



INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, ECONOMICS AND MANAGEMENT

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e-PROCUREMENT USING REVERSE AUCTIONS FOR CONSTRUCTION PROJECTS

T.BALADHANDAYUTHAM
RESEARCH SCHOLAR
SCHOOL OF MANAGEMENT STUDIES
SRM UNIVERSITY
KATTANKULATHUR

DR. SHANTHI VENKATESH
ASST. PROFESSOR (SG) - MARKETING
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ABSTRACT

The growth of e-commerce has been phenomenal and it is radically transforming the way companies are doing business in all sectors, and the construction industry is no exception. At all junctions of construction project there has been continuous encouragement to consolidate, innovate, improve quality, improve safety, make partnerships, reduce wastages, deliver on time, meet / save the budget. Service, cost and time are the measures of Procurement excellence in any construction project and the amount saved on cost of the materials directly adds up to the profit of the project. B2B e-Markets offer innovative tools for strategic sourcing requirements of construction projects. B2B Reverse auction is one such innovative tool which offer real-time access to the marketplace, increase competition, lower costs, and save time. A carefully executed reverse auction can contribute to the success and profitability of the Construction Projects. This paper critically analysis material procurement related to Construction Projects and proposes B2B reverse auction methodologies using an Independent Horizontal B2B e-Marketplace.

KEYWORDS

B2B e-Commerce, Reverse Auction, Construction Industry, Project material Procurement.

INTRODUCTION

The global economy has changed dramatically from an industrial society to an information society. Several information and communication technologies (ICTs) have been developed in the marketplace and these ICTs have presented numerous opportunities and challenges for both developed and developing countries. The Internet is an important information technology that has developed over the years and it is transforming the manner in which several companies conduct their business activities and it has enabled the evolution of electronic commerce (e-commerce).

E-COMMERCE AND E-BUSINESS

In general, e-business is used in the broadest sense. It includes buying and selling on-line, but also other aspects of on-line business activity, such as purchasing, tracking inventory, managing production and handling logistics, customer support services, supply chain management and collaborative engineering. Electronic Commerce, or e-commerce, is buying and selling on-line. It is part of the broader term e-business and involves transactions. In simple words B2B commerce can be defined as "doing business electronically" or business that is conducted over the Internet.

E-MARKETPLACE

In economics, a market is defined as a virtual meeting-place of supply and demand. E-marketplaces fulfil the same purpose. E-marketplaces are a Business to Business relationship model (B2B) in which multiple organizations, both sellers and buyers, can communicate, collaborate, and perform commercial transactions by means of a Web platform which is common to all those participating in the market. The main advantage of the e-marketplace compared with other B2B models is that it allows a purchasing company access to multiple selling companies and to selling companies access to multiple purchasing companies.

PROCUREMENT IN CONSTRUCTION INDUSTRY

In this era of escalated demand for growth, the construction industry across the globe faces issues of constant material price fluctuation and shortage of skilled resources. Today, enterprises are increasingly in need of sustainable, faster and safer methods of construction, innovative project delivery modes and procurement practices, as well as interoperable standards within the construction industry, which is really a big challenge to their existing supply chain to improve the efficiency and effectiveness. The construction sector requires a large quantity of materials, machinery and services from other productive sectors, producing a multiplying effect in the economy. The aim of supply is to deliver the correct quantity of a quality product, at the correct time, in the correct place, and at the best price. Purchasing is seen as a great opportunity for savings since it takes quite a large part in the turnover.

At all junctions of construction project there has been continuous encouragement to consolidate, innovate, improve quality, improve safety, make partnerships, reduce wastages, deliver on time, meet / save the budget. Service, cost and time are the measures of Procurement excellence in any construction project and the amount saved on cost of the materials directly adds up to the profit of the project.

LITERATURE REVIEW

A detailed literature survey was conducted on the Procurement process for construction projects, various e-Business models, e-business applications in construction industry. The sources of literature review includes books, management journals, survey reports, research reports and contemporary articles on the e-business applications in supply chain management. Summary of observations made out of the detailed literature survey is given below:

E-COMMERCE IN RELATION TO CONSTRUCTION

E-commerce can be defined as the conducting of buying and selling of goods and services as well as business communication and transactions over computer networks and through individual computers linked to the World Wide Web (Key IT Solutions, 2005). The potentials of e-commerce technologies applications in the construction industry include: E-marketing; E-selling/e-procurement of goods and services; E-collaboration; E-finance; and E-customer services and relations (Veeramani et al., 2002).

The necessary technological solutions for e-supply chain systems are readily available in the current market. Some of the fundamental issues for successful ecommerce in construction, such as signature exchange (Pederson, 1999; Asokan et al., 2000), secure payment (Shamir et al, 1998; Bellare et al., 2000), and fair contracting models (Coscia et al., 2000; Rohm & Pernul 2000; Liu et al., 2001) have already been addressed in broader business-to-business (B2B) projects. E-commerce applications have enhanced the development process operations of a project, and promoted integration and operation through the shared information network system to diverse participants in the construction supply chain (Jones & Saad 2003).

e-Business has much to offer the construction sector, as it directly addresses the issues that a disseminated industry has to deal with – distributed collaboration, electronic sourcing and purchasing of products and services that meet well-defined requirements, globalization, need for improved efficiency and timely delivery. It is widely accepted that e-business is the way to conduct construction business in the 21st century. It is the means available to companies to continuously improve efficiency and effectiveness in serving their clients' needs and in delivering a return to their shareholders. The development of e-business is upon us, now affecting the short and medium term but it is also the way business will develop over the long term. (Chimay J. Anumba and Kirti Ruikar, 2008). A construction project is a complex activity involving several participants; for example, the client, architect, structural engineer, fabricator and the contractor. It is team efforts, involving several, inter organizational activities and dialogue. Traditional communication and document exchange models were often manual and hence slow. The traditional means of communication involves producing numerous paper copies of documents and drawings. Management of these loose documents is often very time-consuming and tedious. Libraries of documents need to be maintained to effectively access data as and when required by the user. 'A lack of a clear audit trail causes delays in communicating with other members of the team' (Needleman, 2000).

E-business provides mechanisms for cross-enterprise coordination in name of construction supply chain integration. In order to optimize the entire supply chain system cross-enterprise coordination and special business relationship must be established among the organizations along the supply chain (Francisco Loforte Ribeiro and Jorge Lopes, 2001).

E-PROCUREMENT PROCESS

E-Procurement can be defined as the "electronic integration and management of all procurement activities including purchase request, authorization, ordering, delivery and payment between a purchaser and a supplier" (Chaffey, 2002). The more general classifications of the procurement process have been created by authors such as Kalakota and Robinson (2000), Lysons (1996), Fogarty et al (1991), and Whitely (2000). These classifications contain three to four stages of procurement and put the "order" or "sale" as the central phase of the process. In a more recent classification, Archer and Yuan (2000) detail a seven-phase procurement process. The phases include (1) information gathering, (2) supplier contact, (3) background review, (4) negotiation (5) fulfilment, (6) consumption, maintenance and disposal, and (7) renewal.

Six forms of e-Procurement are described by de Boer et al. (2002); (i) electronic-Maintenance Repair and Operations (e-MRO), (ii) web-based Enterprise Resource Planning (ERP), (iii) electronic-sourcing (e-sourcing), (iv) electronic-tendering (e-tendering) (v) electronic-reverse auctioning (e-reverse auctioning) and (vi) electronic-informing (e-informing). Both e-MRO and web-based ERP are built on a web-integrated enterprise resource planning system. The difference between the two is that e-MRO focuses on the procurement of MRO items whereas web-based ERP focuses on direct materials (de Boer et al, 2002). B2B relationships have most effect on the sourcing, fulfilment, and consumption phases of the procurement cycle (Nagle T, Finnegan P, Hayes J, 2006).

Research of enterprises' experiences with Internet-based procurement automation technologies indicates that companies have been able to achieve significant cost and process benefits by automating key procurement activities (Aberdeen, 2001). As a result of their e-procurement initiative, enterprises, on average, displayed a 35% improvement in spend under management, with a 41% reduction in maverick spend. Additionally, enterprises reduced their requisition-to-order cost by approximately 100%, and more than halved their transaction cycle time. In addition to improvement in various performance areas, enterprises reported negotiating, on average, a 4.75% incremental discount with suppliers after implementing their e-procurement solution (Aberdeen, 2007).

e-REVERSE AUCTIONS

In the mid-1990s, a new electronic sourcing tool emerged that has had, and is continuing to have, a profound impact on the way in which firms source goods and services from current and potential external suppliers. This tool, while known by other names (e.g., "online negotiation") is the electronic reverse auction (e-RA). For a growing number of buying firms, e-RAs have found an appropriate niche in their strategic sourcing toolkit, allowing them to efficiently source goods and services that are highly standardized, have sufficient spend volume, can be replicated by a reasonable number of qualified competitors, and have insignificant switching costs (CAPS Research, 2002).

Dimitri P. Bertsekas, David A. Castanon, and Haralampos Tsaknakis (1993) have conducted detailed research and developed reverse auction algorithms for Symmetric Assignment Problems. Auction-based mechanisms are extremely relevant in modern day electronic procurement systems since they enable a promising way of automating negotiations with suppliers and achieve the ideal goals of procurement efficiency and cost minimization (T. S. Chandrashekar, Y. Narahari, Charles H. Rosa, Devadatta M. Kulkarni, Jeffrey D. Tew, and Pankaj Dayama, 2007).

Despite the benefits of e-commerce technologies to the construction industry, there are many challenges in its applications. In many instances, the potential of e-commerce technologies has yet been fully and properly utilized, as many companies are simply utilizing various technologies to automate existing processes without analyzing the company's objectives and realistic needs. In addition, significant people and culture issues need to be addressed to overcome resistance to change and achieve radical revision (Elliman & Orange 2003).

RESEARCH GAPS IDENTIFIED

It has been noted from the above detailed literature survey that, until now, not much evident research has been conducted to pursue successful applications of e-commerce technologies to the construction supply chain. Furthermore, there is very little empirical research available that investigates the implementation of e-Procurement initiative for construction project procurement. Also it has been noted that the available exploratory research does not provide detailed analysis on the various procurement organizational structures (i.e. De-centralized Vs Centralized Vs Center-led) and does not propose a hybrid form of procurement organization coupled with e-Procurement application.

For this reason, this research will focus on developing a methodology for implementation of e-Procurement using e-RA on a B2B e-market platform in construction supply chain. The specific issues which will be investigated include the objectives, reasons/benefits, barriers of using e-commerce technologies. This research will also investigate the encouraging factors and the need for learning, training, and knowledge sharing for better applications of e-commerce technologies and provide suggestions for better utilization of such modern communication and management tools.

Rationale behind this study

This research paper aims to reduce the drawbacks of traditional procurement process adopted in Construction companies and proposes methodology for utilization of web based B2B Reverse Auctions for the construction Projects through the following analysis:

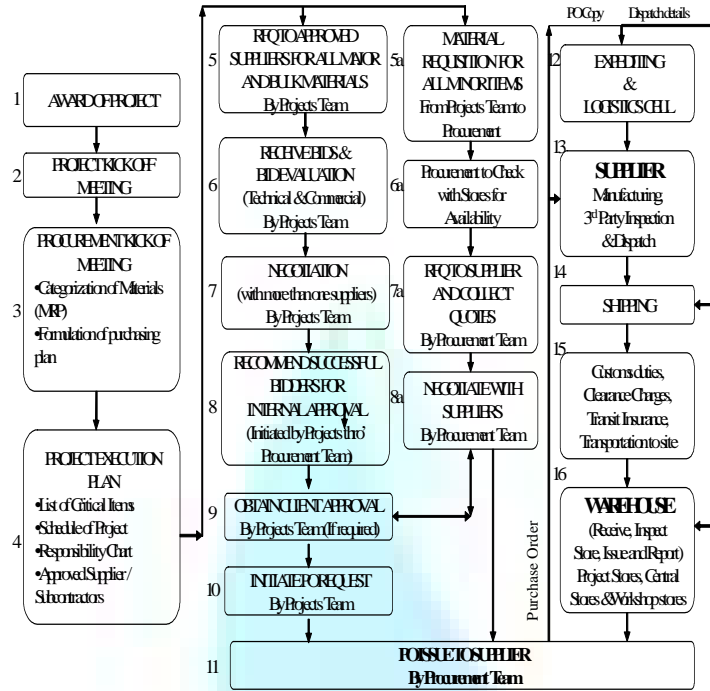
- Project Procurement Process analysis
- Commodity Spend Analysis
- B2B Reverse Auction Analysis
- Auction Implementation Methodology.

PROCUREMENT PROCESS ANALYSIS

Every construction Project generally requires two types of materials namely Direct Material (also called as "Permanent Materials") which will form part of Project Permanent installation and "In-Direct Materials/Services" which are supporting items requires for the day to day site execution of the Projects. As a thumb rule 50 to 70% of the Project Cost is contributed from the Project Permanent Materials.

De-Centralized Procurement Process: Traditionally construction companies are adopting De-Centralized Procurement Process in which Project procurement begins with the award of the Project and issuance of RFQ to the suppliers. In De-centralized process, Procurement Department will play only a meagre role of Processing the Purchase Orders based on the Request received from the Project Offices, where the core Procurement activity is handled by the site Project Team. This type of De-centralized Purchase leads to "maverick purchasing" even the Procurement Departments ensures "checks & balances" as indicated in

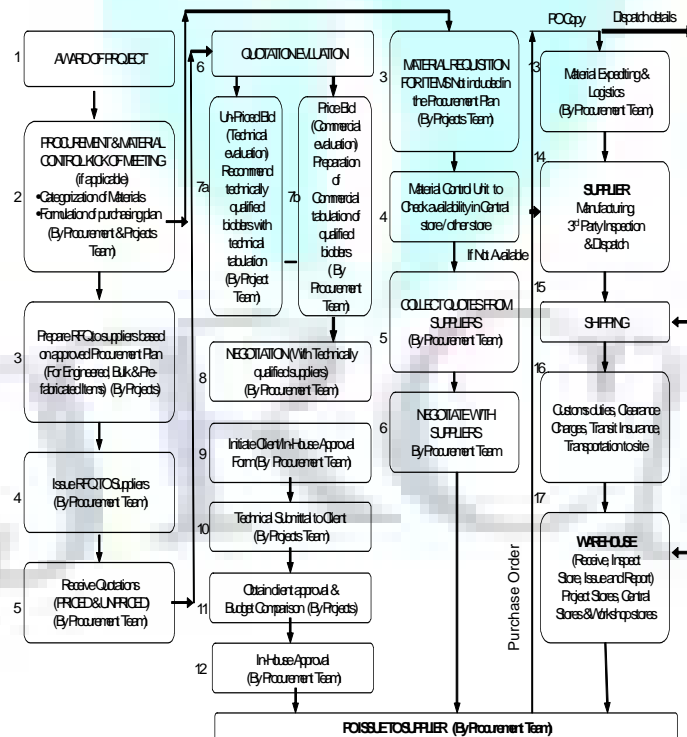
FIG. 1. DE-CENTRALIZED PROCUREMENT PROCESS



Centralized Procurement Process: In order to improve the procurement efficiency Construction companies must centralize the Procurement activities. In the centralized Procurement Process, Procurement Department plays a pivotal role in the sourcing and negotiations. The modified process flow of Centralized Procurement process is indicated Figure-2. According to the modified process flow, Procurement Department will issue Request for Quotations (RFQ) to suppliers and commercial evaluation / negotiations with suppliers will be conducted by Procurement Department. Projects will be notified upon finalization of the successful supplier for obtaining the Client / Consultant approval. The Centralized Procurement has the following advantages:

- Better prices due to volume discounts.
- Greater bargaining power with suppliers.
- Avoids price anomalies and competition for scarce commodities between jobs.
- Standardized procedures.

FIG. 2. CENTRALIZED PROCUREMENT PROCESS



COMMODITY SPEND ANALYSIS

Spend analysis is the examination of the volume and value of purchasing transactions at an organization makes. Corporate purchases can be classified along many dimensions that are relevant for the potential use of B2B e-markets for procurement. Two questions should be kept in mind:

- Given the characteristics, is it possible to use e-markets?
- Given the characteristics, is it economically reasonable to use e-markets, i.e. are e-markets better than any other form of procurement?

The various commodities procured by Contracting Companies for their construction projects can be broadly grouped in to Engineered Materials with a unique assigned number (or tag) such that they can be uniquely identified throughout the entire life of the Project, Bulk items that are manufactured to industry standards and purchased in bulk quantity. (e.g., pipes, cables, fittings, conduits, etc) and Pre-Fabricated Items that are typically fabricated as per engineered specifications at a fabrication shop or shop site separate from the Project site. Depending on the Project, these items are quantified, procured and delivered by the subcontractor. (e.g., process modules, pre-assemblies, pipes spools, control stations, equipment skids, etc.). Complexity, Strategic Importance, Price and Repeat Purchase are the important dimensions of Procurement Spend for conducting a Commodity Spend Analysis (Report for OGC by Europe Economics, 2002). Depending on the complexity and price of the materials, Construction companies have to adopt Suitable strategy as indicated in the Kraljic Procurement Portfolio Matrix (Marjolein C.J. Caniels and Cees J. Gelderman, 2005) in Figure-3 to deal with the suppliers to minimize the Procurement Risks.

FIG. 3. KRLJIC PROCUREMENT PORTFOLIO MATRIX



- High Value – High Risk: Ensure availability of Supply with Close Price Management.
- Low Value – High Risk: Ensure availability even if price premium is necessary.
- High Value – Low Risk: Opportunities to Cut Cost, Improve Savings using competition.
- Low Value – Low Risk: Ensure Automation & Minimize the time spent.

B2B REVERSE AUCTIONS

B2B e-Markets offer following trading functions, which can be adopted for the Procurement Requirements of Construction Companies.

- Reverse Auction
- Exchange (RFQ/RFP/RFB)
- Catalogue

Reverse Auction: In a reverse auction buyers list a product or service they would like to buy. Sellers submit offers, lowering the selling price for each submitted bid. Online bidding is used also for reverse auctions. Online auctions effectively allow for an infinite number of bid re-submissions by suppliers in an open and competitive environment, at a relatively low overhead cost. This turns the concept of a ‘true market price’ into a reality, providing significant benefits to purchasing organizations. Types of web based Auctions:

- Negotiations using EDI: B2B EDI
- Web-based (Sales) Forward Auctions : eBay, Auction.co.kr
- Web-based (Procurement) Reverse Auctions : Priceline.com
- Web-based Double Auctions : Stock Exchanges

The different types of web based auctions are summarized in the Figure 4

FIG. 4. TYPE OF WEB BASED AUCTIONS

		<u>Buyer</u>	
		One	Many
Seller	One	Negotiations using EDI	Forward (Sales) Auctions
	Many	Reverse (Procurement) Auctions	Double Auctions

The reverse auction consists of two important components i.e. Auction style and auction control (Table-1 & 2). Companies can launch their auctions in the following auctions styles depending on their need.

TABLE 1
Auction style

Open	Suppliers can see the active bid Prices and attachments (Optional), the supplier identity is concealed.
Blind	Only the buyer can see bids.
Sealed	Neither buyer nor supplier can see the bids until the bids are unlocked.

TABLE: 2 AUCTION CONTROL

Open for all	All e-market registered Suppliers can quote for the auctions. But still specific suppliers can be invited.
By Invitation only	Only specific invited suppliers can quote for the auctions.

Auction style and auction control are the two important functionalities of online auctions. Buyer need to manipulate the combination of auction style and control depending on the commodity and nature of the item to be auctioned. Right combination will reap a potential savings to Buyers. The Buyers can do a spot purchase using the auctions or they can enter in to a long term agreement with the suppliers.

Buyers can also create a Request for quotations. RFQ and Auctions are similar in functionality, the main difference is an Auction can be of ‘Open Style’ where suppliers are allowed to see each other’s price and can re-bid for the same item, but RFQs are either Blind or sealed and suppliers can not re-bid.

TABLE 3: AUCTION COMBINATION MATRIX

	Auction Control	
Auction Style	Open for all	By Invitation only
Open	A	B
Blind	C	D
Sealed	E	F

Combinations:

- A – Open and Open to all
- B – Open and By Invitation only

- C – Blind and Open to all
- D – Blind and By Invitation only
- E – Sealed and Open to all
- F – Sealed and By Invitation only

The success of an auction, in terms of the savings obtained by the purchaser, depends on two key factors: the ability to define the good with clear and unambiguous specifications (“high specificity”) and a market with supply-side liquidity where there are plentiful suppliers that compete among each other to get the business (“highly competitive”).

Empirically, there is a direct relationship between the order amount and the savings achieved, with larger volumes achieving greater percentage savings. It is therefore preferable for the Buyer Organization to plan and pool requirements together for a specific period of time and to auction its business together, rather than use various auctions.

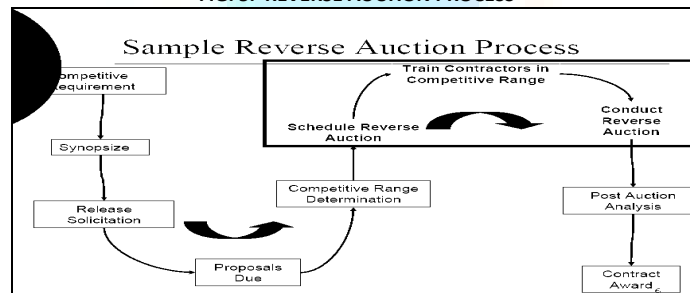
In conclusion, if a product can be perfectly defined, competition between suppliers is high and the value is sufficient, the better suited it will be to an online auction for the purchaser. Experience shows that substantial savings can be made and the risk that the purchaser incurs is minimized if the auction is carried out between approved suppliers.

B2B REVERSE AUCTION PROCESS

The reverse auction process (Figure-5) involves intensive work on behalf of the buyer and market maker to structure the bidding process and prepare suppliers for qualification. The process is represented below:

1. Make Market (specs)
2. Identify Suppliers
3. Pre-Award Review
4. Approved Suppliers Listing
5. Identify Specific Terms & Conditions
6. Invite Suppliers
7. Set Up Auction
8. Conduct Auction
9. Contract Write-up

FIG. 5. REVERSE AUCTION PROCESS



B2B e-Procurement Solution

Based on the above supplier & commodity spends analysis, it has been noted that procurement spend of Construction Companies generally covered under the following combinations (Table-4) and the appropriate B2B e-Procurement strategy has been indicated against the each commodity spend criteria. Based on the detailed analysis conducted on the various functionalities of the B2B e-Market online procurement tools, each of the above procurement strategy has been mapped with the most suitable e-Procurement tool as given in Table-5.

TABLE 4: COMMODITY SPEND CRITERIA & E-PROCUREMENT STRATEGY

Type	Commodity Spend Criteria				Average Annual spend	B2B e-Procurement Strategy
	Price	Repeat Purchase	Strategic Importance	Complexity		
I	Low	High	Low	Low	8%	Develop long term agreement with Suppliers and maintain B2B online supplier catalogues to reduce Transaction cost
II	High	High	Low	Low	8%	Create "Hyper Competition"
III	Low	Low	Low	Low	2%	Develop long term agreement with Suppliers and maintain B2B online supplier catalogues to reduce Transaction cost
IV	High	Low	Low	Low	> 0.5%	Create "Hyper Competition"
V	High	Low	High	Low	4.90%	Create RFQ & Prequalify suppliers and make them technically equal. Create Open auction by inviting only prequalified suppliers.
VI	Low	Low	High	Low	> 0.5%	Create reverse auction with clear item attributes and negotiate online.
VII	High	High	High	Low	> 0.5%	Create reverse auction with clear item attributes and negotiate online.
VIII	Low	High	High	Low	> 0.5%	Create reverse auction with clear item attributes and negotiate online.
IX	High	Low	High	High	75%	Create reverse auction with clear item attributes and negotiate online.
X	Low	High	High	High	1%	Create reverse auction with clear item attributes and negotiate online. The successful supplier will maintain their online catalogue for repeat purchase to reduce the transaction cost.

The following are the essential steps to streamline the procurement process through e-marketplace.

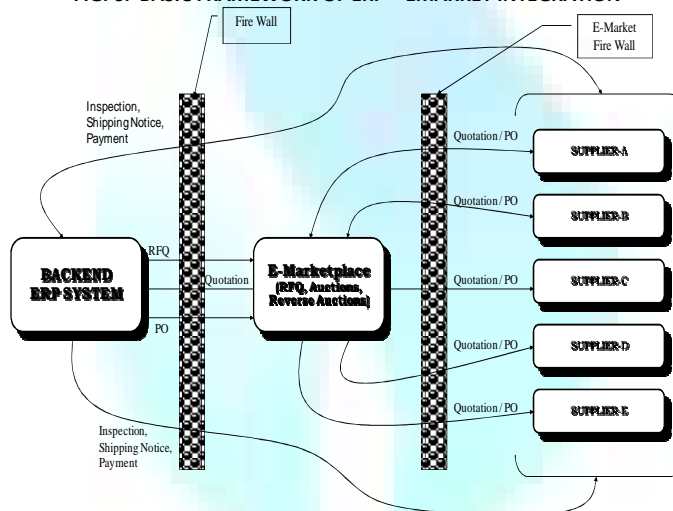
- Create online Supplier Invitation lists
- Create Auction / RFQ templates for each commodity
- Consolidate the requirements of similar commodity
- Select appropriate negotiation tool based on the type of the material.

TABLE 5: COMMODITY SPEND MAPPED WITH B2B E-PROCUREMENT TOOL

Type	Online Supplier Catalogue	Request for Quotation (RFQ)				Reverse Auction				
		RFQ Style		RFQ Control		Auction Style		Auction Control		
		Blind	Sealed	Open	Invitation	Open	Blind	Sealed	Open	Invitation
I	Yes					Yes			Yes	
II						Yes			Yes	
III	Yes					Yes			Yes	
IV						Yes			Yes	
V						Yes				Yes
VI						Yes				Yes
VII						Yes				Yes
VIII						Yes				Yes
IX		Yes	Yes		Yes					
X	Yes					Yes				Yes

In order to improve the efficiency and to achieve the Procurement Process automation, the Construction Companies having a back end ERP system have to integrate their ERP system with the e-marketplace portal as indicated in Figure-6.

FIG. 6: BASIC FRAMEWORK OF ERP – E-MARKET INTEGRATION



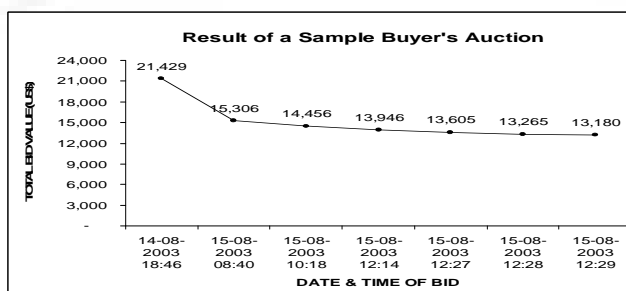
Reverse Auction: Supplier Price Dynamics

The online reverse auction process typically begins with the buyer posting a request for purchase (RFP) to a website and inviting specific suppliers to view the RFP. In a sealed-bid auction, suppliers are asked to submit their bids a few days or weeks later, and a winner is subsequently selected. Only the buyer views the bids.

In the open-bid auction, suppliers bid sequentially through a series of product lots or sub-groups and can view their competitors’ bids and respond in real time. A moving end-time (a “soft close”) is used for each lot, meaning that any bid within the last minute of the closing time will automatically extend the close time for a few minutes to allow other bidders to respond.

One auction characteristic that may influence auction success is auction time or the auto-extension of the bidding period. Most auctions are initiated with advanced notice of a specific closing time. The fixed end time poses an incentive problem—the early bid serves no benefit to the bidder but reveals information to her rivals. The typical model of the English auction would project that bidders would quickly bid their valuations and the auction would end with the highest valuation bidder receiving the price of the valuation of the second-to-last bidder. Yet many auctions with fixed-end times are experiencing “sniping” or submission of bids in the final minute of an auction as shown below in Figure-7. Late bidding deprives rivals of the ability of seeing one’s bid and undercutting it.

FIG. 7. REVERSE AUCTION PRICE DYNAMICS



REVERSE AUCTION TIPS

To conduct successful reverse auctions, buyers must do their homework. To keep the process simple:

- Have a clear and concise requirement (recurring need commodities are best).
- Be certain a significant number of suppliers will compete (through substantial market research).
- Have a dollar amount great enough to offset the cost of conducting the reverse auction.

CONCLUSIONS

In conclusion, if a product can be perfectly defined, competition between suppliers is high and the value is sufficient, the better suited it will be to an online auction for the purchaser. Experience shows that substantial savings can be made and the risk that the purchaser incurs is minimized if the auction is carried out between approved suppliers.

Empirically, there is a direct relationship between the order amount and the savings achieved, with larger volumes achieving greater percentage savings. It is therefore preferable for the Buyer Organization to plan and pool requirements together for a specific period of time and to auction its business together, rather than use various auctions.

A well planned implementation of B2B e-Procurement for contracting companies will result in several benefits and some of the benefits are listed below:

- Cost savings and price reductions
- Reduction or elimination of the role of intermediaries
- Shortening supply chain response and transaction times
- Gaining a wider presence and increased visibility for companies
- Greater choices and more information for end users.
- Improved service as a result of instant accessibility to services
- Collection and analysis of voluminous amounts of data and preferences
- Creation of virtual companies and Leveling playing field for small companies
- Gaining global access to markets, suppliers, and distribution channels.

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