Public Knowledge Base System for Public eProcurement: A Conceptual Model

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Abstract: Public procurement is one of the core activities of each government and as such it draws attention of many stakeholders in a society. This is why governments pay special attention to providing frameworks and standards for public procurements that guaranty openness, transparency and non-discrimination of the overall process. In this paper we will describe the EU framework for public procurement that supports electronic business. As we can see the electronic nature of the framework allows for collection of additional data about procurement. This data can be used to create public database appropriate for creation of knowledge about experiences with particular procurement orders. We will present the concept of proposed knowledge base and its implementation within the described framework. The knowledge from experiences is generated using case-based reasoning conducted over depersonalized data. This is why this public knowledge can be made available to all interested stakeholders – participants of the procurement process. Publicly available knowledge base can encourage main goals of public eProcurement goals and make national economy more competitive as procurement contractors start to take advantage of competing for public eProcurement tenders in neighboring countries.

Key-Words: knowledge management, public procurement, case-based reasoning, e-business, e-government

1 Introduction
With the rise of e-business and e-government, public procurement has witnessed a big change in organization of its processes. The importance of public procurement for each government is crucial as it enables functioning of government institutions. Government or public procurement of goods and services typically accounts for 10-15% of GDP for developed countries, and up to as much as 20% of GDP for developing countries [1]. This makes it an important mechanism of economic activities that needs new solutions for reaching efficiency in terms of ‘value for money’. The goal of this paper is to present a conceptual model of a public knowledge base dedicated to capturing information from experience with public procurement process in order to promote efficiency and transparency of all activities of the tendering process. This knowledge can encourage all stakeholders to enhance their decision making procedures and improve efficiency of the entire economy.

The paper is structured as follows: In section 2 public procurement practices in EU are described along with the public eProcurement framework. In Section 3 knowledge-based decision support systems are described, as well as most important mechanisms that can harness the potential of practical information generated using the eProcurement framework. Based on these principles a conceptual model of public knowledge base for public eProcurement is described in Section 4, and overview of its benefits is given in Discussion in Section 5. Finally, Section 6 gives the conclusions and outlines the future work.

2 Public Procurement
The procurement of goods, services and work commissioned by public governmental entities has a unique significance in any country. It is a core activity for operation of governments as it secures the inputs that enable governments to fulfill their tasks. As such it has a major impact on all stakeholders of a society [2]. Open, transparent and non-discriminatory process of procurement is generally considered the best strategy for optimizing procurements in terms of ‘value for money’ as it optimizes competitions among suppliers [4]. With the development of Internet based communication new strategies have been developed for achieving the strategic goals such as openness of the procurement process, transparency and encouraging fair competition.

Public eProcurement is a concept of employing electronic means and resources while conducting procurement processes. eProcurement can be defined as the use of information technologies to facilitate business-to-business (B2B) purchase transactions for materials and services [3]. Governments recognize the significance of developing e-business models as they make up a
growing part of overall GDPs. Opportunities of better cost and time efficiency can also be exploited in public sector by institutionalizing governmental or public eProcurement. Elaborate models and frameworks of eProcurement have been created and initialized in order to achieve these government goals for the public sector. One of most important is the framework for Electronic Business of the European commission that creates guidelines and standards for electronic business (and thus electronic procurement) in member countries of the European Union. In the remainder of this chapter we will briefly describe this framework and provide insight in current status of implementation. Special attention is given to the state of implementation in Croatia as an example of candidate country for the membership of the EU.

2.1 Current Practices in Public Procurement in Croatia and European Countries

European commission has established an advanced approach to public procurement through the use of electronic means of communication i.e. Internet. This is known as Public eProcurement or Public Electronic Procurement. In order to introduce and develop a stable and efficient infrastructure for data interchange required to conduct transactions during the procurement process a number of eModules are defined [5]:

- **eSourcing**
  This eModule consists of all the preparatory activities both for contracting authorities or purchasers and potential contractors. These activities include collecting and reusing information for preparation of a call for tenders, expressing quotation or manifest interests by contractors, and other exchange of information regarding intentions and capabilities of all the involved entities.

- **eNoticing**
  Publication of call for tenders in electronic format using Official Journals and providing access to opened tenders for potential contractors are the main activities of this module. The main requirement form the infrastructure that enables eNoticing is non-discriminatory provision of tender information and accompanying documents.

- **eAccess**
  This eModule is related to eNoticing during the call for tenders. The main activities include active support for clarifications, questions and answers and receiving the feedback from potential contractors. This module should support transparency and non-discrimination of the procurement process.

- **eSubmission**
  This eModule should enable potential contractors to submit their proposals electronically and provide them with electronically receipt of admission of the proposal. Contracting authority or purchaser should be allowed to receive all the proposals and process them electronically.

- **eTendering**
  This is an advanced stage of eAccess and eSubmission modules where they are interlinked and highly automated. It provides additional capabilities during the preparation of proposals with feedback about improvements before actual documents are submitted.

- **eAwarding**
  This is an electronic equivalent of opening and evaluating received proposals. They are evaluated using criteria defined in the call for tenders (either lowest price or economical properties). The best proposal is then accepted and the procurement is awarded to the contractor. All of the participants should be informed about the outcome of this process.

- **eOrders**
  This is the first of four phases that include the contracting authority and the awarded contractor. It should allow for negotiating, confirmation, conclusion and enactment of an agreement between two parties through electronic means. The capabilities of this phase should also allow for monitoring of compliance of both parties with the agreement during following sub-phases and detection of violations of the agreement.

- **eInvoices**
  This eModule represents the counterpart of the eOrders phase as it includes preparation and delivery of invoice by the contractor and the acceptance of the invoice by the purchaser.

- **ePayment**
  This is the final eModule in eProcurement electronic payment of ordered goods, services or works is conducted through electronic means according to the received invoice. This sub-phase is repeatable as long as new eOrders keep coming during the valid period of the eContract.

Additionally a number of perquisites need to be established and harmonized to perform the above activities from the described eModels. These constructs need to be standardized between different potential
contractors and purchasers of goods and services, as well as control institutions such as tax administration bodies or customs administration. Also these standards should allow for interoperability between countries members of the European Union with the possibility of extending interoperability capabilities with other countries worldwide. These prerequisites are defined as “key-enablers” and they are the following:

- eSignature
  Electronic authentication of data exchanged during the eProcurement process. Digital signature denotes adoption of intentions recorded in an electronic document.

- eIdentity
  Electronic identification of a person or an entity involved in eProcurement process.

- eAttestations
  Electronic set of certificates and attestations which prove that potential contractor can provide goods and preform services defined in procurement tender.

- eCatalogues
  Electronic catalogue of goods and services used for preparation of proposals by the potential contractor.

- eArchiving
  Methods for long-term preservation of documents in digital format that assure retrieval of these documents without conversions on demand (either by involved parties or legal and tax authorities).

Different member states of the European Union have completed different stages in establishing the infrastructure required for public eProcurement. Most of them have implemented eNoticing capabilities that allow the publishing of new tenders publicly online. Most of the countries support the publication of call for tenders along with additional documents and information. These include different standardized nomenclatures such as Common Procurement Vocabulary (or CPV), Nomenclature for Territorial Units for Statistics (or NUTS), Central Product Classification (or CPC), ect…

Croatia as a membership candidate for European Union has also started the introduction of infrastructure for public eProcurement. Croatian legislative already recognizes most of the “key-enablers” (such as eSingiture, eIdentity and eArchiving) that are crucial for implementation of the framework. Some of the eModules are already established and defined. Currently some of these eModules are being developed and implemented (e.g. eNoticing or eContract). For public eProcurement most important is the publication of calls for tenders that is available online in the Official Journal “Narodne novine” at www.nn.hr. This is why all relevant information can be acquired over the Internet and used for preparation of tender proposals. This information also allows for creation of additional tools for potential contractors as well for contracting authorities and purchasers. One of most useful tools is the knowledge base for public eProcurement that can be used as decision support system in a number of activities during the procurement process. The basis of the conceptual model and the model itself will be described in next chapters.

3 Knowledge-based Decision Support Systems

Knowledge management system is a part of organizational information system that is used for creating, capturing, storing, and disseminating information within the organization. Organizations that strive to improve their business performance and capacity for innovation recognize the need to support and maintain organizational and personal knowledge of all employees. One of most important activities that can benefit from a knowledge management system is the decision making which is the crucial managerial activity. This role of knowledge has been recognized by European Commission that started the project of Workshops on knowledge management in 2002 and 2003[6]. The result was the preparation of guidelines for improvement of knowledge management in its member countries. These guidelines recognize the role of publicly available knowledge bases for eBusiness and any other eActivity because it can improve efficiency of business operations on a national level. eProcurement is no exception.

During the eProcurement process additional data is generated that is not related to the process itself but to the conditions of its conduct. For example, each eContract can create a number of eOrders, some of which may not be fulfilled due to unforeseen circumstances, or sometimes ePayements may be delayed, etc… None of these events is recorded permanently within the eProcurement process. Yet, this information can be used for better decision making during eSubmission, eAwarding and eContract sub-phases. This is why knowledge-based system can be used to record these experiences and try to find patterns in data for occurrences of critical events. This information can be depersonalized and distributed to all participants in public procurement so that they make better decision in similar situation in the future.

One of possibilities for creating an information infrastructure that can create this valuable insight is the use of knowledge based decision support systems. For the purpose of supporting the procurement processes on the side of the potential contractors, a case-based knowledge base can be used. The stored data can then be
used for discovering patterns in data generating valuable new information or more generally new knowledge.

In the remainder of this chapter we will explain two most important constructs for establishing this type of knowledge decision support system – case based reasoning as a mechanism for knowledge discovery and information extraction as means of extracting and acquiring relevant information.

3.1 Case-based reasoning

As a problem-solving technique case-based reasoning was first introduced in late 1970s [7]. This type of reasoning is based on information about previous experiences.

Case-based reasoning solves new problems by adapting previously successful solutions to similar problems. The more data about previous solutions is available the more precise reasoning becomes.

As new cases are added to the data, changes and improvements of old knowledge can be attained. Also new knowledge can be generated.

The process of case-based reasoning cycle through four different activities (showed in Fig. 1) also known as the four RE:

- **REtrive**: isolates cases from the case-base most similar to the current problem at hand;
- **REuse**: isolated cases are used in attempt to solve the problem or propose a possible solution;
- **REVise**: proposed solution is adjusted for the specifics of the problem at hand if necessary and;
- **RETain**: succesfull solution of the problem at hand is stored as a new case of the case-base for future use.

The advantages of case-based reasoning are the possibility of creating a knowledge base with previous experiences for solving a particular type of a problem that can alleviate future decision making processes. Also case-based reasoning can be used to evaluate each proposed solution and generate new knowledge and thus broaden the understanding of a particular problem domain.

The most important disadvantage of case-based reasoning is the possible deterioration of case-base over time if false cases are added. This is why additional mechanisms for detection of false cases and their exclusion should be implemented.

3.2 Information extraction

Information extraction denotes any activity which goal is to automatically identify and acquire pre-specified sorts of information or data from natural language texts, aggregate them and store them in a unified and structured database [9].

The process of information extraction is twofold: firstly, precise and robust access to particular data needs to be established and secondly gathered data is structured and stored automatically in a database. The complexity of employed methods for information extraction depends on the characteristics of source texts.

The method can be rather simple and straightforward if the source is well structured. If the source of information is less structured or even plain natural language, the complexity of the extraction method becomes high as it includes natural language recognition and similar processes.

4 Conceptual Model of Public Knowledge-base for Public eProcurement

The conceptual model of public knowledge base for Public eProcurement is shown in Fig. 2. The system is base on server-client architecture.

Server-side application uses two databases. One database is used to store information about calls for tenders. It also used to track status of the call, either its expiry or cancelation if one is published. Server-side of the application also uses information extraction to access and retrieve information and accompanying documentation.

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Figure 1. The Case-based reasoning Cycle (adopted from [8]Amond & Plaza, 1994)

- **REtrive**: isolates cases from the case-base most similar to the current problem at hand;
- **REuse**: isolated cases are used in attempt to solve the problem or propose a possible solution;
The other database is used as knowledge base. It contains data about past tenders and evaluation information supplied by client users. As new calls for tenders become available this information is used for case-based reasoning providing information about preparing optimized proposals, estimating other characteristics of the tender and calculating possible expectations in terms of contract negotiation, ordering and payment. All of this information is made available to potential contractors through the client application to enhance their decision making procedures.

Client-side application contains reporting capabilities for displaying information about currently opened calls for tenders of interest. The data is retrieved from Server side database using search criteria such as CPV, NUTS, and other information. If a potential contractor chooses to create a proposal for a particular call for tenders additional functionalities that can assist in creating proposals are activated. During this process potential contractor can evaluate different stages of the process while the application notes current status of the proposal preparation process.

If the potential contractor does not win the tender he will be asked to evaluate submission and awarding process. If the potential contractor wins a tender he will be asked to evaluate the contract and purchaser in terms of adherence to contract terms and conditions after the expiry of the contract. The collected information describes crucial points during the public procurement process as shown in Fig. 3. This information is sent by client-side application to the server-side application and stored in the knowledge base. Before information is stored all of the data is depersonalized to protect confidentiality of information.

![Figure 2. Conceptual model of the Public Knowledge base for Public Procurement](image)

![Figure 3. Interconnection of the Knowledge-base system and Public eProcurement framework](image)
5 Discussion

As we have described the public procurement information is made available over the Internet and Web. The publication of tenders is widely available but the tools that can help potential contractors in preparation of their proposals, bills of quantities, terms and conditions of their deliveries are not supplied by the framework. Furthermore, innovative tools for better estimations about properties of the procurement notices and procurement purchasers, their rating in terms of payments and expectations is required. These tools can improve overall procurement processes within a certain industry or geographical unit or entire national economy by promoting credibility of purchasers and quality and even specialization of contractors.

The described public knowledge base system for public procurement can promote efficiency of the overall procurement process.

The contracting authorities and purchasers are motivated to make fair assessments of received proposals due to the transparency of the assessment process. They are also encouraged to adhere to the terms and conditions in eContract in terms of ordering and payments in order to generate more potential contractors with even better proposals in next round of procurement tenders.

Contractors are encouraged to submit their proposals to contracting authorities with best reputation; also they can improve their proposals using previous experiences shared publically. Some of the contractors may find it suitable to specialize for certain types of tenders where they can give the best terms and conditions in their proposals, making it more likely that they get awarded future tenders.

6 Conclusion

Procurement of public goods, services and works is one of core activities for every government. If the procurement process is conducted using electronic means i.e. Internet a considerable effort is required to standardize this process and achieve the openness, transparency and non-discrimination of the overall process. European Commission has established a framework that enables member countries to implement electronic procurement in a standardized way. The framework consists of 10 core eModules that can produce additional meta-data about the procurement process that can be collection.

In this paper we have presented a conceptual model of knowledge base for public eProcurement that collects this data and stores it in a database. Using case-based reasoning new knowledge about particular tenders or contracting authorities can be extracted and then shared with all the stakeholders. Potential contractors can use this knowledge to make better decisions when deciding to participate in a tender or while preparing proposals. The effects of using public knowledge about eProcurement can result in improved efficiency of public procurement process on a national level.

In the future stage of this research the proposed model will be further developed in terms of defining data models and developing functionalities of the case based reasoning algorithm that can satisfy information needs of procurement stakeholders.

References:


