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An Investigation on Barriers Responsible for Implementation of E-Procurement Process in Organizations using Interpretive Structural Modeling Approach

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Abstract**—***E-procurement is one of the components that can assist management in streamlining the operations resulting in an efficient supply chain process. Organizations practicing e-procurement rely on a range of information technologies to facilitate contracting and purchasing. Hence the importance of reducing procurement costs through an efficient supply chain should be a priority for any senior manager. Even though e-procurement is widely in use, factors shaping the use of e-procurement are poorly understood. Consequently, this study aims to provide an understanding of the relationship between the factors identified which have affected adoption, and the extent of adoption of e-procurement solutions. An explanatory model of the interpretation of barriers of e-procurement use has been formulated by Interpretive Structural Modeling.*

Keywords:— *E-procurement, Supply Chain Management, Interpretive Structural Modeling.*

1. INTRODUCTION

The trend towards globalization and increased competitiveness across markets has meant that many businesses are looking at solutions to increase efficiency. Many companies are looking at e-Procurement to increase efficiencies and decrease the bottom line. E-Procurement is evolving as one of the shining lights in the evolving e-Business. The Internet has had revolutionary effects on corporate purchasing practices. The overall productivity of the manufacturers often depends on their efficiency in purchasing those inputs. E-procurement sites, also known as business-to-business (B2B) marketplaces, electronic supply chains, trading hubs, or trading communities, are essentially Web-based procurement networks in which one or more companies try to source their suppliers at the lowest costs possible. At one stage the companies used to spend a lot on their supply chain, this has been significantly changed due to e-procurement.

2. FUTURE OF E-PROCUREMENT

With increasing competitive pressures, supply chain management professionals must continually find ways to reduce costs, increase efficiency, and reduce lead time. This comes as no surprise; given one of the key competitive priorities for the 21st century is the maximization of Internet-based technologies such as E-procurement. Companies are gradually moving their procurement functions such as sourcing, negotiating with suppliers, and coordination with research and development (R&D) onto the Internet. E-procurement results in greater

control and flexibility along with cost savings in the procurement operations and provides suppliers with the ability to become more proactive in the way they do business.

Definitions

E –Business: A business dedicated to the technological advancement of information processing and communication network for implementing its business process or completely reinventing its business model, is said to be E-Business.

Procurement: Procurement is the combined functions of purchase planning, supplier research and selection, price negotiation, supply contract negotiation, inventory control and disposal operations.

E-procurement*:* E-procurement has been defined as the use of information technologies to facilitate business-to-business (B2B) purchase transactions for materials and services.

Supply Chain: Supply chain includes the group of all activities concerned to flow of production of products from the stage of raw material to the delivery of customer with proper information management.

Benefits of E-procurement

- Price reduction
- Shortened process cycle times
- Improved visibility of customer demand
- Increased accuracy of production capacity
- Enhanced decision making
- Improved market intelligence

3. LITERATURE REVIEW

Procurement usually represents one of the largest expense items in a firm's cost structure. Recently, attention has been given to the impact of Information Technology on procurement practices. E-procurement is the fastest-growing software segment, followed by customer relationship management, supply chain management, and enterprise resource planning. Six forms of E-procurement have been classified [2], including e-ordering/ e-Maintenance Repair Operate (MRO), web-based enterprise resource planning (ERP), e-sourcing, e-tendering, e-reverse auctioning/e-auctioning and e-informing.

Min and Galle (1999) investigate the determinants of e-commerce usage for procuring activities from the perspective of the buyer. They argue that adoption of e-commerce for procurement is greater for larger companies and for companies with a higher level of familiarity with e-commerce.

Kaplan and Sawhney (2000) developed frameworks to understand what types of exchanges would appear for different types of products and examined how exchanges may evolve. [9]

Jap and Mohr (2002) explored why some organizations are successful with E-procurement strategies while others are not. [7]

According to Kasturi (2000), E-procurement could also result in negative cost impact incurred by manufacturers such as carrying excess inventory, poor transaction turnaround times, and uncertainties in supplier inventory and production schedules. [10]

Nagle et al. (2007) explored the effects that B2B relationships have on E-procurement systems. The authors performed an in-depth field study in six selected companies and successfully showed that adversarial type relationships influence E-procurement systems around the sourcing phases (information gathering, supplier contact, background review and negotiation).

Kheng and Al-Hawandeh (2002) investigated the adoption of E-procurement in Singapore. Firstly, there was concern about security and privacy of procurement transaction data. Secondly, it required a

significant investment in hardware, software, and personnel training to participate in E-procurement which is prohibitive. Thirdly, the laws governing B2B commerce, crossing over to E-procurement, are still undeveloped.

According to Dooley and Purchase (2006), research indicates that E-procurement is being implemented slowly in many organizations, especially government organizations. Their research investigates positive factors influencing E-procurement intentions within semi-government organizations. Research into government organizations has highlighted a number of factors that may influence this approach: inflexibility of organizational structures; lack of financial investment; lack of skills and training; and not suited to traditional government practices [15].

Matsuda (2000) investigated the barriers for the adoption of the Japanese electronic produce market system (EMS) by examining the current status of the produce market, and suggested a way to implement EMS under the current status around such market. [14]

Johnson and Whang (2002) investigate the success factors and challenges to the implementation of E-procurement, one initiative that promises to deliver significant savings to the organization.

4. FACTORS INFLUENCING ADOPTION OF E-PROCUREMENT

Organizational factors

Reasons for this include owner attitudes, resource poverty, limited IT infrastructure and limited knowledge and expertise with information systems [6].

Readiness factors

Buyers have indicated they are willing to use E-procurement, but they perceive that their suppliers are not able to participate. Buyers then have the choice of either limiting the extent of their E-procurement processes (reducing the benefits obtained) or finding new suppliers who are willing to conduct transactions electronically.

Supply factors

E-procurement can have an effect on trust in supply chain relationships [4]. Lack of assistance and the structural inertia of large organizations in supply chains can be a disincentive to implement e-business [21].

Strategic factors

The internet will only become a powerful source of competitive advantage if it is integrated in firms' overall strategies. An e-business strategy should specify the aims, goals and context of the application [20]; these choices should be aligned with other organizational and managerial choices, and integrated with the organization's processes [5].

5. FACTORS INFLUENCING USE OF E-PROCUREMENT

The savings from e-procurement can be realized by both buyers and suppliers through appropriate management of material and administration costs.

Listed below are the factors through the analysis of the literature that have influence in the adoption or non-adoption of the e-procurement system:

Influence by buyers

Dooley & Purchase (2006) state that e-procurement should be viewed by both parties (buyer and supplier) as a tool to assist in the development of a relationship and the alignment of strategies for the future. [3] Due to the fact that buyers benefit from the implementation of e-procurement through improvement of management information across all areas of the purchasing function, have a greater management influence and control over the purchasing process [19].

Improvement of operations

Mahalik (2012) study reveals that e-procurement improves operational processes at the same time allows management to better manage its operations. [12] e-procurement technologies have the potential of reducing purchasing transaction costs as a result of simplifying the purchase process and the reduction in purchasing cycle time, which increases flexibility at the same time, improves the efficiency of the operations. [1] Operational improvements are also evident in the labor costs and increase in productivity as e-procurement technologies are capable to handle increase volumes in order processing without increasing the work force [17].

Internal support

Abu-Elsamen et al. (2010) identifies absence of technological infrastructure required to support business operations, information security as well as privacy of exchange as one of the major reason why organization do not adopt e-procurement. [1] Panda & Sahu (2012) states that push from senior management has been found to be the most important factor for successful implementation of e-procurement. [16] Dooley & Purchase (2006) also argues that staffing levels, training in new technologies, encouragement from management, sufficient financial resources and adequate budget allocation are the internal factors that are vital for an organization to adopt e-procurement technologies. [3]

6. E –PROCUREMENT BARRIERS

Despite the many advantages the implementation of an E-procurement system, very few companies are using E-procurement. However, because the growth in the usage of E-procurement has not met expectations, most recent research has been investigating the barriers to E-procurement usage [11]

The identified barriers focus on different aspects of the procurement process. They can be classified as:

- Cost focus (C)
- Supplier relationship focus (R)
- Internal organizational focus (I)
- Technological focus (T)
- External focus (Ex)

Table 1: A summary of the barriers and their corresponding focus appear.

Focus	Barrier	Code
T	Inadequate Technological Infrastructure	B1
T	Lack of skilled personnel	B2
T	Inadequate Technological Infrastructure of part-ners	B3
C	Implementation Costs	B4
I	Company Culture	B5
EX	Regulatory and Legal Controls	B6
T	Security	B7
R	Co-operation of Business Partners Capacity	B8
I	Upper Management Sup-port	B9

7. INTERPRETIVE STRUCTURAL MODELING (ISM)

Interpretive structural modeling (ISM) is a computer-assisted learning process that enables individuals or groups to develop a map of the complex relationships between the many elements involved in a complex situation. Its basic idea is to use experts' practical experience and knowledge to decompose a complicated system into several sub-systems (elements) and construct a multilevel structural model. The ISM process transforms unclear, poorly articulated mental models of systems into visible and well-defined models. Mandal and Deshmukh (1994) have analyzed some important vendor selection criteria with the use of ISM that shows the inter-relationships of criteria and their different levels. These criteria have been

categorized depending on their driving and dependence power. [13] Raj and Attri (2011) have applied Interpretive Structural Modeling (ISM) approach for identifying and analyzing the barriers in the implementation of Total Quality Management (TQM). [18]

ISM methodology

ISM starts with an identification of variables, which are relevant to the problem or issue, and then extends with a group problem solving technique. Then a contextually relevant subordinate relation is chosen. Having decided on the element set and the contextual relation, a structural self-interaction matrix (SSIM) is developed based on pairwise comparison of variables. In the next step, the SSIM is converted into a reachability matrix (RM) and its transitivity is checked. Once transitivity embedding is complete, a matrix model is obtained. Then, the partitioning of the elements and an extraction of the structural model called ISM is derived.

Structural Self-Interaction Matrix (SSIM)

ISM methodology suggests the use of the expert opinions based on various management techniques such as brain storming, nominal group technique, etc. in developing the contextual relationship among the variables.

Keeping in mind the contextual relationship for each factor and the existence of a relationship between any two factors (i and j), the associated direction of the relationship is questioned. The following four symbols are used to denote the direction of relationship between two factors (i and j):

- V for the relation from factor i to factor j (i.e., factor i will influence factor j)
- A for the relation from factor j to factor i (i.e., factor i will be influenced by factor j)
- X for both direction relations (i.e., factors i and j will influence each other)
- O for no relation between the factors (i.e., barriers i and j are unrelated).

Table 2: Based on the contextual relationships, the SSIM is developed

Structural Self-Interaction Matrix (SSIM)									
BARRIER CODE (i)	BARRIER CODE (j)								
	B1	B2	B3	B4	B5	B6	B7	B8	B9
B1		A	O	V	X	A	V	V	X
B2			O	V	A	O	V	V	A
B3				O	A	A	V	X	O
B4					O	O	A	O	A
B5						A	A	X	A
B6							V	V	V
B7								A	O
B8									X
B9									

Reachability Matrix

The next step in ISM approach is to develop an initial reachability matrix from SSIM. For this, SSIM is converted into the initial reachability matrix by substituting the four symbols (V, A, X or O) of SSIM by 1s or 0s in the initial reachability matrix.

The rules for this substitution are as follows:

- If the (i, j) entry is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- If the (i, j) entry is A, then the (i, j) entry becomes 0 and the (j, i) entry becomes 1.
- If the (i, j) entry is X, then the (i, j) entry becomes 1 and the (j, i) entry also becomes 1.
- If the (i, j) entry is O, then the (i, j) entry becomes 0 and the (j, i) entry also becomes 0.

Table 3: Initial Reachability Matrix

INITIAL REACHABILITY MATRIX										
BARRIER CODE (i)	BARRIER CODE (j)									DRIVING POWER
	B1	B2	B3	B4	B5	B6	B7	B8	B9	
B1	1	0	0	1	1	0	1	1	1	6
B2	1	1	0	1	0	0	1	1	0	5
B3	0	0	1	0	0	0	1	1	0	3
B4	0	0	0	1	0	0	0	0	0	1
B5	1	1	1	0	1	0	0	1	0	5
B6	1	0	1	0	1	1	1	1	1	7
B7	0	0	0	1	1	0	1	0	0	3
B8	0	0	1	0	1	0	1	1	1	5
B9	1	1	0	1	1	0	0	1	1	6
DEPENDANCE POWER	5	3	4	5	6	1	6	7	4	

1* entries are included to incorporate transitivity to fill the gap, if any, in the opinion collected during development of structural self-instructional matrix. After incorporating the transitivity concept as described above, the final reachability matrix is obtained.

Table 4: Final Reachability Matrix

FINAL REACHABILITY MATRIX										
BARRIER CODE (i)	BARRIER CODE (j)									DRIVING POWER
	B1	B2	B3	B4	B5	B6	B7	B8	B9	
B1	1	1*	1*	1	1	0	1	1	1	8
B2	1	1	1*	1	1*	0	1	1	1*	8
B3	0	0	1	1*	1*	0	1	1	1*	6
B4	0	0	0	1	0	0	0	0	0	1
B5	1	1	1	1*	1	0	1*	1	1*	8
B6	1	1*	1	1*	1	1	1	1	1	9
B7	1*	1*	1*	1	1	0	1	1*	0	7
B8	1*	1*	1	1*	1	0	1	1	1	8
B9	1	1	1*	1	1	0	1*	1	1	8
DEPENDANCE POWER	7	7	8	9	8	1	8	8	7	

Level Partitions

From the final reachability matrix, for each factor, reachability set and antecedent sets are derived. The reachability set consists of the factor itself and the other factor that it may impact, whereas the antecedent set consists of the factor itself and the other factor that may impact it. Thereafter, the intersection of these sets is derived for all the factors and levels of different factor are determined. The factors for which the reachability and the intersection sets are the same occupy the top level in the ISM hierarchy. The top-level factors are those factors that will not lead the other factors above their own level in the hierarchy. Once the top-level factor is identified, it is removed from consideration. Then, the same process is repeated to find out the factors in the next level. This process is continued until the level of each factor is found. These levels help in building the diagraph and the ISM model.

Table 5: Partition of Reachability Matrix

PARTITION OF REACHABILITY MATRIX				
BARRIER NO.	REACHABILITY SET	ANTECEDENT SET	INTERSECTION	LEVEL
B1	B1,B2,B3,B4,B5, B7,B8, B9	B1,B2,B5,B6,B7, B8,B9	B1,B2,B5,B7,B8, B9	
B2	B1,B2,B3,B4,B5, B7,B8, B9	B1,B2,B5,B6,B7, B8,B9	B1,B2,B5,B7,B8, B9	
B3	B3,B4,B5,B7,B8, B9	B1,B2,B3,B5,B6, B7,B8,B9	B3,B7,B8,B9	
B4	B4	B1,B2,B3,B4,B5, B6,B7,B8,B9	B4	1
B5	B1,B2,B3,B4,B5, B7,B8,B9	B1,B2,B3,B5,B6, B7,B8,B9	B1,B2,B3,B5,B7, B8,B9	
B6	B1,B2,B3,B4,B5, B6,B7,B8,B9	B6	B6	
B7	B1,B2,B3,B4,B5, B7,B8	B1,B2,B3,B5,B6, B7,B8,B9	B1,B2,B3,B5,B7, B8	
B8	B1,B2,B3,B4,B5, B7,B8,B9	B1,B2,B3,B5,B6, B7,B8,B9	B1,B2,B3,B5,B7, B8,B9	
B9	B1,B2,B3,B4,B5, B7,B8,B9	B1,B2,B3,B5,B6, B8,B9	B1,B2,B3,B5,B8, B9	

Table 6: Iteration 1

ITERATION 1				
BARRIER NO.	REACHABILITY SET	ANTECEDENT SET	INTERSECTION	LEVEL
B1	B1,B2,B3,B5,B7, B8,B9	B1,B2,B5,B6,B7, B8,B9	B1,B2,B5,B7,B8, B9	
B2	B1,B2,B3,B5,B7, B8,B9	B1,B2,B5,B6,B7, B8,B9	B1,B2,B5,B7,B8, B9	
B3	B3,B5,B7,B8,B9	B1,B2,B3,B5,B6, B7,B8,B9	B3,B7,B8,B9	
B5	B1,B2,B3,B5,B7, B8,B9	B1,B2,B3,B5,B6, B7,B8,B9	B1,B2,B3,B5,B7, B8,B9	2
B6	B1,B2,B3,B5,B6, B7,B8,B9	B6	B6	
B7	B1,B2,B3,B5,B7, B8	B1,B2,B3,B5,B6, B7,B8,B9	B1,B2,B3,B5,B7, B8	2
B8	B1,B2,B3,B5,B7, B8,B9	B1,B2,B3,B5,B6, B7,B8,B9	B1,B2,B3,B5,B7, B8,B9	2
B9	B1,B2,B3,B5,B7, B8,B9	B1,B2,B3,B5,B6, B8,B9	B1,B2,B3,B5,B8, B9	

Table 7: Iteration 2

ITERATION 2				
BARRIER NO.	REACHABILITY SET	ANTECEDENT SET	INTERSECTION	LEVEL
B1	B1,B2,B3,B9	B1,B2,B6,B9	B1,B2,B9	
B2	B1,B2,B3,B9	B1,B2,B6,B9	B1,B2,B9	
B3	B3,B9	B1,B2,B3,B6,B9	B3,B9	3
B6	B1,B2,B3,B6,B9	B6	B6	
B9	B1,B2,B3,B9	B1,B2,B3,B6,B9	B1,B2,B3,B9	3

Table 8: Iteration 3 & 4

ITERATION 3				
BARRIER NO.	REACHABILITY SET	ANTECEDENT SET	INTERSECTION	LEVEL
B1	B1,B2	B1,B2,B6	B1,B2	4
B2	B1,B2	B1,B2,B6	B1,B2	4
B6	B1,B2,B6	B6	B6	
ITERATION 4				
BARRIER NO.	REACHABILITY SET	ANTECEDENT SET	INTERSECTION	LEVEL
B6	B6	B6	B6	5

Level Identification

Table 9: Iteration 5

BARRIER NO.	REACHABILITY SET	ANECEDENT SET	INTERESECTION	LEVEL
B1	B1,B2	B1,B2,B6	B1,B2	4
B2	B1,B2	B1,B2,B6	B1, B2	4
B3	B3,B9	B1,B2 B3,B6, B9	B3,89	3
B4	B4	B1,B2 B3,B4, B5, B6, B7,B8,B9	B4	1
B5	B1,B2 B3,B5, B7, B8, B9	B1,B2 B3, B5, B6, B7,B8,B9	B1,B2 B3,B5, B7,B8,B9	2
B6	B6	B6	B6	5
B7	B1,B2 B3,B5, B7,B8	B1,B2 B3,B5, B6, B7,B8,B9	B1,B2 B3,B5, B7,B8	2
B8	B1,B2 B3,B5, B7,B8,B9	B1,B2 B3,B5, B6, B7,B8,B9	B1,B2 B3,B5, B7,B8,B9	2
B9	B1,B2 B3, B9	B1,B2,B3,B6,B9	B1,B2,B3,B6,B9	1

Digraph

A digraph is used to represent the elements and their interdependencies in terms of nodes and edges or in other words digraph is the visual representation of the elements and their interdependence. In this development, the top level factor is positioned at the top of the digraph and second level factor is placed at second position and so on, until the bottom level is placed at the lowest position in the digraph.

The structural model is generated from initial reachability matrix. If there is a relationship between the criterions i and j, this is presented by an arrow which points from i to j. This graph is called as an initial directed graph, or initial digraph. As there is a relationship between the criterions, an arrow represents this.

MICMAC Analysis

MICMAC analysis is used to determine the driving power and dependency of all the barriers. The driver - dependency diagram is divided into four quadrants and on x-axis we have dependency and on y-axis we have driving power. All the barriers are plotted on this diagram based on their driving power and dependency, the plot is as shown in Figure.

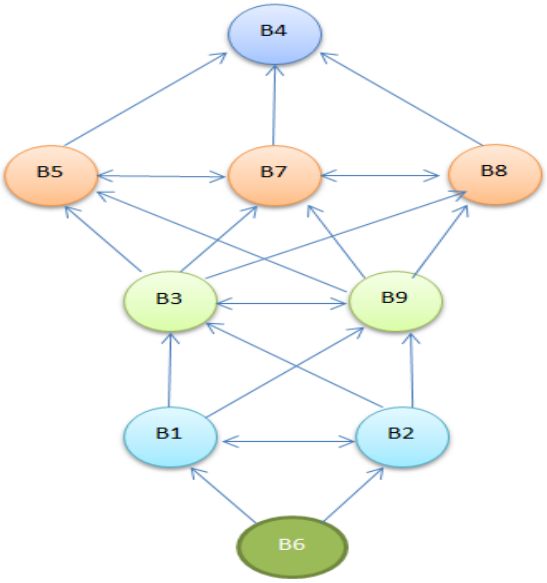

Figure 1: Final Diagraph depicting the relationship between E-procurement barriers

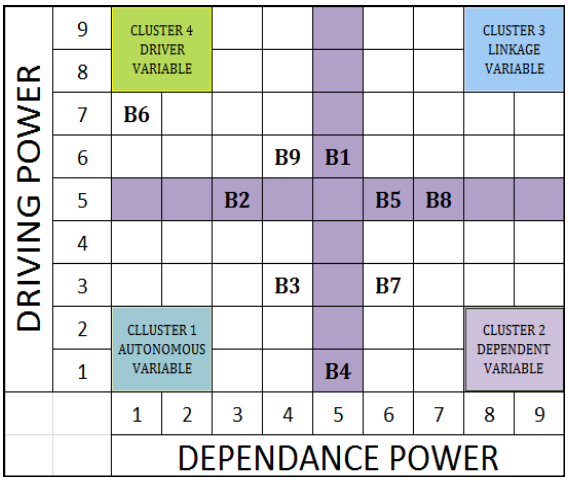

Figure 2: Micmac Analysis

- Cluster I contains barriers with weak driving power and dependency.

These barriers are often not related to the other barriers and have only a few links, which may be strong. They are also known as autonomous barriers.

- Cluster II contains barriers with strong dependency and weak driving power. They are also known as Dependent barriers.
- Cluster III contains barriers with strong driving as well as dependency power. They are often referred as linkage barriers.
- Cluster IV contains barriers with weak dependency and strong driving power. They are often referred as Independent barriers. They have a strong driving power and are less dependent on others.

ISM MODEL

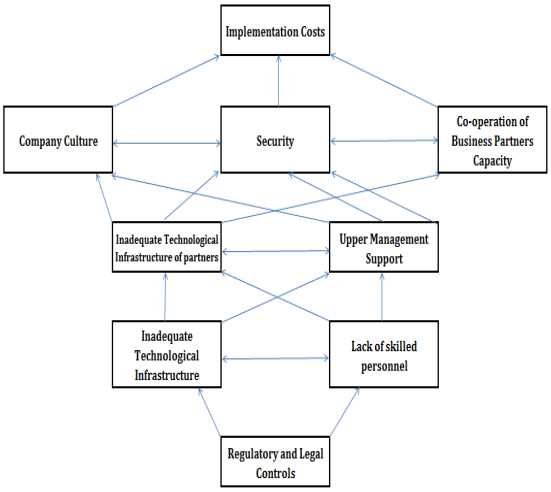

Figure 3: ISM Model

8. CONCLUSION

In this study, we have identified the barriers which inhibit the implementation of E -procurement in any organization. We have compiled a list of barriers which we extracted from a comprehensive literature review. Furthermore we have begun a brainstorming session with panel of experts and academicians from local universities regarding the inter-relation among these barriers. Then Interpretive Structural Modeling (ISM) is applied to analyze these relations and establishing the priorities of barriers according to their driving power and dependencies in the form of structured model. Legal norms for EP are required to be established. Technological infrastructure with adequate training should be provided. Management support and compatibility with partners should be achieved. Then modern culture of e-business with conformance of security should be developed. Research should be done for appropriate requirement for e-procurement activity to minimize the implementation cost. By following this sequence of process a firm can successfully implement E-procurement in the business system.

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