EPOS: e-PROCUREMENT OPTIMIZED SYSTEM FOR THE HEALTHCARE MARKETPLACE

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Abstract

This paper focuses on efficient e-procurement mechanisms that enable hospitals and pharmaceutical suppliers to electronically exchange contractual information, aided by the technologies of optimisation and business rules. E-procurement offers hospitals and ambulatory facilities several notable advantages: convenience, efficiency, broad selection, favourable pricing, information on new products and even more. Optimisation and business rules technologies can help meet buyers' needs and bring a higher level of efficiency to key tasks such as formatting multi-supplier catalogues, costing out indirect procurement alternatives, optimising the sourcing of indirect goods and services, mapping approval processes and following the progress of specific purchase orders. This article presents EPOS which is triggered by the consumer's request, offers the participants the ability to dynamically constellate with other medical suppliers, and promotes collective competition among the constellations.

Key Words: e-procurement, healthcare supply chain information systems, optimisation and business rules.

1. INTRODUCTION

The pharmaceutical industry has yet to confront the major issue of inefficiency. Over 10% of the total production is slow-moving or completely stagnant. Based on estimates of industry professionals, three (3) billion Euros of this slow-moving or stagnant production is destroyed each year. Manufacturers, wholesalers, and distributors would prefer to move this potentially destroyed inventory if they could inexpensively and efficiently do so. In a survey that was conducted in public and private hospitals in the area of Northern Greece, the inefficiencies of the hospital pharmacy inventory management were identified. Such inefficiencies included stock out incidents, which endangered patient safety and life, incidents of expired drugs that had to be thrown away as ineffective [12].

The contemporary concepts of supply chain management have not been yet applied in the healthcare industry as they have been applied in other industries, due to the fact that demand cannot be accurately predicted and safety stocks are needed in order to support unexpected or unforeseen cases and save lives. The science of Logistics is concerned with providing concepts, techniques and models for the optimization and business rules of systems like material management and supplies, inventories, supply chain management that have already been applied successfully in other industries. In the healthcare industry the science of logistics is concerned with the study of the supply chain of medical units including product supply, packaging and storage, the provision of medical services and the service of medical equipment. The science of logistics can provide solutions to decrease the costs of healthcare without affecting the quality of care, improving supply chain processes with the use of information systems [1,2,3,4,5].

Jarret (1998) states that the health care industry has been under extreme political and public pressure during the last three decades to control the rapidly increasing cost for treatment. He also notes that controlling health care costs requires that limits be placed either on prices quantities of services, or both. Prices are measurable and more easily controlled than is quantity. It suggests that an alternative approach to controlling prices is to restructure the market for health services to encourage greater price competition among providers. Accurate invoicing might be

worth the trouble in itself [3]. In theory, hospitals pass their costs on to customer-patients, with a slight mark-up. They waste time and resources searching for specialty items, while manufacturers and distributors are desperately searching for customers. Hospitals have plenty of reasons to use online procurement. Real-time inventories and prices would allow purchasing departments to plan buying and compare prices. Precise pricing information could flow from online sources to hospital systems. Online tracking of orders would allow better planning of inventories and support timely delivery. The cost to the healthcare system of supply chain inefficiencies may reach really high figures. The relationship between buyers and sellers is also in focus as the compatibility of information systems and processes, the understanding of mutual business needs, communications, commitment, flexibility and trust are factors that can reduce operating costs [3]. Therefore it is evident that the answer to efficient procurement of medical supplies is e-procurement.

Hospitals and pharmaceutical suppliers across Europe are the primary target users for an efficient e-procurement mechanism. With a population of around 493 million people in the EU27 and more than 14,000 hospitals in the EU15, the enlarged European Union constitutes the second largest market for opportunities in trading for hospital materials (with the US being the first). On the other hand, the number of suppliers in any given country of the EU15, according to estimates, could be as high as 50,000 with the largest suppliers varying by country. This is because hospitals have so many different functions and needs to satisfy with the appropriate supplies.

EPOS addresses the healthcare supply chain in a unified approach and proposes an innovative procurement environment based on optimization algorithms. Innovation can be seen in three different aspects, namely (1) Content, (2) Planning, (3) Price clearing. Current leading e-procurement solutions concentrate in the dynamic binding of buyer requests and seller offers. This does not fit at all with the requirements of the healthcare sector. The solution that “e-Procurement Optimised System for the Healthcare Marketplace” (EPOS) proposes is a reverse auction optimised procedure. EPOS service effectively addresses this problem through the development of its fast, easy, and confidential online clearinghouse not only for pharmaceutical items but also for health and beauty care.

The paper is structured as follows: In Section 2, we review the literature on Information Technology (IT) with a focus on e-procurement as well as the literature on e-procurement integration into the supply chain. The EPOS methodology is described in Section 3. In Section 4, we discuss implementation of EPOS and the results, analysis and discussions, where we also highlight advantages, scope and the views of the hospitals (users). Conclusions are drawn in the last section of the paper.

2. LITERATURE REVIEW

The potential of e-procurement has already been proven in a number of studies [6,7,8,9,10]. The widespread use of the Internet as communication standard is considered as a fundamental strength for development of electronic procurement. The Internet is a prerequisite for the objective of an open tendering process. The Internet is rapidly becoming a standard office procurement tool for many medical practices. Just about anything can be purchased online, from large medical equipment to rubber gloves and pharmaceuticals. The days of leafing through outdated paper catalogues are over, when one had to fill out forms only to realise a product is on back order when the shipment arrived. Online ordering gives the purchaser real-time information

on any given product and the process can be completed in minutes. Online procurement brings benefits to manufacturers, too. Rarely dealing with end-consumers directly, manufacturers must rely on intermediaries to market and sell their products. In addition, manufacturers could build relationships with the actual customers and discover what they like and don't like about the products. They would be able to monitor demand, plan production accordingly and probably obtain new customers, improving the bottom line and the raw volume of product shipped. Makers of specialty items would especially benefit if their customers had easier access to their products. Intermediaries could also realise substantial benefits. Many already have ongoing relationships with both buyers and manufacturers, which they can bring into online relationships. What's more, group buying has clout, whatever the medium, and anyone who can organize groups of buyers and lead them online will have a competitive advantage [3,6,7].

Ivang et, al. (2005) mentions that buyers are increasingly turning to online applications in their negotiations with suppliers. This means that more and more suppliers are facing the demands of negotiation and trade via e-markets, auctions and e-procurement systems. It indicates that short-term oriented e-market is here to stay and will require new solutions to the classical dilemma of market economy between short-term optimisation and long-term development [7]. E-procurement technologies are IT systems that companies can use in the automation of their procurement processes. E-procurement offers to hospitals, physician practices and ambulatory facilities several notable advantages: convenience, efficiency, broad selection, favourable pricing, information on new products and even more. Furthermore, the cutting edge of e-procurement involves applying software technologies that have some of the highest return-on-investment: optimisation and business rules. Optimization and business rules address some of the roadblocks in e-procurement systems. These technologies can help meet buyers' needs and bring a higher level of efficiency to key tasks such as formatting multi-supplier catalogues, costing out indirect procurement alternatives, optimizing the sourcing of indirect goods and services, mapping approval processes and following the progress of specific purchase orders [6,7].

Talluri et, al. (2006) acknowledges that e-procurement technology has steadily increased in the past few years. Companies view these technologies as solutions to the problem. He also asserts that research in e-procurement lacks a systematic tool to help organisations to optimally integrate suppliers. Furthermore he notes that advantages of e-procurement systems include: (i) better coordination with suppliers; (ii) quicker transaction times; (iii) a higher flexibility; (v) better supplier integration; and (v) lower costs [8].

Bui and Gachet (2006) illustrate the potential use of Web services for negotiation and bargaining in e-procurement. They propose a set of Web services that support the process of negotiation and bargaining to facilitate the matching of supply and demand of Web services. As market brokers, they explain that these web services would help (a) discover the supply /demand of web services in e-marketplaces; (b) find the most appropriate available service for a specific request; (c) facilitate services be modified if needed to satisfy user's needs; (d) arbitrate the pricing mechanism with a resource to bargaining whenever necessary; and (e) generate a contract [9].

Botani et al. (2005) states that the recent literature has highlighted many works related to e-procurement, but few scientific papers dealing specifically with the definition of criteria for supplier selection in the e-procurement context. The

implementation of e-procurement programmes may lead to substantial benefits in terms of supply chain integration [10].

EPOS offers an efficient e-procurement mechanism where hospitals and pharmaceutical suppliers can exchange contractual information (orders, characteristics of orders), using electronic means and specifically the Internet and the World Wide Web, aided by the technologies of optimisation and business rules. Optimisation and business rules address some of the roadblocks in e-procurement systems. These technologies can help meet buyers' needs and bring a higher level of efficiency to key tasks such as formatting multi-supplier catalogues, costing out indirect procurement alternatives, optimising the sourcing of indirect goods and services, mapping approval processes and following the progress of specific purchase orders. EPOS application provides critical decision support functionality to the purchasing departments of the hospitals and the people that make the decisions within the supply chain. With electronic procurement in full function, a virtual marketplace is created and exchange of information happens between the members of the supply chain, basically the suppliers of the healthcare materials and pharmaceutical companies on one end and the hospitals on the other end. The application supports product searches between a multitude of merchandise and a big number of suppliers. In this way maximum cost and time of search effectiveness is achieved as compared to the traditional way of a written, official auction sale with lots of paperwork. Supplier products and pricing information are available and are displayed through catalogues that can be accessed by the buyers through a web-based interface. When upon making a purchase, the decision is easier to take, as it is easier to check inventory levels of already existing goods electronically [14].

3. RESEARCH METHODOLOGY

Presutti (2003) describes that the traditional purchasing process is composed of four main phases. The starting point is the "Definition of buying requirements", based on the demands of the final customer. An appropriate multidisciplinary buying team (engineering, marketing, etc), as well as supply professionals and suppliers, may be involved in this phase. Potential suppliers are then identified and pre-qualified by the buying team "Identification and pre-qualification of suppliers". The team is responsible for the "Definition of contract agreements" and the "Evaluation and rating of suppliers", which encompass generating and evaluating requests for proposals, and assessing suppliers' performance against a set of relevant criteria (i.e., excellent, good, fair, unacceptable) [11].

According to the Survey "Application of Internet and e-Business in Europe", the main success factors for e-business projects is acceptance by parties involved (customers, partner, employees, executive management) and integration in the existing organisational structure (technique, processes). Speed amortisation of the costs, is a significant factor, but costs appear to be a relevant goal but not a significant success indicator. Finally, the focus on consumers / users is in the foreground very important, not only as a goal but also as a success factor for the e-business activity [13].

Based on the above, the success indicators of EPOS, are:

- user's acceptance,
- system integration,
- reduced costs,

- participation of more suppliers from more countries, and
- stock management

User's acceptance is one of the most critical factors in the system success. The users are identified both horizontally and vertically. Horizontally, user's acceptance is recognised inside the hospitals and public health institutions as well as from the supplier's point of view. Vertically, user's acceptance is recognised from top management and policy makers to hospital procurement personnel and bid managers. All marketing and pilot testing efforts will be focused into exploring and reaching into solid marketable conclusions regarding the user satisfaction and accommodation needs in all the above mentioned levels.

System integration in the existing organisational structure is a factor that has already been taken very seriously into account from the system architecture development. The main focus of the initial system development was to be able to accommodate the country specific needs within the European public health procurement. Special attention will be given so as to clearly pinpoint the needs in each pilot country, highlight the system integration potential according to these needs and market them accordingly to each country. Whenever and if necessary minor system integration actions will be undertaken.

The system offers multiple cost reductions both from operating costs and from procurement optimisation costs. These cost savings will be further investigated, quantified and measured in each country pilot test and according to each target market. They will serve later as a best-case show example and a marketing tool for further promoting the EPOS software.

Participation of suppliers from more countries is a critical success factor anticipated to trigger both healthcare policy makers into adopting the EPOS system, since it will actively promote the single European Market as well as procurement managers and suppliers, since it immediately offers cost savings and a larger market accordingly.

Efficient stock management will help hospitals not to pass their costs on to their-patients. EPOS has to clearly demonstrate and quantify the savings occurring from saving time and resources searching for specialty items, while manufacturers and distributors are desperately searching for customers. The cost to the healthcare system of supply chain efficiency through EPOS has to be clearly demonstrated.

System development took place during two EU-funded research projects (OPUS – IST and EPOS-eTen), where the technical infrastructure and the application components were tested and improved in order to satisfy consumers', content providers' and broadcasters' needs in the best way [14]. In order to prepare effectively the pilot sites environment in relation to the above mentioned objectives, efforts were focused on the process of preparation of end users according to the specification of the user profiles, specifications of the services to be used, the organisations' role and reengineering aspects related to the implementation of the service, as well as beneficial factors for the organisation and users.

The Analysis of the system resulted in two modes of operation in the Health procurement sector in Europe, supported both by the EPOS system: In some European countries (i.e. Greece, Italy, Spain), Regional Health Authorities (RHA) have been established and they are responsible for the coordination and implementation of health care policies and services in their entire region of responsibility (i.e 10 RHAs in Greece, 12 RHAs in Italy, etc.). This is not the case

for other European countries in which each Hospital is responsible for its own health care procurement policy (i.e. Belgium).

Also, within the frame of the EPOS Project, we have identified five primary user groups of the pilot sites involved in the verification and demonstration activities:

- Medical doctor – clinic manager
- Procurement manager
- Financial manager
- Supplier
- IT specialist (for both hospitals and suppliers)

Each user group has a specific role in the procurement procedure. A Use Case Analysis took place during the user requirements phase. It's a technique for capturing functional requirements of business systems. It has been proven to be easily understandable by business users, and thus to act as a bridge between them and software developers [15,16].

3.1 Technology Description

Through the design of the EPOS Architecture, the key technology that was used for its development was Java technology. Java is an ideal language to build components, for many reasons, mainly due to (1) interface/implementation separation, (2) safety and security and (3) cross platform.

The multi-tier design proposed, simplifies the development, deployment and maintenance of the EPOS system. The main scope of the multi-tier design proposed is to enable the developers working on the EPOS system to focus on the specifics of programming, relying on various back-end services to provide the infrastructure and client-side applications to provide the user interaction. The business logic of each of the EPOS users participated in both EU-projects, namely the Thessaly PESY (RHA-Greece), the AUSL-BARI/3 (RHA-Italy), Hospital De Vic (Spain), Papageorgiou Hospital (Greece) and Monica Hospital (Belgium) that participated in the pilot application has been deployed on the specific server appropriately.

3.2 Developments

The EPOS system consists of major subsystems and subcomponents which are:

- Catalogue Management Subsystem
- Demand Planning Subsystem
- Tender Planning Subsystem
- Auctioning Subsystem
- Workflow Subsystem
- Document Management Subsystem
- Security Subsystem

The overview of the essential functionality of the system is shown in the diagram below (Figure i). The diagram shows a general time order in the use of the subsystems. All subsystems run simultaneously but the output of one subsystem is a prerequisite for another to function. Moreover, the Security subsystem, the Document

Manager and the Workflow cover the functionality of all the other subsystems. The functionality of each subsystem and the relations with each other are described below:

Catalogue Management Subsystem: The central repository of item related information organised in categories. Includes facilities to: (1) enable authorised users to maintain the catalogue of items and (2) enable vendors to publish product related information.

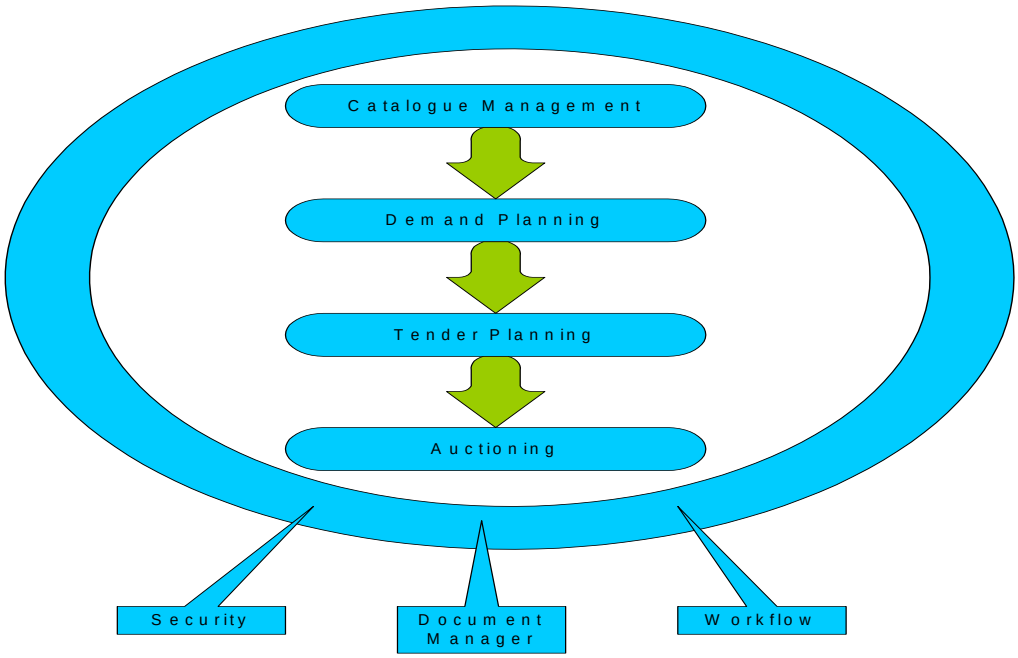

Figure (i) – Overall Functionality of EPOS system

Demand Planning Subsystem: organises the needs of the Health Organisation users, into a unified list for the RHS (RHS Demand List). Includes facilities to: (1) enable authorised users to allocate budgets to subordinate users, (2) enable users to define demands for their area of responsibility, (3) enable authorised users to consolidate lists of demands of subordinate users, (4) enable users to generate urgent purchase orders for the Health Organization they belong to and (5) enable users to generate requests for service for the Health Organization they belong to.

Tender Planning Subsystem: It is the subsystem that will be used to create a tender plan out of an RHS Demand List. The RHS Demand List will contain information about the way and the time each auction will take place. Includes facilities to: (1) enable authorised users to manage (i.e. split, unify, rename) tenders, (2) enable authorised users to determine the way each auction will be executed, (3) enable authorised users to determine the time and the length of each auction, (4) enable authorised users to publish tender related information and (5) enable authorised users to reschedule and create new auctions for pending items of previous ones.

Auctioning Subsystem: It is the subsystem that will execute the online auctions and determine the winner(s) of each auction. It includes facilities to: (1) enable vendors to view detailed information about tenders and corresponding auctions and (2) enable vendors to submit bids in order to participate in auctions. The auctioning subsystem supports both simple and combinatorial reverse auctions

Workflow Subsystem: automates OPUS processes, in whole or part. It passes documents, information or tasks from one user to another for action, according to a set of procedural rules. The objective is to simplify and streamline key business processes and to reduce the amount of manual processing and reporting that users must undertake to perform their daily tasks. Includes facilities to: (1) monitor process execution automatically, (2) issue alerts to users informing them that it is their turn to perform a task for a business process, (3) provide links that will lead users to the interface where they can perform their task and (4) enable authorised users to maintain the functionality of the workflow subsystem by modifying and activating processes.

Document Management Subsystem: It is a central repository of process related documents. It includes an engine that manipulates documents (create, search, delete, modify). Includes facilities to: (1) enable users to search the repository for documents they have been submitted or received up to the current date and (2) enable user to view and produce hardcopies of the documents they find.

Security Subsystem: It is the subsystem that manipulates security and authorization related information. Includes facilities to: (1) enable authorised users to manage user accounts and permissions, (2) authenticate the users that have access to the particular services, (3) protect the documents that will be created after each activity, through Public Key Infrastructure (PKI) and (4) timestamp the documents exchanged within the system.

4. RESULTS, ANALYSIS AND DISCUSSIONS

During the EPOS project three set of trials took place in each of the end users' premises. The measurable indicators which were defined in the EPOS Feedback Plan were selected in two different lines. The first set of indicators corresponded to the system use and included measurements such as number of users, hits, auctions, logins, etc. The results verified that the users actually used the system successfully and quantified the extent of the trials. The second and most important set of measurements was focused on verifying and quantifying the ability of EPOS to electronically simplify current procedures and reduce the time and effort needed to complete an e-procurement, as compared to the conventional procurement process.

In order to quantify this, the hospitals and the representative of suppliers prepared a table with reference data against which measurements were done. These tables indicated the main steps for completing an e–procurement process and the corresponding time and effort currently needed for each step. The corresponding time and effort using EPOS were measured during the second and third trials and compared with the reference data. It is noted that these measurements depend on many factors (e.g. size of auction, skills of personnel, etc.) and can therefore only be used as rough indications.

A calculated summary of the measurements in effort (man-hours) resulted in the following estimations: In many tasks, such as auction evaluation and results publication there was no measurable difference between EPOS and the conventional

procedure. In certain tasks though, there is significant reduction in effort, such as the creation of list of needs (from 2 hours to 1 hour) and the preparation of tender (from 1 hour to 15 minutes). The total saving in effort for the entire procedure was measured as 27%. The results regarding the elapsed time were the following: The time needed to complete certain tasks is significantly reduced but the amount of time saving differs from hospital to hospital. The financial list approval takes 10 days in Papageorgiou and two days in Monica according to the current procedure, while it would take one day in both hospitals using EPOS. Similar time savings were reported for auction publication. The duration of the whole procedure can be reduced from 14 to 7 days in a private hospital like Monica and from 7-8 months to one (1) month in a public hospital like Papageorgiou (excluding the period in which the auction remains open).

4.1 Business Benefits

The efficient e-procurement mechanism that EPOS suggests enables hospitals and pharmaceutical and medical equipment suppliers to electronically exchange contractual information. In the framework of the EPOS innovative procurement environment, the healthcare supply chain can be expanded to embrace suppliers beyond the local border of the buyers' country of origin. Broad, pan-European participation of companies in the healthcare supply chain is not currently being practiced and it is anticipated to strengthen the European industry.

Some of the EPOS system business benefits are:

- Communication is easy and available for all interested parties
- Efficient management of the supply chain
- Lower operational costs
- Market unification
- Enhanced flexibility
- Minimization of the time required
- Price bidding

4.2 Discussion

In this section, important findings on the market characteristics and evidence for potential acceptance of EPOS are discussed. The sources of this information are:

- The feedback from users through the discussion which took place outside the formal questionnaire process.
- The market survey conducted
- The feedback events and contacts within dissemination and promotion activities

The picture obtained on the overall market to which EPOS is addressed consists of the following elements: The success of EPOS is not a technology issue, however the suitability of the solution plays an important role. The market tends to offer general solutions, tailored to the specific area. On this course there is strong competition by large vendors. These competitors are established in the market of e-business and address with ambition the area of e-procurement. However, they don't offer a specialised solution vertical to the health sector. The needs of the health sector

have proved to be quite specialised. A software product only or an e-service would not satisfy the needs of the sector, even if it is integrated and customised to the needs of each customer. The message from the market is that the e-service should be combined with expertise on legal issues and other services, such as supplier certification, catalogue maintenance and consultancy. The trans-European dimension is almost inexistent at the moment, as all health e-procurement solutions are struggling to be established in one single market. In order to address trans-European procurements, a series of organisational, technical, legal and promotional problems arise, which require time and effort to be solved. EPOS has considered this from the beginning and has taken related action. The feedback from manufacturers and hospitals showed that there is expressed need for such as service. On the contrary, traders and representatives are clearly opposed to such developments. The importance of a standardised e-catalogue has been apparent. The possibility to control or impose such a standard is a very powerful advantage. Even if the catalogue itself would be open and theoretically can be adopted by any vendor, in practise it is crucial to have control over the catalogue because of its dynamic nature. This means that the service offered to the buyers should allow them to define new items according to their needs. Then, a well-defined, effective and fast procedure should be applied in order to process the requests, adapt the catalogue in all languages and fix the changes as part of a standard. In fact, the constitution of a state-controlled regulating body has been proposed.

During the EPOS trials, one of the most visible findings was the need for an elaborate catalogue maintenance process. In the case of trans-European e-procurement, the process must be centrally controlled and also rely on national support. The field for such an undertaking is still wide open and a key advantage of EPOS is that a solution is already implemented in pilot form and is ready to be deployed.

In the current market there exist strong supplier-distributor relations. Manufacturers and especially small ones depend on the distributors and do not have the resources to submit offers in tenders by themselves. Although the additional cost allocated to the distributors is very high (from 20% to 50%) and manufacturers would like to save this cost, at the moment there is feeling that the distributors play an important role and their cost is justified. Part of this cost goes anyway to local promotion and support. Another aspect is that the agreements between manufacturers and distributors do not allow the manufacturers to sell directly or though alternative distributors in areas where one distributor has exclusivity. This means that different distributors cannot compete among themselves in a unified European market [14].

Currently, it is also very often not possible for a hospital to buy directly from the manufacturer but only through the local representative. The above two limitations mean that one strong potential benefit of a pan-European EPOS (reduction of cost by avoiding intermediaries) is restricted. In order to maximise the benefit from the adoption of EPOS, it would be required that the role of the distributors and the related agreements are adapted to the new conditions in a European e-market.

The hospitals have expressed their interest for a supplier registry service, integrated with EPOS service. Private hospitals would be mostly interested in a scoring mechanism about the reliability of each supplier, similarly with other e-markets. Public hospitals are interested in passing the burden of eligibility checks and are looking for a trusted service that could certify the eligibility of each supplier. The proposed supplier registry service would need to collect and maintain the necessary certificates from the suppliers, process them and certify to the hospital the ability of

each supplier to participate in a specific auction. In order for such a service to be acceptable by a public hospital it has to be covered by adaptations in the legislation.

It has become evident that the market of private hospitals is more mature, the legal barriers are much less and in general manageable, while the benefits and motivation for the hospitals is at least as strong as the public market. The most reasonable approach is therefore to address the private hospitals first and then expand to the public ones. On the other hand, the entry barriers for competition in the private sector are lower. The public sector is less mature and more challenging. However, if entry is succeeded, dominance can be achieved.

5. CONCLUSIONS

EPOS illustrates a fast, easy, and confidential online clearinghouse for the healthcare marketplace. The application provides critical decision support functionality to the purchasing departments of the hospitals and the people that make the decisions within the supply chain. With electronic procurement in full function, a virtual marketplace is created and exchange of information happens between the members of the supply chain, basically the suppliers of the healthcare materials and pharmaceutical companies on one end and the hospitals on the other end. EPOS platform strengthens the strategic management dimension of procurement decision-making and reduces the huge amounts of administrative hours spent to process the orders. Order placement and fulfilment becomes more accurate (error-free) as manual processes are removed. Therefore, supply chain efficiency improves, and order tracking and tracing become quicker and easier. Future research is mainly concentrated on e-catalogues. The multi-discursive processing model for catalogues delivered by the project need a complete, unified, and semi-automatic handling of content, together with their associated conceptual and structural descriptions, and support their comparative study. In order to fulfil these functionality requirements, a range of innovative technologies currently used in a variety of applications involving access, creation, storage, search, retrieval and exploration of information need to be exploited. Knowledge model formatting, ontology-driven processing of content and scientific visualisation of objects are some of the issues for future research.

REFERENCES

Journal Papers:

[1] Danas K., Ketikidis P.H. and Rudsari A., 2002, A virtual hospital pharmacy inventory: An Approach to support unexpected demand. *International Journal of Medical Marketing*, 2(2) 125-129.

[2] Danas K., Roudsari A. and Ketikidis P.H., 2006, The Applicability of a Multi-attribute Classification Framework in the Healthcare Industry. *International Journal of Manufacturing Technology Management*, 17(6), 772-785.

[3] Jarrett, G. P., 1998, Logistics in the health care industry. *International Journal of Physical Distribution and Logistics Management*, 28(9), 741-772.

[4] Whitson, D., 1997, Applying just in time systems in health care. *IIE Solutions, (USA)*, 29(8), 33-38.

[5] Wilson, J.W. and Cunningham W.A., 1992, Stockless Inventory Systems for the Healthcare Provider: Three Successful Applications. *Journal of Healthcare Marketing*, 12(2), 39.

[6] Puschmann T, and Alt R., 2005, Successful use of e-procurement in supply chains. *Supply Chain Management: An International Journal*, 10(2), 122-133.

[7] Ivang, R. and Sorensen O.L., 2005, E-Markets in the Battle Zone Between Relationship and Transaction Marketing. *Electronic Markets – The International Journal*, 15(4), 393-404.

[8] Talluri, A., Chung W. and Narasimhan R., 2006, An optimisation model for phased supplier integration into e-procurement systems. IIE Transactions, 38,389-399.

[9] Bui, T, and Gachet A., 2006, Web Services for Negotiation and Bargaining in Electronic Markets: Design Requirements, Proof-of-Concepts, and Potential Applications to e-Procurement. *Group Decision and Negotiation*, 15, 469-490.

[10] Bottani E, and Rizzi A., 2005, A fuzzy multi-attribute framework for supplier selection in an e-procurement environment. *International Journal of Logistics: Research and Applications*, 8(3), 249-266.

[11] Presutti, W.D., 2003, Supply management and e-procurement: creating value added in the supply chain. Industrial Marketing Management, 32(3), 219-226.

Proceedings Papers:

[12] Danas, K., Ketikidis, P.H., 2000, "e-logistics:A framework for the hospital pharmacy", *Eurolog 2000 Conference Proceedings*, pp 114-121.

[13] http://ec.europa.eu/information_society/activities/eten/library/news_projects/css/index_en.htm, site accessed at June 2007.

[14] Ilioudis et al., 2002, OPUS-Optimal Public Procurement in the Healthcare Marketplace. *Proceedings of International Conference Challenges and Achievements in E-business and E-work*, Published by IOS Press.

Books:

[15] I. Jacobson, 1992, Object-Oriented Software Engineering: A Use Case Driven Approach. Addison-Wesley.

[16] Sommerville, I., 2007, Software Engineering, 8th Edition, Addison-Wesley.