

## E-Procurement System Challenges And Design: An UML Approach

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**Abstract:** Procurement is a complicated and vital process that affects the existence of any company and involved in information and money exchange among different entities in a supply chain. Coordinating and managing the supply process of different departments of a company are the main responsibilities of a procurement department and are achieved by cooperating different suppliers. However, recent advancements in internet technologies can be employed to facilitate procurement processes and make them more efficient in order to increase the productivity, profitability, and agility of an organization. Portals, as an internet based technology, can be used in procurement process to implement a sophisticated solution to overcome procurement challenges especially issues that are related to auctions. This solution offers new, low cost, and effective methods for carrying out B2B procurement that will not only facilitate the procurement processes and auctions, but increases the revenue of an organization. In this work, a conceptual design for an e-procurement portal with concentration on auctions is presented. The design is developed for a Telecommunication company and some of the system functionalities are illustrated by unified modeling language (UML) diagrams. Finally, by exploiting experts' opinions, it is shown that the design can be implemented in order to improve procurement processes and auctions.

**Key words:** e-procurement, auction, portal, UML.

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### INTRODUCTION

Recently, the emergence of new technologies and significant alterations in global markets made supply chain management more important. To stay competitive, companies need to efficiently manage their supply chain with exploiting new web-based technologies. The purchase of goods and services, as one of main task of a supply chain, that is needed to serve customer at real time is an important issue in any organization and needs at least half of companies' revenue (M. Chen and M.J. Meixell, 2003; W.J. Markham, 1999). Thus, sourcing is one of the main tasks in companies which new technologies are employed to facilitate. Systematic and spot sourcing of goods and services are two main strategies in marketplaces for corporates and businesses. Systematic sourcing is a long-term relationship with qualified suppliers. Therefore, pre-negotiation and long-term contracts are the main parts of it. Spot sourcing is usually applied in procuring immediate needs and credibility of a supplier is not as important as it is in systematic sourcing (D. Chaffey, 2007; M. Singh and D. Thomson, 2002).

E-procurement is a main technology that has been developed and employed in some companies to facilitate sourcing and procurement. E-procurement has become an indispensable tool for automating procurement in a physically distributed enterprise environment. It is important not only for global operations, but also for domestic operations, as well. According to Chaffey, "E-procurement is the electronic integration and management of all procurement activities including purchase request authorization, ordering, delivery and payment between a purchaser and a supplier" (D. Chaffey, 2007; M. Singh and D. Thomson, 2002). E-procurement is a business to business e-commerce and can be defined as applying electronic systems in procurement processes. Moreover, e-procurement provides a fair and transparent environment for auctions and enables auction managers to easily handle auction issues. In fact, managing an auction process by this system, decreases paperwork and increases efficiency. Communication channels, process of receiving auction proposals, proposal evaluation process, and auction closing and opening processes should be considered in order to switch from traditional auction process to electronic and web-based systems.

One of the electronic systems that can be embedded in an e-procurement system is portal. Portals, by providing integrated framework and connecting people and processes, have a key role in managing complexity, operational performance improvement and value adding processes. Portal technology allows the buyers and suppliers to log onto a portal site, and immediately access the structured and unstructured information. Suppliers can be given insight to the inventory levels of other partners and tune their product based on this information. Buyers can check the status of orders and received offers from suppliers and select the qualified suppliers for obtaining required goods and services. In addition, procurement process can be harmonized and simplified, by some additional significant features of portal technology. By using portal technology, a company's procurement

strategy can be defined and certain administrative tasks can be automated. Additionally the number of unprovided purchases by pre-negotiated contracts is reduced and the traceability is increased.

This paper presents a design for an e-procurement portal that can be employed in modern companies for facilitating their sourcing processes. The paper is directed as follows: in the first section, the existing literature on e-procurement and different aspects and benefits of it are presented. In the second section, the design of e-procurement system is explained. UML diagrams are used to illustrate the various aspects and benefits of the design. Finally, by exploiting experts' opinions, it is shown that the design can be implemented in order to improve procurement processes and auctions.

### **Literature Review:**

Traditional procurement systems have not been efficient; lack of prompt information and complicated processes resulting in wasted time and money. To overcome these problems, an e-procurement system can be used as a remedy by facilitating processes, providing timely and related information, and improving coordination and collaboration. Hence, e-procurement can lead to huge savings and higher productivity and efficiency (A. Gunasekaram, 2009; V. Tasis, 2006).

As mentioned, e-procurement is a web-based and technology-based solution that facilitates sourcing in companies. It has the ability to transform the purchasing process because it pervades all of the identified steps. In literature, e-procurement is defined in a way to include e-design at the specification development stage of the purchasing process, ending with the supply manager's evaluation and rating of suppliers. At the early stages, internet technologies can be a helpful tool in the process of supplier selection too. This process that is called e-sourcing starts with prequalification of suppliers through the construction of a comprehensive request for proposals and ends with the selection of final supplier. For example, FreeMarkets, a pioneer in on-line sourcing through the reverse auction process, is emerging as a leader in this area of e-procurement (W. Presutti, 2003). Moreover, the e-procurement system opens doors to purchasing networks for suppliers and buyers, expands the selection of products, and makes information more easily obtainable. e-Procurement also links a vast network of connections, and makes searching and contacting much more convenient (Y. Yu, 2008).

Boer, *et al.* state that e-procurement can be defined as using Internet in the purchasing process. Based on this definition, different forms of e-procurement can be identified. Following names have been assigned to each form by practitioners (L.D. Boer, 2002):

- E-MRO: process of creating and approving purchasing requisitions, placing orders, and receiving goods and services by using web-based software.
- E-sourcing: process that identifies new suppliers for a specific product, using web-based technologies.
- E-tendering: process of sending RFI's and RFP's to suppliers and receiving the responses of suppliers, employing web based technologies.
- E-reverse auctioning: pricing of the goods and services that are auctioned.
- E-informing: is the process of gathering and distributing purchasing information both from and to internal and external parties, using web based technologies.

According to Davila *et al.*, using e-procurement technologies helped companies to save 42 percent of their purchasing transaction costs (A. Davila, 2003). This reduction is rooted into less paperwork, which translates into fewer mistakes and a more efficient purchasing process. Moreover, the simplification of the purchasing process has an interesting impact on the purchasing cycle time too. Faster cycle time provides increased flexibility and more up-to-date information at the time of placing a purchasing order. E-procurement users also report a reduction in the number of suppliers, lower managerial complexity, better prices, and a headcount reduction in the purchasing process (A. Davila, 2003). Following issues are considered as main benefits of e-procurement (A. Gunasekaram, 2009; Bendoly and T. Schoenherr, 2005; M.J. Moon, 2005):

- Decreasing transactional costs
- Expedited ordering
- Wider ranges of buyers
- Efficient procurement processes
- Better control over procurement spending and employee compliance
- Reduced duplication in paperwork and tasks
- Reengineered procurement workflows.

In addition, Yu *et al.*, state that an increasing number of companies are interested in using an online e-auction as one of their purchasing tools. Major drivers that make them invest towards e-procurement are:

- Cutting costs
- Real-time bidding and response
- Transparency
- Shorter cycle time
- Increasing geographical outreach (Y. Yu, *et al.*, 2008).

Indirect benefits of e-procurement include a shorter cycle time between order and use of supplies, greater flexibility in ordering goods from different supplier, increased buyer productivity and lower price through product standardization and consolidation of buyers (D. Chaffey, 2007; M. Singh and D. Thomson, 2002).

The literature for procurement and portals are not very abundant. Bowman-Amuah state that B2B procurement portal is capable of producing incremental revenue to customers from their percentage of the "Acquisition fee" (M.K. Bowman, and M. Amuah, 2001). Suppliers benefit by gaining access to incremental business channels at a low cost. Furthermore, customer service is guaranteed through performance bonds (M.K. Bowman and M. Amuah, 2001).

### ***System Analysis And Design:***

#### ***Analyzing An E-Procurement Portal Scenarios:***

Procurement process can be harmonized and simplified, by some additional significant features of portal technology. By using portal technology, the company's procurement strategy can be defined and certain administrative tasks are automated. Additionally the number of un-provided purchases by pre-negotiated contracts is reduced and the traceability of files is increased.

The process of organizational purchasing goods and services via portal can be done as following steps:

1. Categorized registration of a multiple supplier by an electronic registration form
2. Allowing the suppliers to access the characteristics of required items via internet and other public communication infrastructures and appealing for quotation from all around the world
3. Receiving offers from the suppliers
4. Evaluating the offers by procurement manager and selecting the qualified suppliers
5. Informing the selected suppliers via an electronic mail notice system
6. Establishment of a contract, and
7. Requiring the selected suppliers to secure a performance bond.

In this system, a validator evaluates the necessary and needed information which is submitted by suppliers through the online registration forms. Once the supplier's information confirmed, the validator puts the information in supplier database and determine an ID and password for the supplier to log into the portal.

The supplier can log into the portal and easily access the defined characteristics of the required goods and services and inform the company of its suggestions. The supplier is able to put a bid or an offer for needed goods and products as well.

The validator reviews the offers, which are received from suppliers, and validate the accuracy and format of their information. After validation of the information, the validator changes the status of the offer to "valid" in the database.

Procurement manager frequently queries the offer database to see if any new offer has been received. Procurement manager applies some established business rules to recommend the purchasing award decisions. There are some simple and more complicated rules for the award decisions like "buy from the supplier with the lowest quoted price first" or "buy from the supplier with the fastest delivery time", or a combination of additional factors such as supplier quality and historic delivery performance. As an example, total cost of ownership (TCO) can be used to rank the suppliers who are able to provide the component on time as an input to the allocation of the order if multiple suppliers are to be used. TCO is an effective tool that considers product price, the buying firm's purchasing-related costs, and expected supplier performance into the decision process. The performance metrics may include reliability costs, asset utilization, downtime and cycle time, and inventories as affected by a supplier (M. Chen and M.J. Meixell, 2003; L.M. Ellram, 1995; L.M. Ellram and S. P. Siferd, 1993). During the query, if new offer is found, the procurement manager selects the more convenient offer and marks it as successful offer.

Flourishing offers are queried by electronic mail messenger. If such offers are found, the electronic mail messenger formats an appropriate message and sends it to let the selected suppliers know about it.

In auctions the story is a little bit different. First the auction manager determines the auction specification based on the internal need for different products. Then the company will announce the auction and asks all the suppliers to put all their bids in the portal. Reaching the deadline for bids, auction manager indicates the bid with highest quality and lowest price by searching in a bid database and will inform the winner by an email which will be sent by the electronic mail messenger. The winner will accept and it will be responsible for fulfilling the order in the assured time and amount based on the bid. The portal will inform the internal sections about the bid and will let them know when they will receive the products they have requested.

### ***E-procurement Systems:***

We have reviewed the different procurement systems across the world such as Korean on-line e-procurement system (KONEPS), Global (Telekom) procurement portal, Egyptian Government procurement portal, and Canadian Bidding e-procurement portal to understand the available standards and solutions for e-procurement portals. It is categorizing the ideas and functionalities of an e-procurement portal based on our evaluation.

**Table1:** compare of e-procurement systems.

	Designed system	KONEPS	Government	Global	Biddingo
Purchasing Requirements	Organizational Departments	Korea Governmental and Private Agencies	Egyptian Governmental Organizations	Telekom Departments	Canadian Public Sectors Organizations
System Features	1. E-guarantee 2. Offer's Evaluation 3. E- catalogue 4. E-document Interchange 5. E-payment 6. E-ordering 7. E-bidding	1. E-document 2. E-guarantee 3. E-payment 4. Supplier's Evaluation 5. E-ordering 6. E-bidding 7. E- catalogue 8. E-transaction 9. EDI	1. E-document Interchange 2. E-bidding 3. E-tendering 4. E-ordering 5. E-proposal Acceptance 6. E-payment 7. E-guarantee 8. E-evaluation	1. Offer's Evaluation 2. E-document Interchange 3. E-payment 4. E-ordering 5. E-offering 6. EDI	1. E-tendering 2. E-managing of Supplier/Vendor data base 3. E-payment 4. E-ordering 5. E-bidding

**Procurement Portal Design with UML:**

This section describes the conceptual design of an e-procurement portal with Object Oriented Programming (OOP) and Unified Modeling Language (UML). UML is used to visualize, modify, construct and document the artifacts of object-oriented software that is under construction by a software team. At the center of the UML are its different kinds of modeling diagrams: use case diagram, class diagram, sequence diagram, state-chart diagram. Due to number of different diagrams that has been used in our design, in each section just a sample diagram is demonstrated.

**Actor Interaction Modeling:**

A use case diagram is a type of behavioral diagram to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor (C. Larman, 2001). According to the mentioned objects in the scenario, the actors and use cases of e-procurement portal can be defined as following (Table 2):

**Table 2:** actors and use cases of e-procurement portal.

Actor	Responsibility
Procurement manager	Supplying of the required goods and services of other departments, receiving of purchase requests, evaluating and ranking the requests, sending RFQ to suppliers, receiving offer, evaluating the receiving offers, selecting the supplier, sending order and modifying or canceling orders
Validator	Surveying information entered by suppliers, receiving the suppliers' information and their catalogues, surveying the receiving information, recording the offers and bids information, recording the catalogue information and informing suppliers about errors and problems.
Electronicmail messenger	Informing of suppliers about their offers and bids status, querying in offer and bid database, adjusting electronic mail notification messages and sending them to the selected suppliers
Supplier	Supplying needed goods and services of the organization, registration and entering information, offering or bidding, canceling or modifying the bid or offer, presentation catalogues and related documents, securing a performance bond and supplying the orders
Auction manager	Setting up the auction, sending RFQ, receiving of bid, evaluating the bid, submitting the bid, determining winner, canceling the auction, editing and adding rules
Treasurer	Receiving and handling the collateral money, reporting managers about transactions and paying order expenses
Departments	Sending internal requests, approving received orders from suppliers and modifying internal requests due to change request from procurement department
Financial manager	Managing of purchase documents, allocating necessary credit to the purchase requests, and surveying the estimated expense

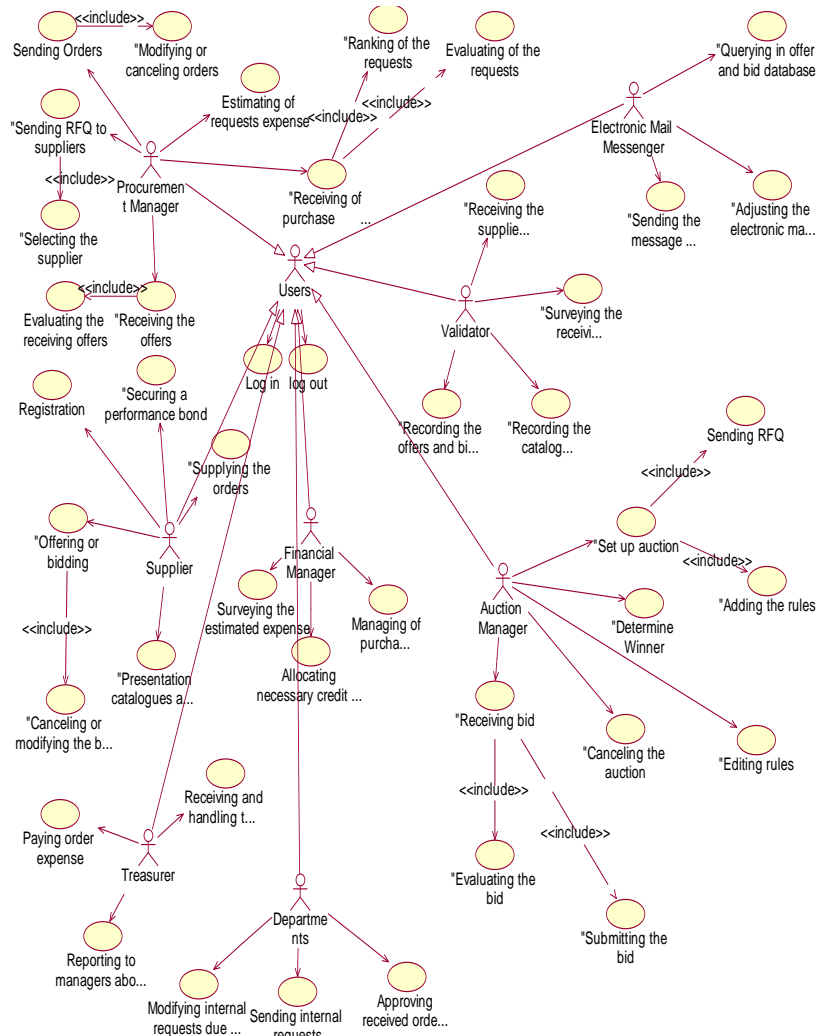
**System Main Entities:**

To identify and illustrate the main entities of the system, class diagram is used. A class diagram is a static diagram that is used to describe the structure of a system by showing classes, their attributes, their methods, and the relationships between the classes (C. Larman, 2001). The main classes in the e-procurement portal system are auction, bid, order, supplier, procurement manager, and auction manager. Each of them has some responsibilities and associations to other classes. Auction manager is responsible for handling issues related to auction and has direct relationship to auction class. Supplier as a main user is connected to many main classes such as offer, catalogue, and contract.

**Entities Interaction and Object Life Cycle States:**

To illustrate the interaction of different entity and classes of the system, sequence diagram is used. A sequence diagram is a powerful diagram in UML that shows different processes or objects that live

simultaneously and their exchanged messages in order they occur (C. Larman, 2001). As an example, Figure 3 shows the specification of an auction runtime scenario in a graphical manner. This sequence diagram indicates a series of operations performed by an auction manager to procure component, material or services from suppliers. In the diagram a supplier is modeled as an object. The methods or operations of the supplier class are the messages. The object of Auction manager calls an object of Auction to set up an auction. Then the auction manager requests for quotation from all qualified suppliers. The Supplier object calls a Bid object to generate an Offer object with the price, delivery time, and quantity. Auction manager based on the organization's business regulations selects the most suitable bid and accomplishes the payment process.



**Fig. 1:** A sample use case diagram of an e-procurement portal.

To illustrate the life cycle of an object state-chart diagram is used. A state-chart diagram helps to represent different states of an object within the system. As an example, different states of Order object are shown in Figure 4. Orders have different states from the time of initialization by an internal entity to their fulfillment by the suppliers as follows:

**User Interface Design:**

In this section, some snapshots of system user-interfaces are illustrated. Each of these interfaces is associated to an interface class in the system class diagrams.

As it was mentioned in previous chapter, suppliers should fill out registration tab and provide all needed information. In the e-procurement portal, suppliers can access the registration form according to the form in Figure 5.

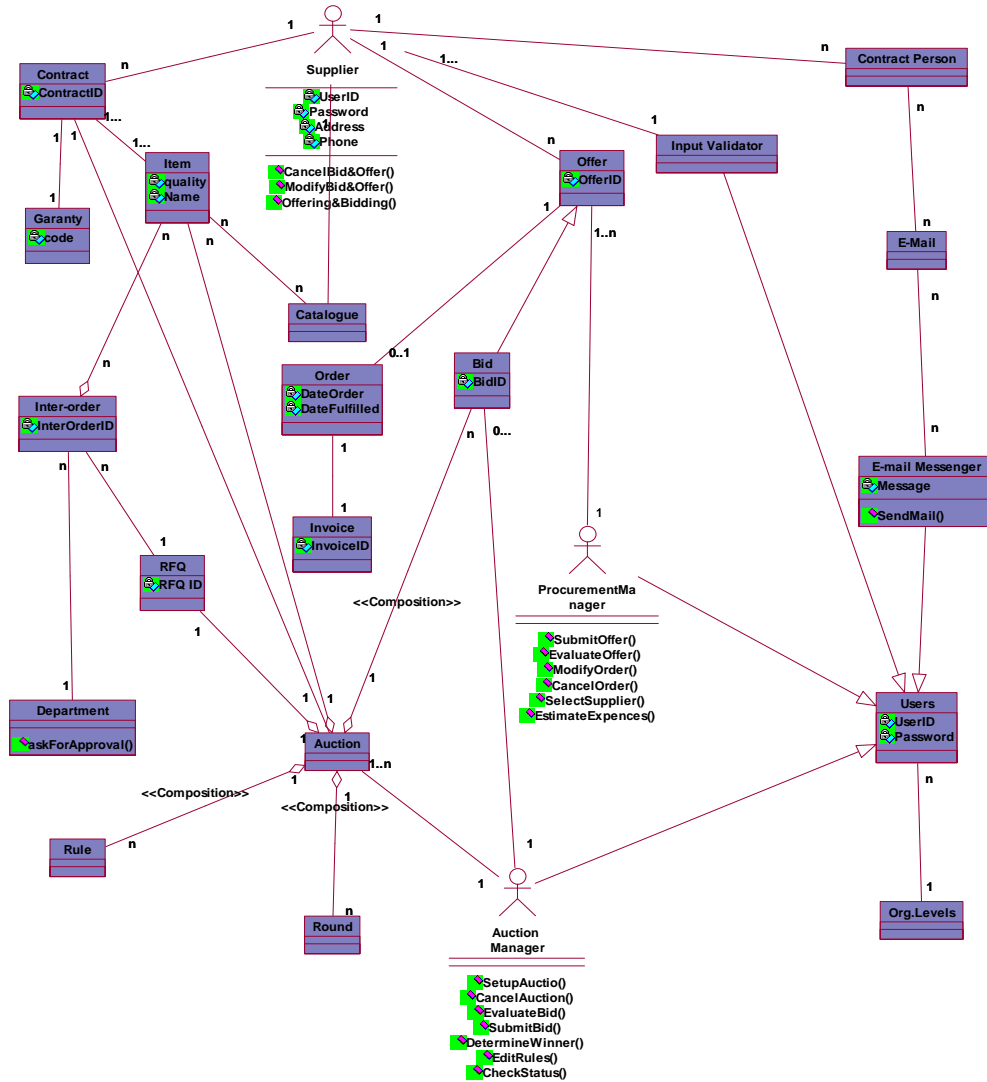


Fig. 2: A sample Class diagram of e-procurement portal.

Figure 6 illustrates a report page that can be used by managers and other users to see the bids and other information based on each product. After reviewing received bids, auction manager should determine auction's status; if any bid would be selected, then related auctions must be closed. If the winner has not been selected yet, the auction should be kept as an open one.

Supplier can be informed of auctions status via "Auction" tab. In this tab, auctions are classified into three categories: open, close and awarded. This information is illustrated in Figure 7.

After qualified suppliers log in to the portal, they have access to the specification of the requested goods by the organization. Based on the requested goods, they can submit their offer in the "Offer list" section. Their responses include the following information: supplier ID, price, quantity-on-hand at the supplier side and an estimated shipping time. Procurement manager selects the best offer and inserts supplier ID and the quantity to be ordered in "Order" section, as depicted in Figure 8.

**Validation Of The Design:**

Since evaluating the validity of designs for information systems and researches for fundamental theories needs special validity methods, questioners have been sent to 7 people who helped in analysis phase and have knowledge of procurement and information technology. Four criteria have been adopted in this work to evaluate the result of the design: Proportionate, relativeness, applicability, and changeability.

Having received the responses from our experts, we summarized the data into following table which contains answers for each index.

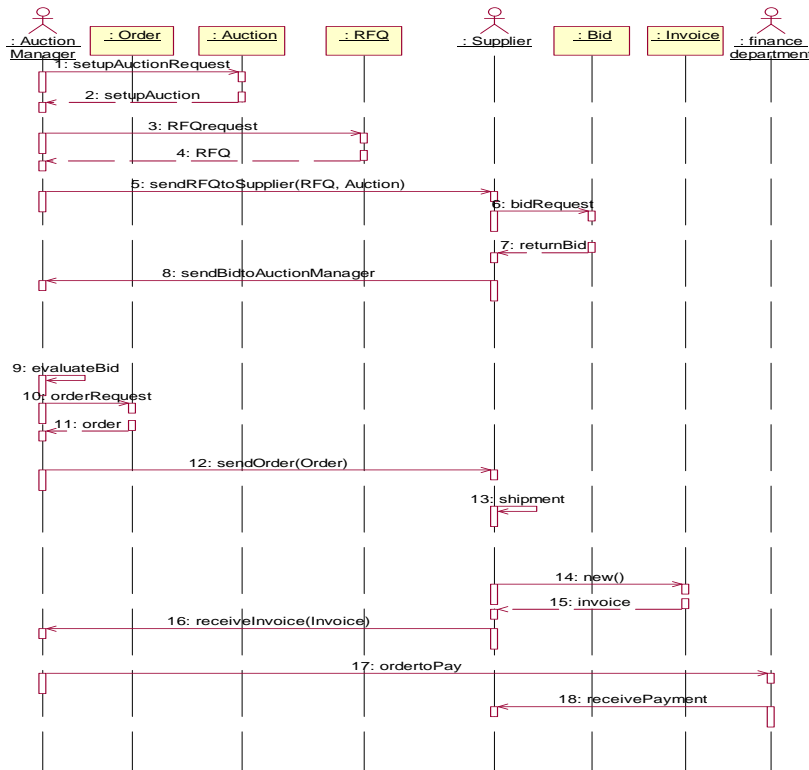


Fig. 3: A sample of sequence diagrams of the e-procurement portal .

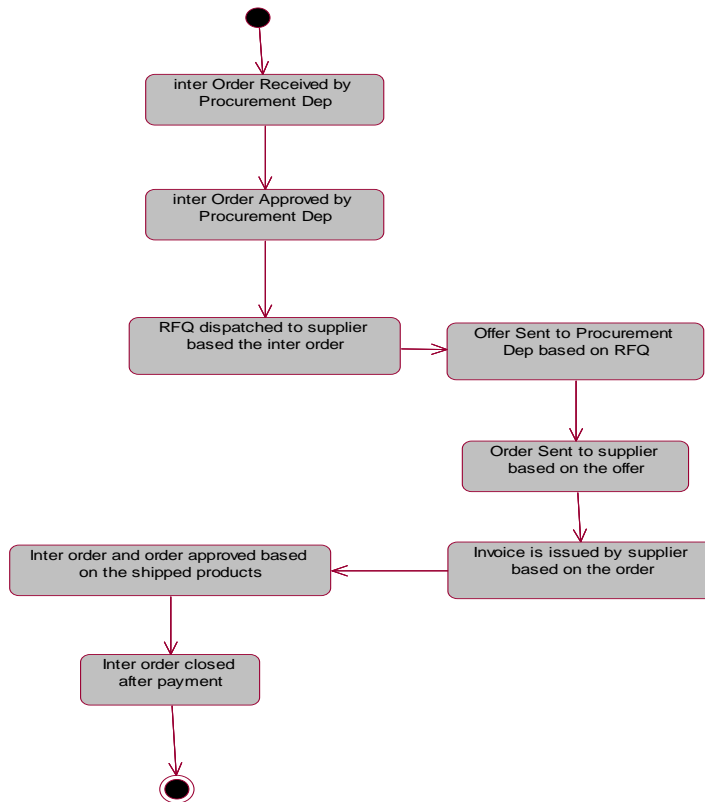


Fig. 4: A sample of state-chart diagram of the e-procurement portal.

Basic Information about your Company

Company Name incl. legal form   
 Street and house number   
 Zip code   
 Town/city   
 P. O. Box   
 Country   
 Province   
 Type of business    
 Central telephone number   
 Web address

Banking account

Bank Country   
 Bank Code   
 Bank Name   
 Account Number

Good and Service Profile

Product ID	Product Name	Type
1		
2		
3		
4		

Upload your Catalogs, brochures here:

Company Information

Year of foundation   
 Number of employees   
 Environment certificates   
 Communication Standards

Fig. 5: Supplier registration form.

**Auction History**

Auction Date  Auction Manager   
 Product ID  Amount   
 Bid Deadline  Status

**Suppliers Bids**

Number	Bid Date	Supplier Name	Price	Amount	Due Date	Winner
1						<input type="checkbox"/>
2						<input type="checkbox"/>
3						<input type="checkbox"/>
4						<input type="checkbox"/>
5						<input type="checkbox"/>

Fig. 6: Auction status determination form.

**Auction Status**

**Open**

Product ID	Description	Open From	Due Date	Amount
1				
2				
3				
4				

**Closed**

Product ID	Status	Open from	Closed at	Days In Line
1				
2				
3				
4				

**Awarded**

Product ID	Status	Winner	Open From	Award Date	Auction Value
1					
2					
3					
4					

Fig. 7: Auctions tab.

**Request ID**   
**Product**   
**Quantity Needed**   
**Requested by Department**   
**Not Later Than**

**Offers List**

Supplier ID	Price	Quantity on Hand	Delivery Time (in Days)

**Order Detail**

Supplier ID	Quantity

Fig. 8: Offering and ordering form.



**Table 3:** Experts Answers for validity of the design.

Questions	Very High	High	Medium	Low	Very Low	Total
Proportionate	2	4	1	0	0	7
Relativeness	1	4	2	0	0	7
Applicability	1	2	3	1	0	7
Changeability	1	3	3	0	0	7

We applied binomial test for the result. As a preparation step for applying binomial test, we categorized the options of the responses in two groups; “very high”, “high”, and “medium” in one group and “low” and “very low” in other group.

for criteria 1,2, and 4: (one sided test)

$$\{H_0: p \geq 0.7$$

$$\{H_1: p < 0.7$$

The statistic for the test (z) would be:

$$z = \frac{\frac{X}{n} - p}{\sqrt{\frac{p(1-p)}{n}}} = \frac{\frac{7}{7} - .7}{\sqrt{\frac{.7(1-.7)}{7}}} = 1.73 > Z_{0.05} = 1.64$$

The test reveals that H0 can be accepted. Moreover, the test result shows that for criteria 1,2, and 4 the design satisfies the goals with at least 70 percent of certainty and for criterion 3 we have 60 percent of certainty.

**Conclusion:**

In this paper we analyzed a procurement system and documented the business logic. We evaluated the role of users concisely and provided a portal based e-procurement solution and designed the needed components. Using UML, different behaviors and states of the system and their interactions are shown. Finally we developed some of the main interfaces of the system and design the connections of the menu and other pages. Validation of the system was the last step of our design which was done by an expert validation method. Based on expert validation result and due to the availability of required tools and information for the procurement management in the designed system, we believe that organizations can manage procurement process more effectively and avoid unnecessary burdens which reduce their productivity.

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