the total discount applied to a particular item. The sale is added to running total, increasing the discount rate.

In addition to multi-level discounts, the system facilitates multi-tier discount schemes, in which the total sales volume for a product increases a real-time discount rate. For example, a piece of equipment may have 3 discount tiers that specify a 1% discount for sales volume between $1MM and $5MM, a 2% discount for sales volume between $5MM and $10MM, and a 3% discount for sales volume between $10MM and $30MM. Traditional e-commerce systems suffer the same limitations that prevent multi-level discount computations, namely, single-dimensional auction determinant and item-centric pricing mechanism.

Applying generalized symmetric exchange technology to healthcare supply chain scales up the ability of GPOs, manufacturers, and distributors to deliver better supplies, equipment, and service at better prices to their members. Specifically, a symmetric exchange customizes and expedites the complex order making, discount computing, and group marketing and negotiations. Its worldwide customers include medical equipment and supplies manufacturers, distributors of medical equipment and supplies, GPOs, hospitals, healthcare providers, financing/leasing companies, shippers, inspectors, refurbishers, insurance companies, packaging companies, service contractors, and providers of expert consultation, quality inspection, and electrical conversion.

By using a generalized symmetric exchange, the GPOs negotiate better discounts from manufacturers, increase membership at the expense of non-participating GPOs, and increase order volume by increasing membership and by offering better prices. Manufacturers and distributors increase order volume for new equipment, upgrades, spare parts, and consulting services, reduce sales and marketing costs. Both players gain low cost entry to e-commerce.

3. Example of Symmetric Exchange Operation

Figure 2 illustrates the symmetric exchange model in action, where a system assists the buyer to minimize the total cost of a two-item purchase in four transactions. The system also maximizes buyer’s productivity by completing the entire cycle in four steps in parallel instead of the standard sequential twelve-step
operation. The names of different vendors here are used for example purposes only, without any relevance to specific pricing available from these vendors.

In this example, the buyer posts two buy requests; one for a used linear accelerator and one for an order of catheters. The buyer also simultaneously posts a request for financing, inspection, and shipping. The buy request for the linear accelerator is matched with two sell requests posted by Varian and Siemens, and the request for additional services is matched with request to provide services posted by Sharpelease and Absolute X-Ray. The process allows users of the system to mix and match best-of-breed offers and maximize the total value of each deal. In the case of the linear accelerator the buyer chooses Varian's offer, which saves him $200,000 over Siemens' price. The buyer is able to negotiate with Varian and further reduce the price to $900,000 (total savings of $300,000 over Siemens' initial price of $1.2 million).

Figure 2. Simultaneous Transactions and Price Optimization Raise Procurement Productivity

Simultaneously, the buyer negotiates with service providers and is able to choose the one that best fits his needs. After closing the deals, payments and orders are secured through TradeMD's escrow accounts or independently between the parties. In both cases, the buyer is able to dramatically reduce the time involved in posting singular listings, and to drastically reduce costs.

4. Market Complexity Comparison

The symmetric market model is more attractive to both buyers and sellers because of reduced complexity, increased number of potential participants and increased deal potential. We formalize the intuitive notion of (user) complexity as the total number of items that every participant must sift through while using the system. We can calculate complexity for a system of 10 buyers, 10 sellers, and 10 service providers, and 1,000 listings:

Traditionally, each buyer sifts through 1,000 listings, yielding a multiplicative complexity of 10,000. Each service provider must sift through each of the 10,000 potential deals, yielding a total of 100,000 items through which to search. Finally, each seller must manage his listings, adding 1,000 to the complexity. Thus, the total system complexity is 111,000. Analogous calculations yield the same complexity in a buyer-driven market.
Because a symmetric exchange automatically matches requests, the total complexity is the sum of the number of requests in the system and the number of users. For the example system, the resulting complexity is only 2,030; symmetric exchange reduces complexity by two orders of magnitude.

The symmetric model reduces complexity by substituting multiplicative with additive complexity, expediting participant interactions, which in turn grows participatory rate and thus increases market efficiency and liquidity. Efficient and liquid markets attract users.

5. Increasing Deal Potential through Automatic Matching

Matching buyers and sellers is the first step in making a transaction. In the case of the seller-driven market, the buyers will match to the sellers, yielding 3 total matches at iteration 3. In the symmetric system, complementary requests are matched automatically, yielding a fully connected graph of possible transactions. At the third iteration, this yields 33 matches, an order of magnitude improvement. In iteration 4, the traditional e-commerce system yields 9 matches. The new and improved system yields 396 matches.

In general the behavior of a symmetric exchange can be described by the following set of simultaneous difference equations:

\[
\begin{align*}
f_n &= f_{n-1} + 3g_{n-1} \\
g_n &= g_{n-1} + 3f_{n-1} \\
f_0 &= 0 \\
g_0 &= 1
\end{align*}
\]

(where \( f \) describes number of buyers in the system, and \( g \) is number of sellers in the system)

Assuming:

a) Unlimited Exposure: a large number of participants browse the system daily
b) Selective Postings: buyers and sellers prefer not to post requests on an empty system. In this example, we assume that only three buyers will list their requests on the system for every existing sell request. Conversely, only three sellers will list their requests on the system for every existing buy request.
c) Discrete Cycles: for simplicity, we assume that on even days, buyers visit the site, while on odd days, sellers visit the site.

The solution for this set of simultaneous difference equations is

\[
\begin{align*}
f_n &= \frac{1}{2} [4 \cdot (-2)^n] \\
g_n &= \frac{1}{2} [4 + (-2)^n]
\end{align*}
\]

The solution illustrates exponential growth of the numbers of participants, and thus deal potential.

6. Outlook for the Future

To gain market liquidity in the healthcare supply chain industry quickly, on-line healthcare service providers must combine control of product flow and pricing. Through teamwork with distributors and GPOs, they can create e-marketplaces that exceed the range of products and scope of services offered by traditional companies, while dramatically cutting costs and improving customer service.
It is predicted that only one out of ten B2B companies will survive its first year.(?) However, Aaron Dickson of the Millennium Research Group maintains that “Dot-Coms will survive as long as they serve an economic purpose -if they help reduce supply chain costs through more efficient procurement, savings resulting from better production management, and improved inventory management, there will be a place for them in the market regardless of recent stock market uncertainty.” In this extremely unpredictable environment it is clear that healthcare supply chain e-commerce providers must exemplify their ability to deliver on the promise of streamlining the healthcare business, dramatically cutting costs, and enhancing bottom line in lucrative local and global markets.

Another lucrative and not fully realized source of revenues is international sales of used equipment. The international market for healthcare supply chain is estimated to be at least double the $180 billion domestic market. The trade in used medical equipment accounts for an estimated 40% of the international market. Nevertheless, the international sales of used medical equipment has largely been an untapped resource for US healthcare supply chain e-commerce companies.

There are a few barriers that hinder e-globalization: currency exchange rate fluctuations, cultural differences, unexpected changes in regulatory requirements, tariffs, export controls and other trade barriers, difficulty collecting receivables, difficulties managing and staffing international operations, potentially adverse tax consequences, compliance with a wide variety of foreign laws, political instability, and competitors with greater local market exposure. However, the sales of used medical equipment abroad can help these companies gain quick profits by matching the overwhelming demand for American equipment overseas and turning excess products into revenues.

7. Survival Advice

- Combine executive expertise in both technology and healthcare supply chain.
- Quickly gain market liquidity through focus on complexities and combined control of both product flow and pricing.
- Rapidly build transaction volumes in both the international and the US domestic markets.
- Build local points of presence for sales and support in countries around the world.
- Team up with domestic GPOs, manufacturers, and distributors; provide them with e-commerce tools and infrastructure that can be customized and branded.

The Internet will help streamline the healthcare procurement industry offering smaller markups, faster turnaround times, and longer useful life of equipment.
1 Aaron Dickson, Millennium Research Group. E-mail interview. June 23, 2000.