Modeling an Intelligent E-marketplace Software: Another Outlook of an E-commerce Environment

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Abstract

Virtual market places are known to be the most current expression of today's business-to-business electronic transactions. Through the worldwide communication network (Internet), virtual markets enable direct business relations between buyers and suppliers coming from many different horizons. These interactions bring out crucial problems such as procedures automation, transaction and market analysis, decisions taking, value added services and pricing negotiations, which need to be solved in order to create an e-market forum where participants benefit from its offers. Our contribution in the building of such an infrastructure focuses on the architectural design of an embedded knowledge management module intelligent enough to streamline the process of tackling the above mentioned aspects of a business-to-business (B2B) e-marketplace.

1. Introduction

Internet is becoming more and more unavoidable in today's business-to-business (B2B) transactions. Strategically a superior supply chain will increase a business's responsiveness and competitive advantage [1]. According to Aberdeen Group, organizations spend over US$ 20 trillion on external goods, services and procurement [2]. Commercial exchanges are now made through a new medium called e-marketplace that could be downsized to specific domains such as the procurement process of an enterprise. Thus, one very important application of B2B marketplace is e-procurement. Transaction cost economics describes the economic activity between firms in terms of two competing costs; production costs and transactions costs. Production costs are the actual prices paid for goods or services. Transaction costs are those additional costs incurred in undertaking the transaction [3]. The growth of online procurement is undeniable as organizations are more willing to shift the focus from reducing the cost of transactions to reducing the cost of materials and services for production [4].

Taking a look back into the e-marketplaces' boom of the 2000s [5], results show that e-marketplaces have experienced various fortunes. Some (such as Covisint in the automotive sector, Altra in the energy sector) are thriving while others (such as Chemdex, MetalSpectrum, GoFish, e-chemicals) have closed. Of course there are various reasons to those failures which span from the viability of some business models to the reluctance of suppliers to participate in marketplaces. However, one important aspect of the failures resides in the technical issues faced by participants in marketplaces. Building an e-marketplace involves many complex tasks to achieve and a lot of information to process and to manage. Furthermore, the fact that marketplaces are often in a fast-paced state of change, does not facilitate the matter. Such a complex system comes into being when someone can visualize how new technologies can make things less intricate.

This paper discusses our experiences in building a solution tuned specifically to the e-procurement process for a single company or consortium of companies with similar interests in procurement. However, rather that presenting all aspects of the software, we focus our description on how knowledge management or intelligence could easily be integrated in the solution. The paper commences with a description of the type of e-marketplace we experience along with its objectives. The problematic of intelligence in an e-marketplace is then introduced and an architectural design for its integration in the software solution is presented. Concluding remarks are found at the end of the document.

2. E-commerce, e-marketplace and e-procurement

2.1. Defining e-commerce and e-marketplace

E-commerce can be defined as any electronic communication that enables goods and services exchange or any other assets transaction between buyers and suppliers. It includes operations like electronic data interchange (EDI), electronic banking operations or other online services [6]. These activities are of daily concern to enterprises and are very present in a new concept that appears because of inter-enterprises relationships: Business-to-Business e-marketplaces.

Due to the significant amount of change that has occurred in e-marketplaces' lifetimes, there are various definitions of what constitutes an e-marketplace. According to T.J. Strader and M.J. Shaw [7], an e-marketplace is "an inter-organizational information system that allows the participating buyers and sellers to exchange information about prices and product offerings". For Choudhury et al. [8], it's "an inter-organizational system through which multiple buyers and sellers interact to accomplish one or more of the following market-making activities:

- Identifying potential partners
- Selecting a specific partner
- Executing the transaction".

For A. White et al. [3], "e-marketplaces are web-based systems which enable automated transactions, trading or collaboration between multiple business partners."

Thus, from a simplistic point of view, B2B e-marketplaces could be seen as electronic versions for traditional market places. They are a unique place, an electronic interface where buyers and sellers meet and realize transactions. The aim of an e-marketplace is to establish relations between buyers and sellers of a given sector, to establish a trusted environment for market actors. Its goal is to supply information, and especially to permit transactions between enterprises, and also to integrate all these processes into their information system. The market place offers many services like sourcing, buying through catalogs, request for proposals, request for quotation, and auction transactions [9].

2.2. Types of e-marketplaces

Depending on various factors e-marketplaces can be divided into wide range of categories. A number of papers and reports have sought to classify them. A summary of this classification is shown in Table 1[3]. There is a slight variation categorizing e-

Table 1. Summary of e-marketplace classification [3

Classification of e-marketplaces	Categories within classification
Industry orientation – based upon the number of industries served by the marketplace and the range of goods offered	Vertical marketplaces – provide products and services that are specific to a particular industry. Horizontal marketplaces – provide products and services that are used by many different industries, sometimes termed maintenance, repair and operations (MRO) Diagonal marketplaces – specialize in providing a tailored service to support a specific type of buyer or seller, or specific type of product category across multiple industries
Marketplace Ownership – based upon the number of owners and their role in the marketplace	Third party or public marketplaces – owned and operated by one or more independent third parties. Consortium marketplaces – formed by a collaboration of firms that also participate in the marketplace either as buyers or suppliers. Private marketplaces – formed when a single company develops an electronic network to undertake trading with either their customers or suppliers or both of these parties
Bias of the marketplace	Neutral – does not favor either buyers or sellers. Biased to one of these two groups; in which case they are termed either 'buyer orientated' or 'seller orientated'
Nature of sourcing relationship	Systematic sourcing – where relationships are established between buyers and sellers. Spot sourcing – where the buyer's only goal is to find the required products at the lowest cost
Nature of items purchased through marketplace	Direct goods – inputs to the products or services manufactured. Indirect goods – not directly input to the goods and services produced by the firm, but necessary for the effective operation of the firm itself

marketplace based on the marketplace ownership classification (as mentioned in the table) [9]:

- "buyer-driven" e-marketplace. This type of e-marketplace is set up by a single company (or a group of associated companies). Thus, the market maker is also the sole buyer in the marketplace (one buyer, multiple suppliers).
- "supplier-driven" e-marketplace. This is the reverse of the previous type of e-marketplace. In this case there is one supplier (a single company or a group of associated companies) and multiple buyers. There is no transactions billing as is the case of other categories.
- "third-party" e-marketplace. As stated in Table 1, it is a public market with multiple buyers and sellers. The market maker is an independent company distinct from participants on the market.

2.3. Advantages of e-marketplaces applied to e-procurement

Referring to e-commerce, e-procurement (or e-commerce for procurement) could be defined as the use of electronic technologies to streamline and make more efficient the procurement activities of a business [10]. These electronic technologies are numerous and lead to a variety of forms of e-procurement, including:

- Products and services ordered from electronic catalogs
- Any form of electronic exchange of tender and contract documentation
- Procurement processes integration with both buyers' and suppliers' financial and inventory control software packages.
- Etc…

"Early attention to e-marketplaces focused on their potential to lower costs of doing business. […] By lowering search costs and making it easier to match buyers and sellers, e-marketplaces raised the possibility that firms could conduct large volumes of their B2B transactions using dynamic channels such as auctions and exchanges. Later, e-marketplaces sought to provide value by offering services to facilitate collaboration and information-sharing, rather than just online commerce. […] The e-marketplaces also sought to improve supply chain efficiency by automating business processes such as procurement, order management, and fulfillment." [11] Hence, the use of e-marketplace is another form of performing e-procurement. In fact, it is even one of the strongest media that could be used to improve companies' procurement processes.

This observation leads us in our research to focus more attention on the aspects of an e-marketplace that facilitate procurement processes of an organization, in other words looking at the e-marketplace from a buyer standpoint.

Such an e-marketplace (which is the focus of our studies) is owned by the buyer. This solution has various modules amongst which the obvious ones (with regards to the subject matter area) include purchase requisitioning, control, order and reception, invoicing, payment, sourcing, security, and even accounting or whatever item may be interesting given a specific case. The software could also be linked to the company's ERP (Enterprise Resource Planning) system or its equivalents. However we want to emphasize on the digital catalog management and the intelligence (precisely negotiation process) modules.

The buyer's e-marketplace has a detailed catalog made up of items (products or services) he usually buys or is susceptible to buy from external vendors (remember the buyer could be a group of companies with similar interests). This is one the critical areas of the e-procurement solution. Users should be able to quickly search and choose items they need. Thus, catalog data should be complete, conformed and well structured. Standard products codes (such as the UNSPSC-United Nations Standard Product and Services Code) should be used to facilitate hierarchical, grouped or fuzzy logic searches. This also helps vendors to quickly find and register in the
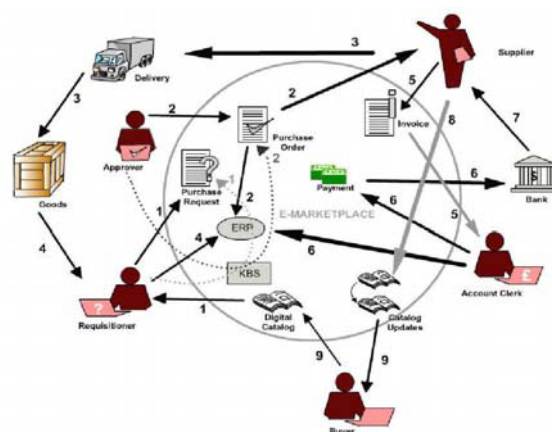

Figure 1. E-procurement process streamlined through the use of a "buyer-driven" e-marketplace.[12].
ERP = Enterprise Resource Planning; KBS = Knowledge-Based Sytem. 'Approver', 'Requisitioner', 'Buyer' and 'Account Clerk' are departments (UML actors) from the buyer entity. 'Supplier' is the equivalent of the vendor side.
NB: 'Bank' is not an active actor of the e-marketplace, but rather an external partner

Table 2. Figure 1, e-procurement process activities [10]

Activity Number	DESCRIPTION
1	The requisitioner selects items from the catalog and requests a purchase order, using or not the intelligence module (KBS) which introduce competition amongst vendors supplying the selected products
2	The approver approves the purchase request also using or not the KBS module. Preferably he will use it. He then notifies the winner or selected supplier by issuing a purchase order with agreed conditions and save the transaction. Issuing the purchase order is still done within the e-marketplace
3	The supplier receives the order in its view of the marketplace and ship the ordered products
4	The requisitioner receives the goods and notifies the ERP system of the delivery effectiveness.
5	The supplier sends the invoice through the system and the account clerk is notified.
6	The account clerk performs through the system a cross-check of the invoice, the delivery and the purchase order. When everything is ok he orders the payment.
7	Bank payments are notified to the supplier and books are updated after reconciliations (preferably with the e-payment module)
8	At any moment, a supplier can modified his selling nominal conditions, as well as products properties. He can select another item that he wants to supply
9	The buyer maintains the catalog, approves or rejects any vendor proposition be it subscription or catalog modification

catalog what items they could supply. When registering any product they may supply vendors who are participants to the e-marketplace also indicate a 'nominal' price that could have been pre-negotiated between the buyer and the vendor at the vendor acceptance into the marketplace. Apart from price, some product-related selling conditions or value added services are mentioned by vendors. These include elements like product availability,

quality, ship delays, promotion campaign, reduction options, etc… These conditions are extremely important to enable the e-marketplace not to be just a web portal of vendors, but rather a medium to improve the procurement process. Those conditions are part of the input the intelligence module needs to be 'intelligent'. They constitute part of the information that builds the knowledge of the e-marketplace, knowledge that can rapidly grow and needs the intelligence module to manage it. We will look at this aspect in more detail in the next section. Figure 1 and table 2 show an overview of the e-procurement process within the e-marketplace.

On the overall, e-procurement done through an e-marketplace can significantly improve a buyer's efficiency. Business transactions are normally very sensitive to the information factor. Due to geographical fragmentation, buyers may not be well informed, because of not being exposed to diverse alternatives. By using an open place accessible from virtually everywhere, the right information can now be sent at the right moment to the right destination which is made up of several complex organizations rather than being issued to a single company. Using Internet also enables companies to control their supply chains since the have access to information.

Another aspect that helps procurement processes to be streamlined is transparency. Transparency, which is a key element of an e-marketplace, which is apparent through the following three main dimensions [10]:

- the price
- availability and the product
- multiple suppliers, multiple alternatives

Having the right information in three dimensions could substantially change the buyer's behavior and decisions he has to make regarding his procurement activities. Multiple sellers on the marketplace bring competitive pricing. Prices are more subject to become uniform because of the competition between suppliers. Furthermore, this will even force suppliers to become specialized and/or form virtual dynamic companies to remain competitive. All those transformations are to benefit buyers who can therefore afford to build and implement good procurement and supply chain policies because of the clear picture the have.

A summary of advantages gained in practicing e-procurement through an e-marketplace is as follows:

- better information through multi-criteria search of the catalog
- information flow securities
- Procurement cycle reduced
- Unique portal for purchases
- Buyer orders easily aggregated

- Reduced direct and indirect costs
- Administrative tasks alleviated
- Focus activities on more strategic missions
- Improved information quality
- Improved buyer's customer satisfaction
- Better budget control

Higher level efficiencies come to light through e-marketplaces. E-marketplaces encourage simplicity in needs expression and facilitate data transmission. There is a cheaper and pertinent search for vendors, products, services and overall an intelligent business management for the company. Figures 2 and 3 below show some use cases diagrams of the solution we are presenting.

3. Intelligence in an e-marketplace

3.1. Negotiation processes within the knowledge management

Logics of financial flow of incomes on the marketplace are very complex. There is a collection of fix and variable fluctuating payments. A payment, to be agreed upon must fulfill logics of payments based on transaction, on fixed prices or based on volumes. All those requirements constitute a lot of information that has to be managed. Furthermore, for the market to be more efficient, it must include, as we earlier mentioned, the concept of transparency, which implies that market actors can change their habits.

We experienced a buyer-driven e-marketplace where suppliers offer products and services to sell and the buyer discuss prices, propose exchanges or adhere to procedures offered. It is a portal web site that includes different functionalities. In our solution, apart from the management of catalog contents, another key area is the powerful negotiation process which constitutes part of the knowledge management or intelligence module, along with the management and use of historical information on any single transaction and vendors' behaviors during daily marketplace activities. The negotiation process is divided into different packages including:

- Negotiation of buying and selling conditions with a particular supplier. This could follow a previous direct contact between the two parties. It is an interface for traditional negotiation made up of textual propositions and concessions. The process continues until a common agreement or final divergence appears. All the negotiations take place within the marketplace. This is more related to buyer-supplier established relationship.

- Competition between suppliers based on optimal buying conditions required by the buyer. The system finds out how it can progressively infer selling conditions for each vendor until optimum conditions are obtained (No other inference is possible). This results as a dynamic pricing process intended to lower prices for equivalent selling conditions.
- Online reverse auction. The buyer makes a request for quotation for a specified item, fixing starting buying conditions (price, quality, quantity, delay, etc). Suppliers are then selected through a reverse auction where the price is decreasing until one supplier wins the auction.
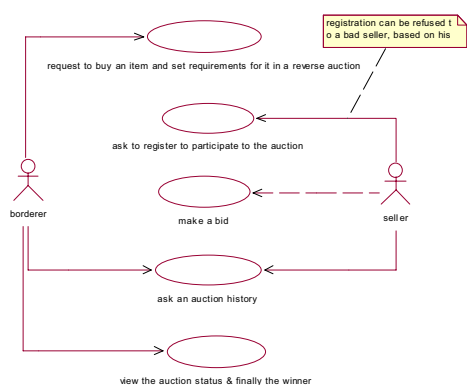

Figure 2. Use Cases diagram: auction competition.

3.2. The concept of e-intelligence

B2B e-marketplaces bring out crucial problems within its process, which are procedures automation, transactions and market analysis, decision taking and taking into account of previous activities. Obviously there is a problem of knowledge management, which justifies one of the new concepts regularly encountered in modern enterprises, that results from the putting online virtually all activities related to the economy of the enterprise: e-intelligence.

E-intelligence is defined simply as the online management of knowledge. In a context of online economic transactions, it should be made possible for users to obtain and rapidly analyze specialized information that concerns their needs within the time they need it.

The negotiation processes, particularly the last two mentioned above (competition and reverse auction), that occur within the e-marketplace are, in fact, a large set of business rules that are put into play. Products within their categories, their quality, minimum stock, availability, ship delays, prices, and
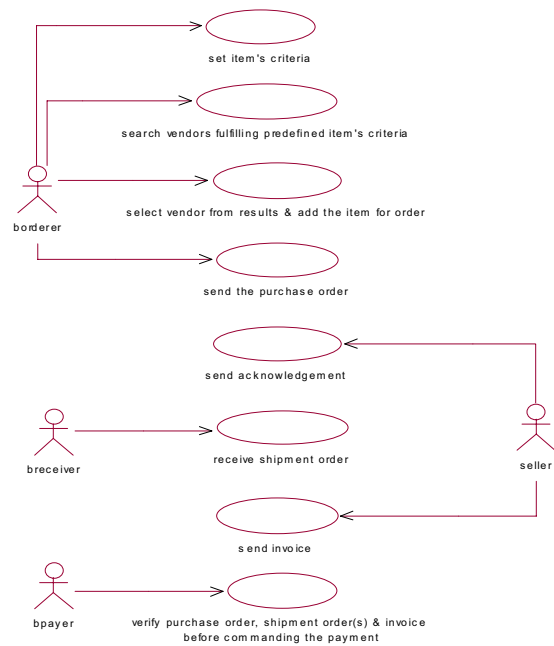

Figure 3. Use Cases diagram: purchase process.
The 'b' before the actors 'borderer', 'breceiver' and 'bpayer' mean buyer.

other properties are expressed in terms of rules. Discounts based payments delays as well as on quantities, vendors' promotions or periodically special offers, value added services are also expressed as business rules (NB: It should be possible at any given moment during the marketplace lifecycle to add, delete or modify those rules). All those rules are then categorized. Categories and rules within the respective categories are prioritized or weighed. A more sophisticated approach would be to define rules on how to apply the previous rules during negotiation processes. This later approach is obviously more complicated and will require a different context to smoothly be deployed and maintained.

3.3. Using a Knowledge-Based System

The main impediment to the rules handling we have just presented in the previous section resides in the ability to programmatically express them; to represent them is such a way that they could be integrated in a software package.

One way of managing knowledge online is through Knowledge-based systems (KBS). Knowledge-based systems are regularly used to facilitate means of resolving recurrent problems, problems requiring many production rules or problems of classification, decision, conception and expectation [13].

A KBS, especially an Expert System (ES) is made up of two independent parts:

- The knowledge base which consists of:
  - The rules base which models the knowledge of the considered domain
  - The facts base which contains facts and data particular to a problem to be solved in a considered domain.
- The inference engine, the heart of the system, which is capable of "reasoning" using information contained in the knowledge base.

The independence between the knowledge base and the inference engine is an important element for the system. It allows knowledge representation purely in a declarative way, without any link with the method of using that knowledge. This also makes it possible to have evolving data without constantly changing reasoning mechanisms. We only have to organize and formalize the knowledge base, seeing meanwhile which strategies could be considered for rules utilization.

The inference engine is a mechanism that permits inference of new knowledge from previous ones. It is the expression that we usually apply because of the important number of business rules to infer. Hence, the components of this type of systems even suggest that a KBS is a mean of smoothing out the above-mentioned obstacle to rules implementation.

4. Integrating intelligence into the e-marketplace

Business rules represent the practice of the decision policy for the market maker. The process of developing business rules must solve the problem of how to represent business knowledge and the utilization of this knowledge as an entire part of the e-marketplace application. Many rules have been written to formalize the market knowledge in accordance with the following two statements:

- Isolate the application business rules in specific components and separate from the entire system. This prevents the spread of knowledge management everywhere in the e-marketplace application programming.
- Represent the knowledge in an appropriate manner so that its integration in decisions taking is made easier

As mentioned in the previous section, the identification of business rules is guided by many factors like the different negotiation processes, the behavior of participants in any market transaction, selling conditions for vendors and the ways of progressively modifying these conditions, market maker's conditions, just to name some.

Relationships between these rules are very complex and frequent changes that regularly occur in the business knowledge ought to be anticipated. Thus, the key to success in designing and processing the business knowledge within production rules based systems resides in their ability to explicitly represent knowledge in the form of rules, and in a suitable format that allows one to correctly apprehend units and steps followed by business analysts in resolving complex problems. In the system we developed, we use a production rules based system without having to re-write a new inference engine.

The knowledge management architecture for the e-marketplace consists of:

- Data, which is information on specific e-market actors, elements or items of the catalogues and all activities of the marketplace (orders, buying conditions, negotiation, auctions, etc.).
- Rules. All rules should be expressed in the If-Condition-Then-Action format.
- The inference engine. We use The Java Expert System Shell (JESS) developed in the Sandia National Laboratories, Livermore, CA, USA [14]. JESS is an expert system shell and scripting language written entirely in the Java language. This has an important advantage as it can be tightly coupled to code written in Java.
- Knowledge components. The concept of knowledge component consists of encapsulating a set of rules solving a given problem, and permits to correctly manage business information. Hence knowledge management process consists of the cooperation between technologies of knowledge components encapsulation and methodologies for the design and development of business rules. We use the Component Object Model (COM) technology as the software component technology. This provides a good means to integrate business rules in the applications development, specifically the other modules of the software solution. Those components encapsulate the JESS package along with the market business rules. They then appear in the rest of the application as normal application components. Furthermore, using components also benefits the solution in reusability of those components.

The overall application architecture is a three-tier based web application. This can be seen on the figure 4 below. The figure also shows a knowledge component that appears as a normal application component.
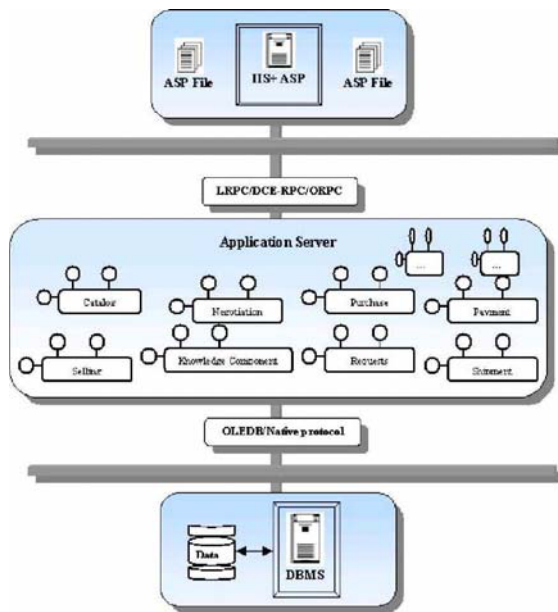
Figure 4. Application three-tier architecture.

The application server is made up of COM components comprising also knowledge components. The user service layer is done through ASP pages. Components access the database through OLEDB or any other protocol be it native or not.

ASP = Active Server Page; IIS = Internet Information Services (Microsoft Web Server); LRPC = Lightweight Remote Procedure Call; DCE-RPC = Distributed Computed Environment – Remote Procedure Call; ORPC = Object Remote Procedure Call; DBMS = Database Management System; OLEDB = Open Linking and Embedding Databases.

5. Conclusion

This paper has sought to demonstrate the use of electronic marketplace as a strong medium for any organization to improve the efficiency of its procurement process. The e-marketplace brings out specific advantages. Furthermore, building it, with embedded intelligence maximizes what is got from it. Also, we noticed that an e-marketplace linked to the company's (the buyer) ERP system (or equivalent software packages) helps in having a completely integrated solution since paper work is substantially alleviated.

All through the paper we have looked at the architectural aspects of some key areas of a buyer-driven e-marketplace. Even though our goal was to streamline the company's procurement process through the e-marketplace, we focused our description solely at the buyer's point of view. Although we were looking at the buyer's advantages, we strongly recommend that looking at a buyer-driven framework should also be targeted from a vendor perspective. The risk of existing preferred buyer's suppliers to be reluctant towards the e-marketplace should thus be mitigated. The vendors' will to participate in the e-marketplace should be fostered when having that analysis of the framework.

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