

E-Procurement, the Golden Key to Optimizing the Supply Chains System

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Abstract—Procurement is an important component in the field of operating resource management and e-procurement is the golden key to optimizing the supply chains system. Global firms are optimistic on the level of savings that can be achieved through full implementation of e-procurement strategies. E-procurement is an Internet-based business process for obtaining materials and services and managing their inflow into the organization. In this paper, the subjects of supply chains and e-procurement and its benefits to organizations have been studied. Also, e-procurement in construction and its drivers and barriers have been discussed and a framework of supplier selection in an e-procurement environment has been demonstrated. This paper also has addressed critical success factors in adopting e-procurement in supply chains.

Keywords—E-Procurement, Supply Chain, Benefits, Construction, Drivers, Barriers, Supplier Selection, CFSs.

I. INTRODUCTION

AS a major part of supply chain management, supply chains in procurement are traditionally supported by information technology. With the implementation of enterprise resource planning (ERP) or manufacturing resource planning (MRP) systems in the 1980s electronic data interchange (EDI) connections with suppliers were established [1],[2]. Since the mid-1990s companies have also been redesigning their relationships with business partners for indirect procurement. Direct procurement addresses all components and raw materials that are used in the manufacturing process of a finished product, such as sheet metal, semiconductors, and petrochemicals [3], whereas indirect procurement relates to products and services for maintenance, repair and operations (MRO) and focuses on products and services that are neither part of the end product nor resold directly [4]. Traditionally, ERP systems have been applied to products with high transaction volumes and direct implications for value-adding processes. As a consequence, we still find paper-prone and labor-intensive processes for indirect procurement that harbor large inefficiencies.

The diffusion of e-procurement systems in the late 1990s has created the potential for reorganizing the MRO supply

chains. Compared to ERP, these systems were considerably less expensive and more flexible due to increased standardization on a technical level. More or less all studies on e-procurement report large efficiencies regarding process and procurement costs [5]. The main idea of e-procurement is to include the end-user (requester) in the procurement process via an electronic multi-vendor catalog and to close the process gaps (e.g. re-entry of data) in the supply chain for indirect goods [6]. A third phase of development in e-procurement has also been observable with the integration of electronic markets (e-markets) in the supply chain since the end of the 1990s [7]. These e-markets evolved alongside the early system vendors like Ariba, Commerce One or SAP and support the outsourcing of operational procurement functions, offering tools for auctions and requests for quotations. However, the following evolution of e-markets has led to a substantial consolidation and many now focus on outsourced solutions for catalogs and auctions.

E-procurement (electronic procurement, sometimes also known as supplier exchange) is the business-to-business or business-to-consumer or Business-to-government purchase and sale of supplies, Work and services through the Internet as well as other information and networking systems, such as Electronic Data Interchange and Enterprise Resource Planning.

Companies like Oracle, SAP, PeopleSoft, and Baan have recently released electronic procurement products tied into their enterprise resource planning (ERP) software packages. These products act as a virtual mall, linking the buyers to a number of different suppliers. Companies such as Eastman Chemical, MCI, Cisco Systems, Chevron and Bristol-Myers Squibb are using these products [8].

II. BENEFITS OF E-PROCUREMENT

A procurement system is a vital component of a company's supply chain system. Typically, a company's procurement function is subdivided into strategic and operational processes since activities and priorities in these two areas are entirely different [9],[3]. Supplier management, the pooling of purchase requisitions and procurement-oriented product development are tasks that are typically assigned to strategic procurement. Procurement also involves the following major business activities:

1. Enter orders;
2. Check order status;

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3. Look up product prices and availability;
4. Set standards/specifications of the products;
5. Coordinate workflow design;
 - Approval process
 - Budgeting
 - Custom bundles
 - Check status of invoices and orders
6. Check account status;
7. Check status of resources;
8. Look up detailed information on accounts receivable; and
9. Request reports
 - Form an existing list
 - Special reports
 - Reports delivered by e-mail for added security

The use of Internet technologies in procurement is aimed at realizing faster and more efficient operational procurement processes which bypass the purchasing department and enable those people to concentrate on more strategic tasks (see Fig. 1) [10].

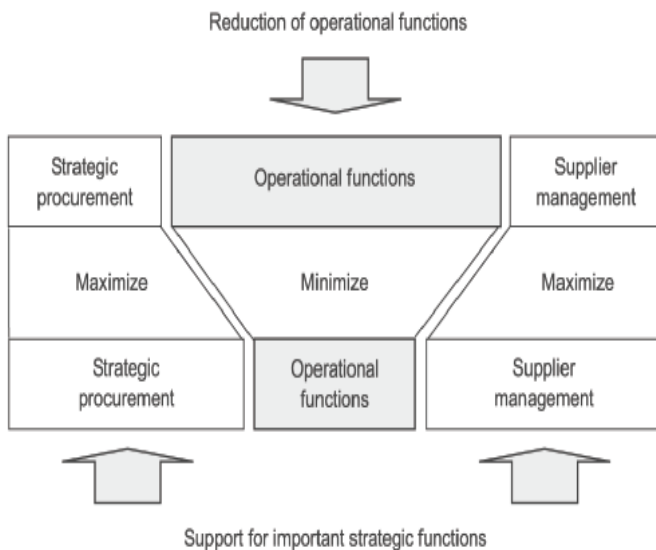


Fig. 1 Effects of e-procurement [10]

E-procurement enables companies to decentralize operational procurement processes and centralize strategic procurement processes as a result of the higher supply chain transparency provided by E-procurement systems. E-procurement can also include activities such as:

- Advertising tenders;
- Electronic ordering;
- Research into supplier markets; and
- Internet sourcing via third parties;
- Electronic submission of tenders;
- Electronic mail between buyers and sellers;
- Electronic mail in contract management;
- Integration of procurement within the financial and inventory systems.

Also Table I classifies major benefits of e-procurement.

Furthermore, e-procurement can be used in conjunction with the varied technologies of electronic commerce such as document imaging, workflow management, bulletin boards and e-mail to enable business process reengineering.

TABLE I
SIGNIFICANT BENEFITS OF E-PROCUREMENT [8]

Types	Benefits
Strategic	Help to consolidate purchasing practices that will lead to greater discounts and better service from suppliers
	Accelerate the flow of important information between the buyer and supplier
	Reduce administrative hours, freeing them up to do other work
	Help to respond quickly to highly competitive new market entrants
	Improve the chances of winning new business
Opportunity	Enhance image and improve corporate trading relationships
	Improve buyer/supplier relationships, as mutual cooperation is required
	Better accuracy since an order is less likely to be delayed or the wrong goods delivered because there are no transaction errors
	Improve financial control by making it easier to match orders
Operational	Eliminate paperwork resulting in great saving
	Improve auditing and better security by enabling staff and auditors to verify and track the movement of orders through the system
	Shorten the delivery time by cutting time waiting for documents in the mail
	Eliminate time zone obstacles, as the e-procurement can be used any time of the day
	Reduce inventory levels, hence costs associated with inventory.
	Maximize labor by empowering the employees who want the product to make the transactions that are right for their work

It is important to conclude that e-procurement is a technology that allows companies to focus on customer needs and expectations. In few years, doing business without this technology will be unthinkable.

III. E-PROCUREMENT IN CONSTRUCTION

In a number of industry sectors it has been shown that the development of business process models has supported the embedment of the business process within the organization [11]. The study of these other industries shows the many benefits that construction could potentially harness through e-business savings and efficiencies. The identification of the drivers and barriers to e-procurement in construction is vital to gaining an understanding of how the benefits of e-procurement can be used to increase its uptake and to provide a model to embed e-procurement. A limited study had been carried out in this field; Eadie et al (2007) carried out a preliminary study into drivers and barriers in construction and ranked these from a Northern Irish Public Sector Contractor's perspective [12]. The study applied drivers and barriers identified from other industries to e-procurement in construction and produced a ranking of the importance of drivers and barriers. The drivers and barriers commented on

by Martin (2008) were also analyzed to identify those which are applicable to construction; the relevant ones were subsequently added to Eadie's list of drivers and barriers [13]. It was felt a more rigorous verification of the application of general

e-procurement drivers and barriers to construction e-procurement may provide a clear outlook for the potential for the advancement of e-procurement in construction.

The proper implementation of e-procurement is a key management issue. To make this technology successful, IT managers must work to a plan and lay technology groundwork. They must believe in the benefits of this technology, opt for a comprehensive approach, define new relationships with vendors, train and support suppliers, and openly communicate with employees. The employees play an equally important role in the success of this technology. Getting people to buy in is an important challenge for the management.

To prepare workers for their new roles, management needs to begin an education and training program. Education is a significant factor in reducing resistance to implementing the technology. Opportunities for significant benefits enabled by e-procurement technology can only accrue to those organizations that have integrated this technology into their internal application systems.

IV. CONSTRUCTION E-PROCUREMENT DRIVERS AND BARRIERS IDENTIFIED FROM LITERATURE

The implementation of online procurement systems, however, has never been easy due to the barriers created by the different hardware/software, diverse corporate culture and varying users' skills of interacting with IS/IT. As a result, use of technology such as EDI tends to be limited to well establish businesses and their trading partners. On the other hand, the Internet has largely removed those barriers and opens the door for businesses of all sizes to seriously consider linking with suppliers for electronically exchanging supply/procurement-related information.

The variables which impact on the uptake of e-procurement were divided into two sections. These are the determinants of whether the implementation of e-procurement will be successful or not. Depending on their actions, these variables can either act as drivers promoting e-procurement or as barriers causing challenges to its embedment within the organization. Those actions which produce a positive result will be denoted by the term Drivers and conversely those producing a negative effect as Barriers. The literature search revealed a collated set of drivers and barriers to e-procurement containing 21 drivers and 30 barriers. These are identified in Table II and Table III respectively.

TABLE II
DRIVERS TO CONSTRUCTION E-PROCUREMENT IDENTIFIED FROM LITERATURE

No	Drivers from Literature	Referenced in:
1	Process cost savings - (Tender / Purchase Process)	[14],[15],[16]
2	Service / Material / Product Cost Savings	[15],[16] – Reduced Waste
3	Transaction Administration Cost Savings	[17],[18]
4	Reduced Administration Costs	[19],[20],[21]
5	Increasing Profit Margins	[22],[23]
6	Strategic Cost Savings	[14]
7	Enhanced Inventory Management	[20],[13]
8	Decrease in Costs through reduced staffing levels	[17],[19]
9	Shortened Overall Procurement Cycle Times	[15]
10	Shortened Communication Cycle Times	[14]
11	Reduction in time through greater transparency (Less objections)	[18]
12	Reduction in Evaluation Time	[18],[16]
13	Reduction in Time through improved internal workflow	[18]
14	Reduction in purchasing order fulfillment time - Contract Completion	[17]
15	Reduction in time through increased visibility	[24]
16	Increased Quality through increased competition	[24]
17	Increased Quality through Benchmarking (Market Intelligence)	[20]
18	Increased Quality through increased visibility in the supply chain	[15],[20]
19	Increased Quality through increased efficiency	[22],[13]
20	Increased Quality through Improved Communication	[20]
21	Gaining Competitive Advantage	[23]

TABLE III
BARRIERS TO CONSTRUCTION E-PROCUREMENT IDENTIFIED FROM LITERATURE

No	Barriers from	Literature Refer
1	Upper Management Support / Lack of Leadership	[17],[20]
2	Other Competing Initiatives	[25]
3	Resistance to change	[17],[13] - Natural Inertia
4	Lack of a widely accepted solution	[17],[13]
5	Magnitude of Change	[25]
6	Lack of a national IT policy relating to e-procurement issues	[26]
7	Lack of Flexibility	[26]
8	Bureaucratic dysfunctional ties	[26]
9	Complicated procedures and extended relationships	Carayannis et al (2005) show how excessive state intervention is a barrier to e-procurement.[26]
10	Lack of technical expertise	[17],[13]
11	Staff turnover	[24]
12	Slowdown in the uptake of internet services since the dotcom bubble burst	[18]
13	Company access to the internet	[27]
14	Religious objections to the internet	[17],[13]
15	Insufficient assessment of systems prior to installation	[19]
16	Security in the process - Data transmission to the wrong person	[25] -59% of Singapore sample cite security as the main barrier
17	Confidentiality of information – unauthorized viewing	[18]
18	Prevention of tampering with documents -	[24]

	changes to documents	
19	Data transmission reassembly – incorrect reassembly of data transmitted in packets	[28]
20	Partial Data Display - incomplete documents provided	[28]
21	Lack of pertinent case law	[20],[13]
22	Different national approaches to e-procurement	[26]
23	Proof of intent - electronic signatures	[13],[19]
24	Clarity of sender and tendered information	[14],[21]
25	Enforceability of electronic contracts	[28]
26	Information technology investment costs	[13],[23]
27	Cost of assessment of systems to find correct system to fulfill tasks	[23]
28	Internal Compatibility	[17]
29	External Compatibility	[17],[21]
30	Investment in compatible systems	[17]

V.A FRAMEWORK OF SUPPLIER SELECTION IN AN E-PROCUREMENT ENVIRONMENT

Supplier selection studies have dated back to as early as 1960s. Few of the more referred papers of that era due to their classical contribution are those by Busch (1962), Dickson (1966), Hakansson and Wootz (1975) and Dempsey (1978). These studies established the importance of quality of products and delivery are important factors for supplier selection [29].

Traditional methodologies of the supplier selection process in research literature include the cost-ratio method, the categorical method, weighted-point evaluations, mathematical programming models and statistical or probabilistic approaches. One of the more cited conceptual papers in supplier selection literature is that of by Weber, Current and Benton (1991) and they develop an interpretive structural model (ISM) to show the interrelationship of different criteria and their levels of importance in the vendor selection process. Their study reveals that “attitude”, “willingness for business” and “after sales service” is also important factors for supplier selection [30].

In contrast with the abundant literature dealing with various domestic supplier selection problems, previous analytical studies on international supplier selection were virtually absent in previous studies. Min (1994) introduced 7 selection criteria such as “financial terms”, “quality assurance”, “perceived risks”, “service performance”, “buyer-supplier partnerships”, “cultural and communicational barriers” and “trade restrictions” and thus addressed the geographically dispersed suppliers, increasingly getting important, with the advent of the e-procurement scenario [29].

Among recent studies, Petroni and Braglia (2000) suggested that criteria such as “management capability”, “production capacity and flexibility”, “design and technological capability”, “financial stability”, “experience” and “geographical location”, address integration capabilities of viable suppliers, and thus provide an updated framework of criteria in the era of integrated supply chain management, which seems more apt in the wake of e-procurement [31]. Bottani and Rizzi (2005) advanced their work and

incorporated electronic transaction capabilities as another key criterion consisting of electronic catalogue management, electronic order management, electronic financial management and supplier e-skills into the supplier selection framework. This was done with a strong focus to study supplier selection in the e-procurement scenario (see Fig. 2) [32]. However, it is worth stressing that the e-procurement framework presented here has to be thought of as complementary to supplier selection schemes.

This new branch to the original tree will make it possible to ponder thoroughly the aptitude of potential suppliers for electronic transactions. On the grounds of these premises, the “electronic transaction” represents the framework’s first level. The framework presented here has been developed as a hierarchy tree. The reason for this choice is twofold. First, this approach reflects the nature of the problem, where upper-level criteria are dependent on lower-level ones. This is, for instance, the case with “electronic transaction” factor, which has been found to rely upon many other criteria, such as the technical and managerial characteristics of the electronic catalogue (“electronic catalogue management”), the electronic management of orders (“electronic order management”), the automation of B2B financial settlements (“electronic financial settlements”) and the aptitude of the supplier to respond promptly to technological innovations and opportunities (“supplier e-skills”), as shown in Fig. 3 [32]. Again, under some circumstances, the second-level factors could be influenced by third level ones, and so on. A hierarchy is the best way to deal with a complex structure that can be broken down into clusters and sub-clusters, following a top-down approach.

Most of the studies in the area of supplier selection were based on empirical work and qualitative work. Very few work addressed the problem to provide decision support using analytical modeling techniques. Mandal and Desmukh (1994) used an interpretive structural modeling for vendor selection by combining both qualitative and quantitative factors. Youssef, Zairi & Mohanty (1996) developed a simple model for supplier evaluation and selection in an advanced manufacturing environment. Ghodsypour and O’Brien (1998) approached this problem with an integrated analytic hierarchy process modeled through linear programming. Weber, Current and Desai (2000) proposed a linear weighting model for supplier selection by placing a weight on each criterion and providing a total score for each supplier by summing up the supplier’s performance on the criteria multiplying them by the weights. Lam, Hu, Thomas, Skitmore and Cheung (2001) proposed a general feed forward fuzzy neural network approach for contractor prequalification and ranking of suppliers. Zaim, Sevkli and Tarim (2003) proposed a fuzzy analytic hierarchy based approach for supplier selection. Bottani and Rizzi (2005) proposed a fuzzy multi-attribute framework for supplier selection in an e-procurement environment [32]. Kubat and Yuce (2006) proposed a supplier selection methodology by integrating genetic algorithm and fuzzy analytical hierarchy process for choosing the best

supplier from a pool of supplier data points. Choi and Kim (2008) proposed a hybrid decision support model based on screening candidate suppliers first by multi-criteria decision making methodologies and then optimization modeling based on rule based reasoning for selecting highly qualified suppliers [29]. Verma and Koul (2008) proposed a methodology for dynamic vendor selection using fuzzy analytic hierarchy process for multi-criteria decision making [33].

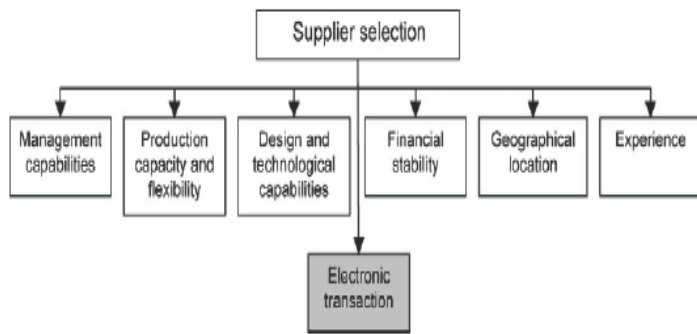


Fig. 2 the supplier selection framework in an e-procurement environment [32]

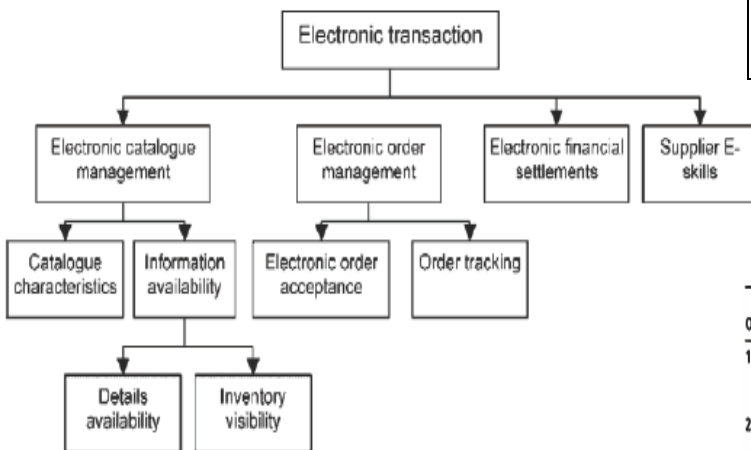


Fig. 3 the e-procurement decision tree to assess supplier aptitude for electronic transaction [32]

Today in the wake of e-procurement in B2B transactions, most of the firms have more than a single supplier supplying the same product to the firm. Strategically, being dependent on only one supplier to supply all the needs will shift the greater bargaining power from the firm to the supplier. So it would be actually beneficial to source from more than one supplier. Also, one supplier may not have the technical competence to provide for the complete requirement of the firm. So, multiple suppliers may be equally suitable for supplying a certain product and so, the firm may need to choose more than one supplier to fulfill the needs of the firm.

VI. CRITICAL SUCCESS FACTORS IN ADOPTING E-PROCUREMENT IN SUPPLY CHAINS

Puschmann and Alt (2005) conducted a research and determined a list of critical success factors (CSFs) for the implementation of e-procurement [34]. This is summarized in Table IV.

TABLE IV
E-PROCUREMENT CRITICAL SUCCESS FACTORS [34]

Introduction project	Complete implementation of e-procurement system
	E-procurement in operation, six months
	Change management system in place
Organization	Multinational enterprises with large procurement volume
	High degree of implementation
	Reorganization project as part of e-procurement project
Content and catalog management	Criteria for the development of a procurement portfolio
	Company-wide product classification scheme (e.g. UN/SPSC)
	Use of catalog hosting on the intranet
Supply chain processes and system architecture	Use of e-procurement standard software
	Internal integration with ERP systems
	External integration with e-markets
Operational efficiency	Measurement system for procurement (e.g. balanced scorecard)
	Use of key performance indicators
	ROI analysis

Puschmann and Alt (2005) further investigated those CSFs in five international companies and found that not all factors are critical in every company [34]. The results are represented in Table V.

TABLE V
E-PROCUREMENT CSFs IN FIVE INTERNATIONAL COMPANIES [34]

Object of comparison	Success factor	Babcock Borsig	Bayer	Cisco Systems	SAP	Xerox
1. Introduction project	1.1 Realignment of the purchasing organization	✓	✓	✓	✓	✓
	1.2 Preparation of catalogs	✓	✓	✓	✓	✓
	1.3 Embrace of suppliers at an early stage	✓	✓	✓	✓	✓
2. Organization	2.1 Automation of authorization workflow	✓	✓	✓	✓	✓
	2.2 Creation of a central coordination instance for supplier management	✓	✓	✓	✓	✓
3. Content and catalog management	3.1 Identification of the right e-procurement strategy for each commodity	✓	✓	✓	✓	✓
	3.2 Standardization of services for representation in the catalog	✓	✓	✓	✓	✓
	3.3 Strategy for the physical hosting of the catalogs	✓	✓	✓	✓	✓
4. Supply chain processes & system architecture	4.1 Alignment of e-procurement strategies with the procurement process	✓	✓	✓	✓	✓
	4.2 Integration of the e-procurement system with other relevant systems	✓	✓	✓	✓	✓
	4.3 Use of standards for catalogs and data interchange	✓	✓	✓	✓	✓
5. Operational efficiency	5.1 Redesign of the procurement process in order to gain efficiency improvements	✓	✓	✓	✓	✓
	5.2 Link to the balanced scorecard	✓	✓	✓	✓	✓

VII. CONCLUSIONS

This paper demonstrated the subjects of e-procurement and its applications and benefits to organizations. E-procurement in construction and its drivers and barriers were discussed and

a framework of supplier selection in an e-procurement environment was demonstrated. Finally, critical success factors in adopting e-procurement in supply chains were addressed.

The results imply that the e-procurement is expected to reduce lead time and therefore to provide agility to supply chains, strategically. It facilitates the supplier-company-customer relationships. E-procurement has an enormous amount of potential benefits like accelerate the flow of important information between the buyer and supplier, Improve buyer/supplier relationships, as mutual cooperation is required and Improve financial control by making it easier to match orders. These could be classified into strategic, operational and opportunity benefits and will vary in emphasis across different organizations, depending on how it has been implemented.

However, the construction of online procurement systems has never been easy due to the barriers created by the different hardware/software, diverse corporate culture and varying users' skills of interacting with IS/IT. This paper listed 21 drivers and 30 barriers were compiled using an extensive literature review on general e-procurement drivers and barriers from other domains (Table II and Table III).

In this study, the supplier selection framework consisting of 7 criteria has been shown and also the process of supplier selection in e-procurement requires the problem to be broken down into a hierarchy tree and considering an added sub hierarchy called electronic transaction, which facilitates quantitative decision making, using approaches such as multiple attribute decision making (MADM), analytical hierarchy process (AHP), etc. (Fig. 2 and Fig. 3)

Finally a list of critical success factors (CSFs) for the implementation of e-procurement has been shown and base on investigating those CSFs in five international companies, was found that not all critical success factors are critical in every company.

As it was mentioned in this paper, it seems that the e-procurement is a new subject and the golden key to optimizing the supply chains system. Therefore almost all the issues addressed provide new opportunities to researchers for future studies like redefine or add criteria for the selection of suppliers, ranking of drivers and barriers to e-procurement within the construction industry, develop critical success factors for the implementation of e-procurement.

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