Computer Supported Contractor Selection for Public Administration Ventures

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ABSTRACT
Ventures undertaken by public administration significantly contribute to development of economy. Such ventures are usually complex, so they require effective collaboration of a number of autonomous organizations. To face the challenge of efficient cooperation, public administration should adopt the model of *Virtual Organizations (VO)*. A key phase in each *VO* life-cycle is *selection of partners* which in case of public administration takes a form of *public auctions.* In this paper a *Collaborative Contractor Selection* method, denoted *C-CS*, is proposed to support selection of contractors for a portfolio of public ventures. In the *C-CS* method a number of requirements are considered associated with contractor offer properties, contractor competences, and social relationships among them. The selection is performed step by step as successive ventures are performed. If justified, the selection is done in collaboration between administrative units and potential contractors. The *C-CS* method provides an opportunity for better computer support of public auctions leading to more efficient and effective realization of public administration ventures.

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K.4.3 **[Computers and Society]:** Organizational Impacts: reengineering, computer-supported collaborative work

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Economics, Human Factors, Performance, Design, Algorithms

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1. INTRODUCTION
In every country, public administration is a significant economical actor, quite often a major one. Ventures undertaken by public administration are usually complex and cannot be handled by a single organization but require effective collaboration of a number of autonomous organizations from both the public and private sector. Cooperation on complex ventures is usually a challenge for public administrations. To face this challenge, public administration should adopt the model of *Virtual Organizations (VO)* [1, 2, 3] which permits to deal with complexity, pursuit for agility, and take advantages of broad use of information technologies in economic and managerial operations. VO is "a set of at least two autonomous partners, where at least one of them is an organization, cooperating within a particular structure of social and legal relationships in order to carry out a particular venture due to the demand from virtual organization clients and having a plan to carry out this venture" [4]. *Partners* collaborating within a VO are organizations – enterprises, public administration units, and non-government organizations – people, and information systems.

The success of a VO strongly depends on ability of all participating organizations to efficiently and seamlessly cooperate via Internet. Good level of cooperation may be achieved by an appropriate selection of partners. In case of public administration ventures this selection takes a form of *public auctions*. In European Union, approaches to conducting a public auction are regulated by two main directives 2004/17/EC and 2004/18/EC [5].

Due to importance and complexity of partner selection problem, a number of computer supported methods has already been proposed. Modern approaches to modeling cooperation among organizations are built around the concept of service and the paradigm of Service-Oriented Architecture (SOA) [2]. Examples of methods supporting selection of partners and service for VO have been described in [6, 7]. In some of the proposed methods [2, 8] existence of Virtual Organization Breeding Environment VOBE is assumed. Public administration playing a role of VOBE is presented in [1]. So far, none of the proposed methods, has been evaluated for the use in public auctions. Existing methods have the following shortcoming preventing them from effective application to contractor selection for public administration ventures: (a) the aspect of past collaboration between potential contractors is not included; (b) it is assumed that the process model of a venture is known in advance and that it does not change; (c) all the partners are selected before a

venture starts, while in practice new partners may be required when the venture progress, or some initially selected partners may appear useless so the evolving aspect of the partner selection is not addressed.

In this paper a *C-CS* method is presented in which selection of contractors based on multi-variant analysis is not seen as a single act, but as a process conducted in parallel to the public administration ventures. In the *C-CS* method legal restrictions following from the public auctions are taken into account. The *C-CS* method takes advantage of process mining techniques for analysis of past contractor selections and provides recommendations for ongoing and future contractor selections processes. The above features make the *C-CS* method well suited for big public administration ventures.

The remainder of this paper is organized as follows. In Section 2, the main law regulations concerning public contracts and public auctions are presented. In Section 3, the approach to selection of partners to portfolio of projects is justified. In Section 4, the proposed *C-CS* method supporting contractor selection is presented. Finally, Section 4 concludes the paper.

2. PUBLIC AUCTIONS IN EUROPEAN UNION

The aim of a public auction is to elaborate a *public contract* between one or more economic operators and one or more contracting authorities. *Contracting authorities* mean here the state, regional or local authorities, bodies governed by public law or their groups. An *economic operator* is understood as any organization which offers on the market products or services. An economic operator or a set of economic operators undersigning a public contract and responsible for its realization is called a *contractor*.

European Union directives define five main procedures allowing contractors to be selected: *open procedures*, *restricted procedures*, *competitive dialogue*, *negotiated procedures*, and *design contests*. To establish a *complex public contract* defined as a one where "the contracting authorities: are not objectively able to define the technical means, capable of satisfying their needs or objectives, and/or are not objectively able to specify the legal and/or financial makeup of a project" competitive dialog or negotiated procedure procedures are used.

Conduction of the competitive dialog and negotiations is based on collaboration that takes place on two levels: (1) inside public administration units, and (2) among public administration and candidates for contractors. Collaboration inside public administration units arises during preparation of public auction and during the interaction with candidate contractors. Collaboration concerns *contractor selection participants* comprising domain experts, public administration unit representatives, legal and technical advisors, non-government organizations, etc. Collaboration aims at: (1) definition of the contract notice content; (2) agreement on the set of economic contractors invited to take part in selection procedures; (3) evaluation of offer variants submitted by candidates during negotiations and dialog. Cooperation on the second level with economic contractor is the essence of negotiation and competitive dialog. It relies on exchange of information aiming at identification and definition of the means best suited to satisfying the needs of contracting authorities.

A basic observation is that public administration usually has to conduct not just one but a portfolio of projects. A common approach to management of such projects favored by public administration is selection of one contractor per project. In this approach, however, the managerial role of public administration is reduced to supervision. A contractor manages a network of specialized organizations executing different tasks comprising the project. Currently, public administration is focused on selection of contractors for single ventures in separation from one another, while paying not enough attention to the holistic view of the whole portfolio of ventures. As a result, contractor selection for public administration ventures is not performed effectively and often leads to non-effective realization of public ventures.

Current approaches to contractor selection for public administration ventures has the following shortcomings: (1) limited support for analysis of potential contractors in terms of relationships existing among them, while these relationships can have a great impact on efficiency of realization of the portfolio of projects; (2) limited support for analysis of correlation among former and ongoing public auctions, while the result or the course of one public auction should be taken into account during others; (3) limited support for analysis of sets of economic contractors involved in many public auctions; (4) limited sharing of good practices concerning public auctions among public administration units due to the fact that such practices are difficult to be identified; such good practices may concern used requirements, definition of public auction scope, association among auctions and projects, economic contractors, experts, public administration units, non-government organizations involved in the selection process, and invited economic operators for negotiations.

3. CONTRACTOR SELECTION FOR PORTFOLIO OF VENTURES

To deal with drawbacks of the current selection process, it is necessary to change the approach to conduction of public auctions and management of public administration project portfolio. In this paper we propose to consider a portfolio of projects and apply a coordinated partner selection process in a number of auctions to all the projects contained in the portfolio, instead of selecting independently a contractor per project. The contractors selected need to be able to mutually communicate, synchronize, and cooperate to efficiently realize a set of projects. Thus, in the proposed approach analysis of interrelations among potential contractors is included. Public administration together with all the contractors (a contractor per project) constitute a VO within which they collaborate as partners to conduct a portfolio of projects. The *Collaborative Contractor Selection (C-CS)* method proposed in this paper in Section 4 refers to computer support of two the most complex cases of public auctions, i.e. competitive dialog or negotiated procedure.

In the *C-CS* method the *contractor selection for public administration venture* is a process consisting of a set of possibly overlapping public auctions associated with a set of projects. These auctions lead to definition of a set of public contracts associated with the execution of projects comprising project portfolio. The input for starting a contractor selection process for

public administration is a project portfolio. *Contractor selection process* encompasses: (1) definition of a set of public auctions to be conducted for the project portfolio, relationships existing among these auctions, and main assumptions of these auctions; (2) conduction of the public auctions, where each auction is followed by establishment of a public contract for each project; (3) if applicable, as contractor selection proceeds (i.e. subsequent auctions are performed and concluded), redefinition of the set of auctions, relationships among them, their scope and assumptions. Step 3 captures the evolving aspect of contractor selection. Contractor selection is completed when all the projects from the project portfolio have assigned public contracts.

4. C-CS METHOD

The *C-CS* method is a refinement of the *MAPSS* method proposed in [8]. The refinement of the method encompasses: (1) selection of contractors for a subset of projects composing a portfolio– economic operators are not assigned to all the projects at once; (2) analysis of social relations among contractors selected during several public auctions; (3) collaborative approach to contractor selection involving interested parties; (4) support for contractor selection participant activities by recommendation of good practices in the form of activity patterns; (5) support for analysis of various variants of possible assignment of contractors to projects, where variant evaluation is based on requirements and preferences of selection process participants including social aspects.

4.1 C-CS concept

It is assumed that a contractor selection process consists of a set of public auctions. he aim of each public auction is to find a *contractor* providing the best *offer* that observes the requirements: (1) defined in the public notice and (2) imposed on an auction as a consequence of already completed auctions. Such constraints usually take a form of social requirements. They follow from a holistic approach to selection of contractors for a portfolio of projects. Subsequent auctions may be organized in parallel to venture proceeding.

A *contractor specification* is a set of requirements that an economic operator must satisfy to be assigned to a particular public contract. An *offer specification* is a set of requirements that an offer of an economic operator must satisfy to be assigned to a particular public contract. *Social requirements* concern relationships among contractors. An *acceptable contractor* is an economic operator satisfying requirements defined in the contractor specification. An *acceptable offer* is an economic operator offer satisfying requirements defined in the offer specification.

Public contract specification is a pair: <*contractor specification, offer specification*>. An *acceptable public contract* is a pair <*acceptable contractor, acceptable offer*>. Requirements defined in a specification may refer to expected experience of contractor, financial stability, etc. Social requirements express dependencies among contractors being public auction outputs. Note that each acceptable contractor can be a VO. Thus, requirements defined in contractor specification may refer also to internal structure of such a VO, e.g., a requirement concerning maximum number of subcontractors. Social relationships may concern: past cooperation, recognition, former financial exchange, etc.

4.2 Overview of *C-CS* phases

In every stage of contractor selection, the *C-CS* method consists of four phases and follows the general selection method guidelines presented in [2]: (1) specification of public auctions envisioned for contractor selection stage – definition of requirements and associated evaluation criteria (preferences, fitness function); this phase is performed within public administration and its output is published in a form of contract notices; (2) contractor analysis prior negotiations – the set of acceptable public contracts is created and analyzed internally within public administration; the aim of the analysis is to define the best possible contractor group that the public administration will strive to achieve; such analysis is used for preparation of a set of economic operators to be invited to participate in negotiations or a competitive dialog; (3) contractor analysis during negotiations – the set of acceptable public contracts is created on the basis of acceptable offers submitted by candidate contractors during negotiation or competitive dialog; the aim of the analysis is to identify the group of best acceptable public contracts or indicate the shortcoming of the acceptable public contracts being currently negotiated; (4) stage conclusion – selection of the best acceptable public contract for each public auction envisioned in this contract selection stage.

All the phases of the *C-CS* method are performed in a collaborative manner. Phase 1 assumes collaboration of public administration units, employees, domain experts and others. Phases 2-4 include in addition acceptable contractors.

4.3 Information model and selection technique

The *C-CS* method is based on the concept of public administration being a VOBE [1]. It is assumed that public administration collects information concerning former public auctions and their results for future reuse. Collected information may include properly documented former experience of economic operators or recommendations from former clients. Such information refers both to single economic operators as well as relationships among them. Such information is stored in a repository consisting of four modules: (1) contractor and offer specification module – provides relevant information concerning economic operators, their operations and their offers (offer variants) submitted during past and current public auctions, (2) social network module – provides information about relationships among contractors and between contractors and their offers, (3) requirement module – provides information concerning requirements used in various public auctions; (4) participant's activity module – stores information concerning activities performed by contractor selection process participants throughout selection processes.

The *C-CS* method aims at finding a subset of economic contractors and offers submitted for an ongoing auction and stored in the repository that are best suited for activities analyzed during a given contractor selection stage. The contractor selection is performed on the basis of specification created in Phase 1. As the result of the specification phase, the formulated public contract specifications are published in a form of public notices and a set of requirements concerning social relationships. Requirements associated with specifications may be selected from the repository or created for the need of a particular contractor

selection stage. Definition of requirements for contractor selection includes also definition of: (1) *preferred value*; (2) *fitness functions*. In Phase 2 and Phase 3, contractor analysis is divided into two steps: (1) acceptable public contract analysis, (2) acceptable public contract group analysis.

In the *acceptable public contract analysis step*, on the basis of public contract specifications defined in Phase 1, a set of acceptable public contracts is created for each public contract specification. Identified acceptable public contracts are ranked according to the level of conformance to corresponding specification. The conformance is calculated on the basis of preferences and fitness functions defined in Phase 1. Analysis performed in this step is followed by effective selection of promising acceptable public contracts and rejection of those that should be disregarded. The number of potential acceptable public contract group that may be constituted for the contractor selection stage with acceptable public contracts identified in the previous step is usually high. The goal of *acceptable public contract group analysis* step is to search for a sorted list of acceptable public contract group ranked according to a *fitness function*. This step takes advantage of technique proposed as a part of the *MAPSS* method [8]. Genetic algorithm is used for generation of optimal acceptable public contract groups ranked according to a fitness function. In this phase each contractor selection participant may define his/her own fitness function. Thus, suggestion concerning best acceptable public contract groups may be different depending on a participant. In this phase, social relationships among acceptable contractors are verified and validated.

In the *stage conclusion* phase, once all public contract specifications that are defined for contractor selection stage have assigned acceptable public contracts, this fact is registered in the repository. If applicable, this stage encompasses redefinition of the set of planned upcoming auctions, relationships among them, their scope and assumptions

4.4 Recommendations during contractor selection

Characteristics of a contractor selection process are such that in general prediction of its full course is impossible. Nevertheless, identification of its repeatable parts is useful in context of boosting efficiency of selection execution and promotion of good practices among selection process participants, especially those being representatives of public administration.

Mechanism of recommendation in the *C-CS* method aims to detect activity patterns in contractor selection process, where *activity pattern* is a set of activities that are frequently performed in a structured way in a particular context by a contractor selection participant. Identified activity patterns are later recommended to other selection participants. Identification of activity patterns is possible due to information stored in participant's activity module of the repository. To identify activity patterns, the approach presented in [4] is used.

5. CONCLUSIONS

The *C-CS* method contributes to increased efficiency of the contractor selection process. It is achieved by computer support for multi-variant automatic analysis of economic operators and offers submitted by them. A structured approach is proposed to definition and reuse of requirements, stored in a repository in a form of contractor or offer specifications. An important aspect of the *C-CS* method is an analysis of relationships among candidate contractors from various ongoing or completed public auctions. Such analysis eliminates the risk of selection of a set of contractors unable to mutually collaborate which could lead to one or more project failures. Identification of activity patterns in every phase of the *C-CS* method addresses the problem of process evolution and unpredictability. Activity patterns allow good practices to be identified and reused. Recommendations generated on the basis of activity patterns enable more effective execution of contractor selections.

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