

## BPMN ANALYSIS OF PUBLIC PROCUREMENT\*

Maria Semerdjieva, Evgeniy Krastev

**ABSTRACT.** This paper formulates a realistic case study of a public procurement process, where the national legal system is taken in consideration. Business Process Modeling Notation (BPMN) is used for encoding processes related to the analysis of public procurement tasks. Critical elements in the public procurement process that affect time, quality and cost are identified at the organizational, process execution and system levels. The main phases of public procurement are described and problems related to each phase are distinguished. A BPMN collaboration diagram is used to show how different participants in a process are related and interact with each other. Choreography diagrams of the latest version of BPMN are being used to model the abstract behavior of the participants in business interactions for the purpose of providing a standard mapping to the Business Process Execution Language for Web Services (BPEL) and enable the execution of this behavior.

**1. Introduction.** Public Procurement (PP) is the process of implementing a legal framework of procedures by means of which all levels of government and public agencies buy goods and services or commission work. PP

---

*ACM Computing Classification System* (1998): D.0, D.2.11.

*Key words:* Business Process Management, Modeling, BPMN, Public Procurement.

\*This work is supported by the National Scientific Research Fund of Bulgaria under the Contract ДТТК02-69/2009.

contracts represent about 16% of the EU gross domestic product of the EU market. The objective of PP is to select contractors by means of harmonized transparent procedures. EU promotes e-procurement, where the Action Plan for e-procurement 2010 is being considered as a solution to typical problems in the implementation of the PP process as follows:

- Ensuring timely access to relevant information.
- Alleviating the administrative burden.
- Giving sufficient time to draw up tenders.
- Efficient coordination of PP activities.

Some of these problems are also subject to regulation by relevant national and EU Community legal framework and practice.

The software implementation of public procurement typically results in a complex software architecture that is difficult to manage and accommodate in terms of the frequently changing legal framework and practice [1]. The basic approach to investigating such case studies focuses on Business Process Modeling (BPM) [11], [2], [3], [4], [4]. It starts by an analysis of the business process management layer that is used to manage, maintain and operate the core business processes, including the process's modeling and simulation, deployment and execution, business activity management and real-time process monitor. This layer integrates all kinds of business rules and logic [12], that are subject to optimization. BPM is an improvement of process management and highlights the importance of process in enterprises. Business Process Modeling Notation (BPMN) offers BPM a standard approach to optimize such case studies [7], [10]. A key point in using BPMN is the integration of application systems for the purpose of getting quick response to change of business rules.

In this paper we formulate a realistic PP case study according to the national legal system. Our approach aims to implement a BPMN model of the PP business process and identify the critical elements in this model that affect Time, Quality and Cost at Organization, Process execution and System levels.

**2. Case Study.** The sources of this paper are publications in National media and the Agency for public procurement providing a legal system for management of public procurement in accordance with the national law requirements and ECC recommendations [6], [1]. Additionally, definitions of key problems are based on customer's interviews.

PP procedures are generally represented by two main phases—procurement and purchasing (Fig. 1). Each of these phases is a complicated business process. In this paper we are going to consider only the procurement process.

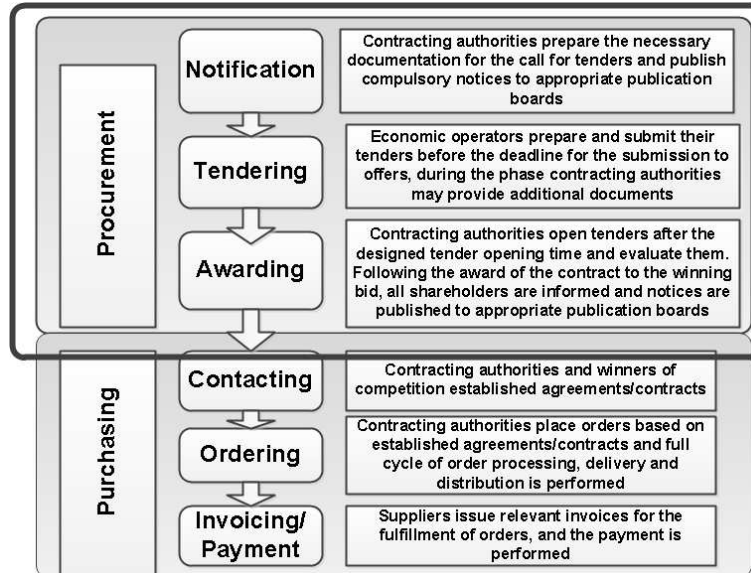


Fig. 1. Main phases of PP procedures according to the ECC

To describe the main problems that occur at the Organizational, Process and System levels we divide the procurement process at each of these levels into four distinct business processes (Fig. 2).

This uniform architecture of the three levels of the procurement process allows analyzing the main information processing problems of this process in detail. In particular:

- The Creation of public procurement stage refers to contracting authorities and determines the procurement type and financial parameters, depending on the PP requirements. Contracting authorities should determine the responsibilities and the respective authorized persons.
- The stage of Executing procedure deals with preparing the necessary documentation from contracting authorities to calling for tenders and publishing compulsory notices to appropriate publications boards, which is the agency for public procurement, national newspaper and(or) the EC. Economic operators prepare and submit their tenders before the deadline for the submission of offers.

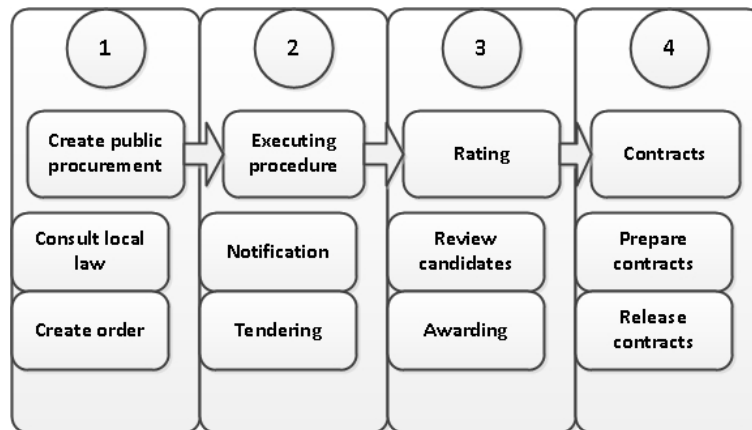


Fig. 2. Main stages of procurement process

- The stage of Rating deals with opening tenders after the specified tender opening time or may cancel or prolong the procedure in case there are not enough tenders or on the basis of a decision of the contracting authorities. Following the award of the contract to the winning bid, all stakeholders are informed and notices are published to the appropriate publication boards.
- At the stage of Contracts contracting authorities and winners of competitions sign agreements/contracts.

There is a National Bulgarian agency of public procurement [6] and local law, but problems related to PP process management still exist. Some of the most important problems are the following:

- There are many different documents that have to be processed in a non-systematic way through the stages in the procurement process.
- There are many people involved in the procurement process and this makes the process prone to mistakes in the decision making.
- There are co-ordinations between different departments and companies that lead to misunderstandings.
- Prolonging the procedures of the initial assignment is allowed and it may lead to a delay in providing solutions of important problems.
- There are frequent changes in the law.

- Decisions made at different stages of the procurement process are unclear to the public.

The existence of management problems focuses the attention on performance measurement in PP and optimizing the process in accordance with the main set of objectives. Performance management of PP is a complex matter that involves establishing baseline requirements and a set of performance indicators [14]. In this case study we have adopted performance criteria that are generally referred to as Time, Quality and Cost depending on the indicator used. For clarity, Time refers to the set of input and output indicators related to the regularity of data production and the execution duration of a task or a system of tasks in PP. Quality relates to input and output indicators that focus on efficiency in the use of public funds. Cost includes input and output indicators that relate to delivering “value for money” in the use of public funds. A common approach to establishing appropriate indicator values is to employ a benchmarking method. By means of benchmarking various aspects of PP operations of a similar contracting authority known for its excellence are being used as a performance target.

**3. BPMN approach objectives.** To define and manage the problems that occur in the procurement process we employ BPMN. It allows to:

- Review the co-ordination process among participants.
- Prepare a process flow ready to analyze.
- Review how time delays can be reduced.
- Analyze the impact of changes in the model and the involvement of the human factor with respect to the Time, Quality and Cost parameters of the PP process.

BPMN is the new standard for modeling the business process flows and web services, created by the Business Process Management Initiative (BPMI). This standard provides a notation that is readily understandable by all business users [10]. This includes the business analysts that create the initial drafts of the processes to the technical developers responsible for implementing the technology that will perform those processes.

BPMN ensures that XML languages designed for the execution of business processes, such as BPEL4WS (Business Process Execution Language for Web Services) and BPML (Business Process Modeling Language), can be visually expressed with a common notation [5], [9]:

- **Choreographies and Conversations**, introduced with BPMN 2.0 enable modelers to describe interactions among different participants as well as message exchange.
- **Gateways** are used to model control flow branching in BPMN. Gateways split and join sequence flow.
- **Pools represent the participants** in a collaboration diagram. They are used to show the change of control within the process.
- **An event** is something that “happens” during the course of a business process.
- **Events** are discovered when an event or multiple events occur that match the pattern’s definition. Sense and respond rules allow combining one or more event patterns with arbitrary event conditions in order to describe complex business situations [13].
- **An activity** is a generic term for work that a company performs.

**4. BPMN Model of Public Procurement.** BPMN allows presenting a general view of the procurement process through a collaboration diagram (Fig. 3). This diagram shows the main participants in the process, which are separated by roles. These roles can be shown using pools, swim lanes (or lanes) that are supported in BPMN collaboration diagrams. It allows us to monitor message and activity flow between all units involved in a process. Now we can review the procurement process in BPMN, where the separate stages have been described in Fig. 2.

The process of Creating a public procurement is a starting point of all activities and it is very important for the proper functioning of the process (Fig. 4).

Processes that are executed at the Organization level determine the type of procurement, depending on national law and information in the purchasing area.

There is a national agency of public procurement and references to law, but still it is hard for organizations to choose the right procurement type in the manner specified by law. This leads to a waste of time. Incompetence in this area leads to delays and financial losses.

At the Process level we establish problems related to improper sets of responsibilities and authorization competencies.

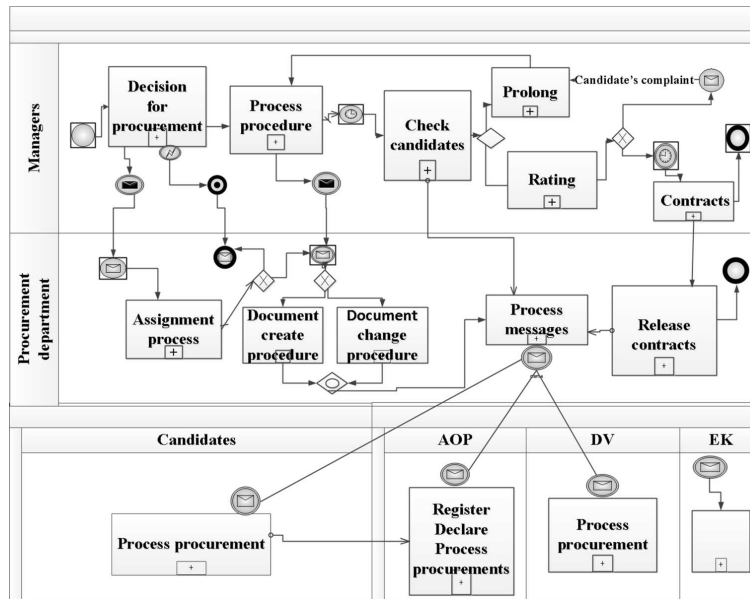


Fig. 3. A general view of the PP process collaboration diagram

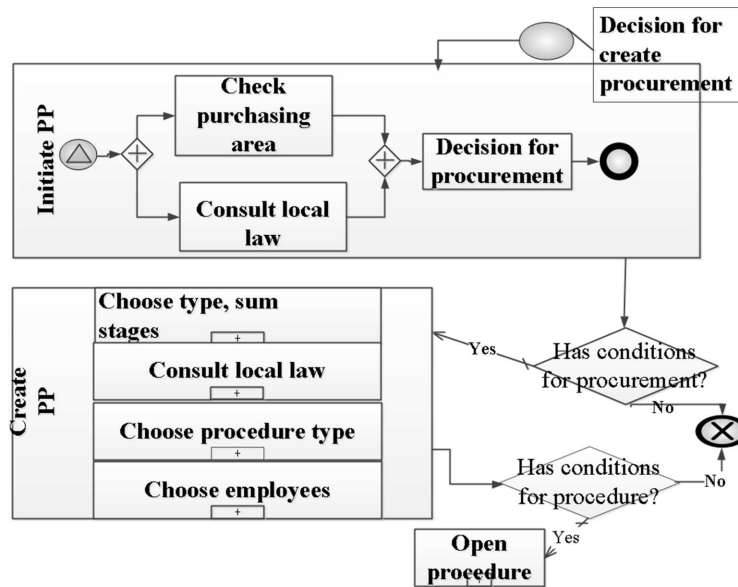


Fig. 4. The process of creating public procurement

At the System level there are many periods of time without system support, because there are no common systems or services which are related to cover all stationary rules and orders. After the creation of the procurement procedure, the process of the execution of this procedure begins.

The process of the procedure execution is quite complicated (Fig. 5). Its starting point is the process of the opening of the procurement procedure. During the opening procedure all the terms of sending information and receiving applications from potential candidates must be set, depending on the national law. A Commission for rating should be selected and all the tasks of informing tenders and appropriate publication boards should be executed.

At the Organizational level, the different times for response from candidates per purchasing area leads to prolonged procurement procedures and time delay problems.

At the Process level it is usually difficult to implement the editing requirements for the constantly changing business rules.

At the System level, there are often changes in the legal requirements that lead to difficult transformation of legacy software to implement these changes.

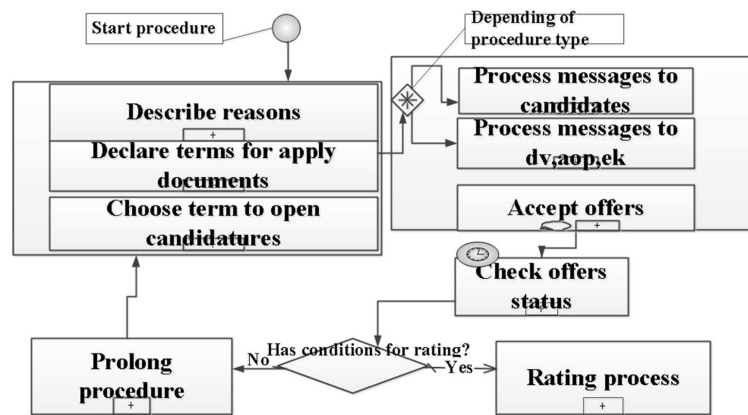


Fig. 5. BPMN for executing a procurement procedure

The notification correspondence flow is not even under system cover. All these disadvantages lead to time delays and misunderstandings between participants.

The stage of the execution of the procurement procedure can be finished with rating or by a prolonging procedure, depending on the candidate's status and the tenders received. If there are enough conditions for starting the rating, the procurement procedure is prolonged and the steps for the processing of the



procurement procedure are repeated.

When enough tenders' offers are received, the process of rating is initiated. A model of the rating process flow is shown as a BPMN diagram in Fig. 6.

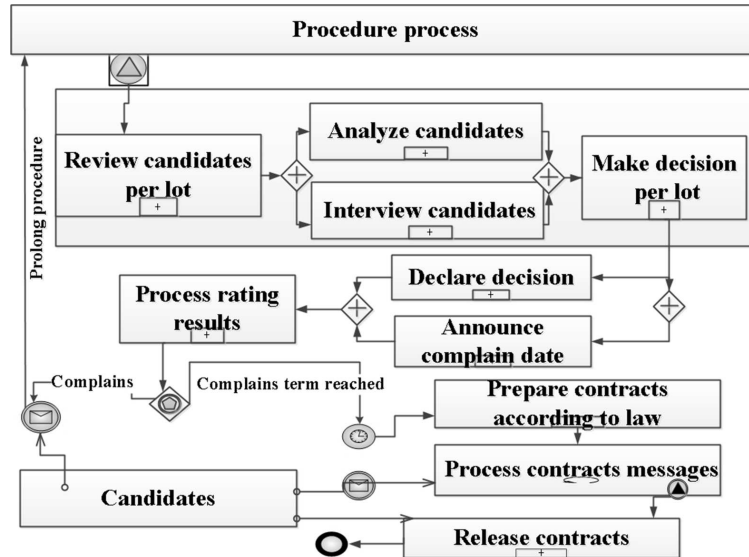


Fig. 6. The Rating process model

During the Rating process the problems at the Organization level comprise lack of competencies in the purchasing area and incomplete requirements for rating. Usually no clear criteria are observed. Complaints from candidates can prolong the procedure.

At the Process level there is no “Fit-to-Organization” standard process. There are no standard data models. Eventual complaints from candidates lead to prolonged procedure loops.

Finally, at the System level of the Rating process there are many idle periods of time without systematic support. Consequently, an inappropriate candidate may be chosen and the risk of corruption increases.

The last phase that is being investigated is the Contracts process. Problems identified in the Contracts process are related to the involvement of the human factor at all three levels (Organizational, Process and System). The reason for the majority of these problems at the Organizational and Process level resides in intensive and scattered data processing activities performed by the personnel, manual correction of un-coordinated process steps, as well as the lack of traceability between the steps of tasks that are being executed manually. On the

other hand, the difference between the software system solutions and proprietary software employed at the System level results in substantial operational costs. Additionally, the use of heterogeneous software is the reason for poor integration of information systems, poor communication between the participants in the process, and also results in serious time delays in the Contacts process execution and increases the cost of the whole procurement procedure.

**5. Conclusion.** The overall PP process flow is evaluated in terms of the following characteristics:

- Time (response delays, sequential processing of activity, uncertainty due to the impact of the human factor etc.)
- Quality (information processing, non-standard data modeling, poor traceability of activities and reporting of execution)
- Cost (administration, processing steps etc.)

The overall PP process flow can be improved by:

- Time (unified model for exception and event handling, concurrent and asynchronous task processing )
- Quality (Data access for area of public procurement can be standardized)
- Cost (Minimizing the impact of the human factor and quantity of documents.)

The approach to investigating the PP process in terms of formal representation by BPMN diagrams proposed here facilitates the documentation of business rules.

The next step in this research is to develop an improved BPMN model of the PP process in terms of the time, quality and cost parameters subject to the documented business rules. It also involves solving the Reverse engineering problem, where the set of business rules documented with BPMN modeling is being updated with the business rules extracted from legacy source code that is subject to improvement. The objective is to create a standard mapping to the Business Process Execution Language for Web Services (BPEL) to enable the execution of this improved process behavior.

## REFERENCES

- [1] Commission of the European Communities. European Code of Best Practices Facilitating Access by SMEs to Public Procurement Contracts. Brussels, 25.6.2008, SEC(2008) 2193.  
[http://ec.europa.eu/internal\\_market/publicprocurement/docs/sme\\_code\\_of\\_best\\_practices\\_en.pdf](http://ec.europa.eu/internal_market/publicprocurement/docs/sme_code_of_best_practices_en.pdf)
- [2] Commission of the European Communities. IDABC e-Invoicing and e-Ordering project for public procurement. e-Catalogue Feasibility Study. DIGIT/B4, MARKT/C4, 2009.  
<http://ec.europa.eu/idabc/servlets/Doc1808.pdf?id=32432>
- [3] IDABC program. Software demonstrators for eProcurement. September 2009. <http://ec.europa.eu/idabc/en/document/3488/5874.html>
- [4] Commission of the European Communities. Analysis of Business Requirements for e-Invoicing in a Public Procurement Context. Version 1.1, 2009.  
<http://ec.europa.eu/idabc/servlets/Doc9a95.pdf?id=32108>
- [5] OASIS. Web Services Business Process Execution Language". OASIS Standard, April 2007.  
<http://docs.oasis-open.org/wsbpel/2.0/OS/wsbpel-v2.0-OS.html>
- [6] Public Procurement Portal. Public Procurement Agency. Legal Framework. 2011. [http://rop3-app1.aop.bg:7778/portal/page?\\_pageid=173,1082252&\\_dad=portal&\\_schema=PORTAL](http://rop3-app1.aop.bg:7778/portal/page?_pageid=173,1082252&_dad=portal&_schema=PORTAL)
- [7] Object Management Group. Business Process Model and Notation Specification, Version 2.0. dtc/2010-05-04, January 2011.  
<http://www.omg.org/spec/BPMN/2.0>.
- [8] DAVIS R. ARIS Design Platform. Springer- Verlag, London Limited 2008.
- [9] OWEN M., J. RAJ. BPMN and Business Process Management. Popkin Software, 2003.  
[http://www.omg.org/bpmn/Documents/6AD5D16960.BPMN\\_and\\_BPM.pdf](http://www.omg.org/bpmn/Documents/6AD5D16960.BPMN_and_BPM.pdf)
- [10] SHAPIRO R., ET. AL. BPMN 2.0 Handbook. Future Strategies Inc., 2010.
- [11] LING C., L. XIN. Achieving Business Agility by Integrating SOA and BPM Technology. In: Proceedings of the 2009 International Forum on Information Technology and Applications, Vol. 1, 334–337.

- [12] CARTER SANDY. The Role of Business Process Management in SOA. Information Management Magazine, May 2007.  
<http://www.information-management.com/issues/20070501/1082553-1.html>
- [13] SCHIEFER J., et. al. Event-Driven Rules for Sensing and Responding to Business Situations. In: Proceedings of the 2007 inaugural international conference on Distributed event-based systems DEBS '07, June 20-22, 2007 Toronto, Ontario, Canada, 198–205.
- [14] SIGMA (Support for Improvement in Governance and Management). Performance measurement. Public Procurement Policy Briefs, Brief 21, 2011.  
<http://www.sigmaxweb.org/dataoecd/61/48/48630147.pdf>

*Maria Semerdjieva*  
*Faculty of Mathematics and Informatics*  
*Department of Information Technologies*  
*St. Kl. Ohridsky University of Sofia*  
*5, J. Bourchier Blvd*  
*1164 Sofia, Bulgaria*  
*e-mail: maria\_semerdjieva@yahoo.com*

*Evgeniy Krastev*  
*Faculty of Mathematics and Informatics*  
*Department of Information Technologies*  
*St. Kl. Ohridsky University of Sofia*  
*5, J. Bourchier Blvd*  
*1164 Sofia, Bulgaria*  
*e-mail: ekrustev@gmail.com*

*Received March 2, 2012*  
*Final Accepted June 11, 2012*