An Ontology-Based Approach to Use Requirements Engineering in Portals of Transparency

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Abstract. *For information technology professionals can develop systems that assist in governance and in meeting the obligations given by the legislation, they need to understand the conceptual basis involved in the complex areas of the problems experienced by local governments. The lack of standardized concepts complicates the process and elicitation of validation requirements for the development of new software systems.Given this reality, we present an ontology for bids and administrative contracts and propose a form of application of this ontology in the activities of Requirements Engineering. This will provide software engineers an alternative way to verify the elicited requirements seeking to ensure that the software meets the needs of public administration, as the obligations foreseen in law.*

1. Introduction

With the rapid growth of urban centers and technological resources, the challenges faced by public administrations increase significantly. This requires increasingly fast and efficient actions in the use of information and communication technologies to ensure constant interaction between government and citizens. To the needs and changing obligations, there is the publication of government data on the Internet. For that government actions can be developed with quality information systems that promote communication between the public and government levels, they have become indispensable.

One of the biggest challenges faced by software developers to the government area is the complex and non-standard structures. This reality makes it difficult to understand and build the necessary knowledge to solve government problems. With the aim to facilitate the software development process and enable the understanding, sharing and exchange of information between people, devices and computers, we understand how important the definition of conceptual and structural patterns. From this standardization, requirements engineers can minimize the difficulties encountered in the process of knowledge of the problem domain, as they will have access to an organized and documented conceptual framework that will facilitate the understanding of definitions and concepts presented by professionals in the government area.

In this context, with the goal of facilitate the activities of requirements engineering, we present a domain ontology for bids and administrative contracts.

This ontology aims to standardize the structure of the information, which is essential and necessary for the understanding of the domain and the process for defining software requirements in the municipal area. The application of ontology in requirements engineering activities allow verification, analysis and the formulation of

suggestions for improvements in search of a definition of requirements concise and consistent with the real needs and interests of the government and the population.

This paper is organized as follows. Section 2 presents the theoretical framework and related work. Section 3 describes the materials and methods used to build the ontology and for the definition of the application process engineering requirements. The final considerations are presented in Section 4.

2. Theoretical Background

In this section, we present the issues discussed in the literature review. For its realization, we established the relationship between each subject studied and the purpose of this work. Thus, we present the definitions, concepts and state of the art on Electronic Government, Public Transparency, Ontology and Requirements Engineering and discussed related work.

2.1. Electronic Government

Faced with the rapid growth of urban areas in recent times, many challenges have emerged and many are yet to come, as the next two decades the cities of developing countries concentrate 80% of the urban population of the planet (Leite & Awad, 2012). This intense migration of population to urban areas is accompanied by great challenges aimed at improving the organization and quality of life. The rapid process of urbanization and the emerging population classes put enormous pressure on cities, increased the demand for social services and benefits imposing complex fiscal, institutional and political challenges. This pressure is directly related to municipal government for being the first level of responsibility in the chain of implementation of public policies (Macroplan, 2013). In this situation, it is expected that government authorities and society know how to use the available resources wisely, intensively exploring existing technologies and innovations in search of higher productivity and quality of services.

In addition to innovations in information technology, infrastructure and urban mobility, a number of achievements in recent years in the world are related to governance. The government seeks the creation of mechanisms aimed at strengthening the communication links with the population and can thus improve public management through the implementation of information and communication technologies to build a participatory and collaborative government (Leite & Awad, 2012). In this context, it highlights the creation of technological means that integrate and bring together public services and society, enabling public participation in monitoring management (Macroplan, 2013). This was the purpose of the adoption of e-government, increase the supply and improve the quality of available information and services to the society.

The current challenges are facing the development of an effective policy data opening and stimulating citizen so that it realizes that technological resources used in their daily life can be used as political tools, making it an active member of a participatory government (Lemos, 2013). Competent, inclusive and transparent government is more likely to be able to develop community interest projects and deploy technologies that make it more intelligent. These characteristics favor the development

of a resilient administration, which is won with the empowerment of citizens to participate in decision and planning your city together with government authorities.

The challenges that come with population growth beyond the limits of being solved using only communication technologies, information and interaction. Require the creation of computational solutions that fall within smart cities. One of computational solutions used in several countries to strengthen the relationship between citizens and government is the availability of government data in open formats on the Internet. This enables the population to participate actively in public administration.

2.2. Public Transparency

As provided for in the Federal Constitution (Brasil, 1988) and Supplementary Law number 131, published in May 2009, also known as the Transparency Law, the right of every citizen to have access to government information, as is the obligation of the State ensure this access through objective and timely, transparent, clear and easy to understand language. Therefore, the creation of the Transparency Portal was one of the solutions defined by the Brazilian government to improve the state of relations with citizens, with enterprises and among government bodies. This is to improve the quality of services rendered; promote interaction with business and industry; and strengthen citizen participation through access to information, in building a more efficient and effective administration (Araújo & Aguiar, 2014).

Despite the existence of specific legislation, some problems are worth mentioning when it comes to government transparency: how the information is presented to citizens, accessibility, heterogeneity of data format, temporality of publication, inappropriate content to the user's profile, among others. Because transparency portals may contain content from different government databases, there is the concern with understanding the information published, which need to be organized so that users understand its syntax and semantics. Much of the government data is difficult to interpret for lay users and professionals in the computer area that use them as a base for the development of information systems. The problems go beyond the publication of the information required by law. They refer to the integration of government services and citizens, covering methodologies, structuring and perceptions used to organize and present information in population interest in transparency portals.

To cater the principles of transparency, a semantic organization of data is required. In order for this to become reality, international government agencies have sought to define standards to mitigate data integration issues published (Farinelli et al., 2013).One of the policies proposed by the Brazilian government on e-government interoperability standards shows that: to facilitate the crossing of data from different sources of information, when its use by other member organizations of public administration, by civil society or by citizen, they should be used resources such as controlled vocabularies, taxonomies, ontologies and other methods of organization and information retrieval (Brasil, 2015). As shown, ontologies have been described and shown as solutions that contribute to standardization and the organizational structure and semantics of government data to be made available to citizens.

Analyzing the bibliographic databases and studies, realize the contribution of ontologies in the understanding of concepts and organization of knowledge. Therefore,

we emphasize the need and importance of consolidating a formal model of ontology for the fields to be shown on transparency portals (Corrêa et al., 2015).However, present domain ontologies to managers is not the best solution for most problems. We believe that the ontologies should be known, understood and used by the teams developing systems used in public administration and in providing information to citizens. According to current legislation, there are several information to be published by the municipal government. However, due to the breadth, scope of ontology modeled in this study was limited to the areas of Bids and Administrative Contracts.

2.3. Ontologies

According to the W3C Consortium (W3C, 2015) ontology is understood as "the definition of the terms used in the description and representation of an area of knowledge." Briefly, ontologies should provide descriptions for the types of classes of concepts / things in various fields of interest, relationships between these classes / things, as well as properties / attributes that these classes / things must have (Breitman, 2005). Yet, the ontology is defined as an explicit specification of a conceptualization, which is a simplified view of a knowledge domain (Corrêa et al., 2015).

One reason for the use of ontologies in computing is related to the sharing of promise and common understanding of some domain of knowledge that can be communicated between people and computers. Thus, ontologies have been developed to facilitate the sharing and reuse of information (Breitman & Leite, 2004), in addition to clarifying the structure of knowledge, promoting a shared understanding of the area in question. In the context accosted by the study, ontology is defined as a computational device consisting of a vocabulary of concepts, their definitions and their properties. A graphical model that shows the possible relationships between concepts and a set of axioms that constrain the interpretation of these concepts and their relationships, representing the knowledge of the bidding field and administrative contracts clearly and unambiguously.

2.4. Requirements Engineering

The Requirements Engineering is an important area of software engineering, defined as the stage for the delimitation of the software context. This step is the recognition and modeling of the problem domain and the definition of the fundamental requirements for the system to be developed. During this step, the requirements engineer work together to stakeholders (customers and end users), seeking to recognize, analyze, synthesize, model, specify and validate the requirements.

This work devotes special attention to the following activities of the engineering requirements, based on (Sommerville, 2011):

- Requirements Elicitation: activity where software engineers work with customers and end users of the system to get information and understand the application domain, the services to be offered, system performance, restrictions and other important information;

- Requirements Validation: conference process where they are checked if the elicited requirements define the system as per the requirements presented by the client.

The results of the engineering requirements of the process is a robust key documentation requirements in all subsequent stages of the software development process. Therefore, use ontologies in the process of knowledge and understanding of the problem domain is a way to minimize excessive effort demanded in the elicitation activity. In this case, the ontology is used as a means of standardized presentation of clear and scope accosted, avoiding the erroneous setting requirements for lack of knowledge of the context.

2.5. Related Works

There are several studies related to the modeling of ontologies in the governmental area, and there are studies on the use of ontologies in Requirements Engineering. In the governmental area, domain ontologies are used as a form of standardization and presentation of a problem domain. In Requirement Engineering domain ontologies establish a common understanding between the parties involved, allowing better communication in the pursuit of elicitation and most complete analysis possible for the requirements of the systems (Zapata et al., 2010).

In ontoGov project (Apostolou et al., 2005), the team used semantic web technologies to build ontologies that represent the meaning of the processed data, features and functionality coming from the services of e-government. Is a platform that facilitates composition, configuration and evolution of services in order to offer the government a vision of service configuration models and improve services to users.

Recently (Amina Adadi, 2015) presented an ontology related to public administration domain, called WebGov. The same is intended to provide a global knowledge model of implementation of the administrative services provided by the government, in order that it be used in the development of electronic services.

In 2006 (Kaiya & Saeki, 2006) presented a method of requirements gathering called ORE (Ontology-based Requirements Elicitation), which suggests that ontologies are used in the field of knowledge they contain semantic rules that give meaning to requirements of sentences . Thus, when using rules of inference can find out what requirements must be added or deleted to ensure completeness and consistency. In this method, the concepts and relationships modeled in the domain ontology allow, through an analysis formula, check the quality of elicited requirements outside his correctitude, completeness, consistency and ambiguity.

In 2007 Zong-Yong et al. (2007) proposed a framework based on KADS knowledge modeling (Knowledge Aided Design System), which uses multiple ontologies for lifting requirements. The structure combines foundational ontologies, domain ontology and task ontology in a metamodel to organize and standardize the assessment process requirements.

Given the above, the existence of a domain ontology to be used in the engineering of transparency portals requirements or other systems related to procurement and administrative contracts is a way to minimize human efforts. In addition, insert the reuse approach, allowing the ontology to be reused as a means of presentation and formalization of the context in various other software related projects modeled domain.

3. Materials and Methods

We divided the study in three phases, each with specific activities involving studies, research, ontology construction and definition of ontology application process engineering of government transparency portals requirements. The Following are each work phases.

3.1. Analysis and Specification

The activities developed in the first phase of work sought to understand the complexity of the information used in the context of public management, directing the focus of study for the area of procurement and administrative contracts. The choice of this area considered the complexity of the concepts involved, the lack of structural standardization of information and the importance of these topics to society, considering that they are part of municipal financial management. We sought to identify the problems that can be solved or minimized by the use of ontology in requirements engineering process.

After the study and construction of the necessary knowledge about the problem domain, the process of verification and search of information to be modeled as concepts, properties and relationships in the ontology started. This activity considered the recommended transparency standards by the Brazilian government and the requirements presented in the current legislation in the country.

3.2. The Ontology

The activities d The second phase of work includes the definition of the methodology to be used in the construction of ontology, the choice of language and editing tool, the conceptual definition and relationship to be modeled in addition to the actual construction and documentation of the domain ontology.

3.2.1 Methodology and Tools

Due to the existence of various forms of ontology construction, the first step of this stage was the study of the most commonly used methodologies in order to identify the most appropriate method to be used in this work. The following methodologies were analyzed: Cyc, Uschold, TOVE, Methontology, NeOn, Methodology 101. Upon completion of the analysis, it was decided to use the Ontology Development 101 methodology. The choice was based on its simplicity and the details presented for each work step. As (Isotani & Bittencourt, 2015), the method presents an iterative approach and describes in detail the steps that guide the work of those involved.

Further, there was the choice of tool to be used. Second (Isotani & Bittencourt, 2015) the most popular are: Apollo, OntoStudio, Protégé and TopBraid Composer, among others. Analyzed the editors, the Protégé is one of the most known and used by the international community, is open source and free. Also, another important and decisive factor in choosing the editor is the fact that the Ontology Development 101 method has a close relationship with the tool (Noy & McGuinness, 2001).

The choice of implementation language complete the requirements needed to start construction of the ontology. Among the languages recommended by W3C[1] (W3C, 2015), highlight the RDF and OWL. OWL is recommended because it is suitable for situations where information needs to be processed and interpreted by the machine, as well as having easy to express meanings and semantics. Thus, OWL was adopted as the ontology language development.

3.2.2 Construction of Ontology

After defining the concepts, properties, relationships and semantic rules to be modeled in the ontology, has started the process of building it in the Protégé tool. During the modeling process, it was emphasized the inclusion of details and descriptions of each concept, attribute and relationship, thereby building documentation. This documentation will be important for understanding and building the knowledge base represented by domain ontology. Figure 1 shows one form of graphical display of the modeled ontology classes.
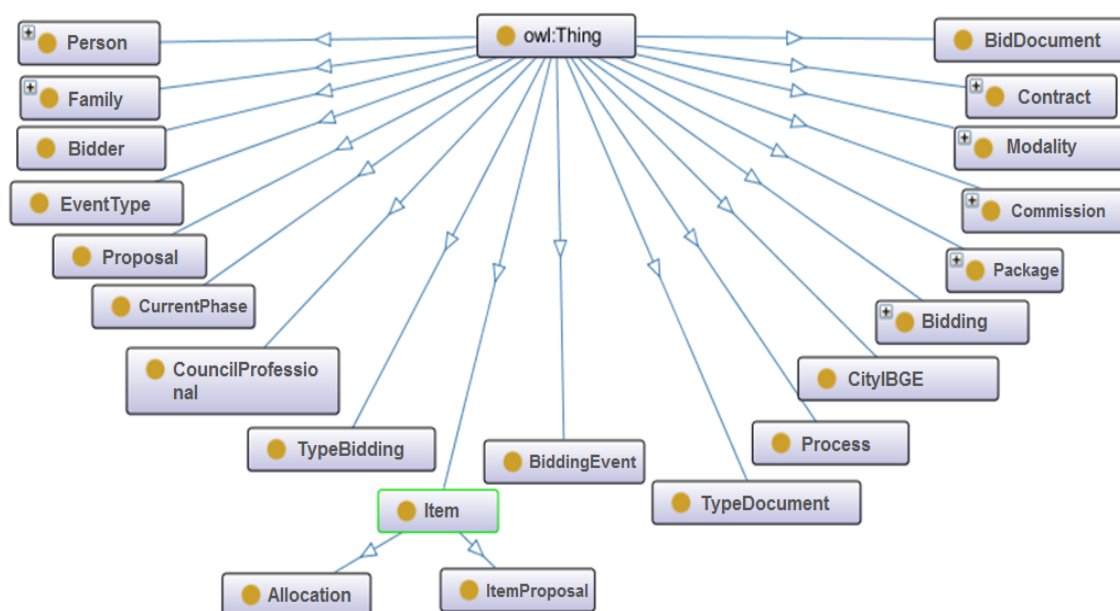

Figure 1. Ontology for bids and administrative contracts.

3.3. Application of Ontology

Ontology proposal will be applied as exemplification process of its use in the elicitation activities and validation requirements. The modeling and documentation will be used as a means of standardizing knowledge, providing professional computing area the understanding necessary to maintain clear communication with stakeholders.

Based on the concepts and the submitted information, software engineers will make the process for defining a new system requirements. They should relate each requirement to one or more concepts in the ontology, as the similarity between them.

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Through the process relationships, it will be possible to identify the concepts that are not covered by the requirements set, indicating that they may be incomplete, or even the need to define new requirements for the system. On the other hand, the existence of concepts that have many relationships can alert ambiguities. The ontology will allow requirements engineers make these assessments, because not always the application of elicitation techniques such as interviews, questionnaires, meetings are sufficient to capture all the conditions required for the development of a good information system.

Through the process of comparison made between the terms of ontology and the requirements already elicited in order to validate them, we seek to ensure that the portal of transparency meets the needs of citizens and obligatoriness under the laws. The process of using the ontology engineering requirements should submit suggestions for improvements to be made in the requirements. As an example, the existence of terms that are mandatory in the field and are not covered by the requirements set; the presence of ambiguous requirements, which can directly affect the quality of the information provided; the existence of confusing definitions and wrong relationships between requirements; and enables engineers to make other analysis using the structure modeled by the ontology. The comparison of terms proposed in the first instance, be performed manually using the graphical visualization of the ontology to relate the concepts and elicited requirements.

With the completion of the use of ontology engineering requirements, a report with the test results and the suggestions for improvement given the document of official requirements of the new system will be developed. The application processes the ontology elicitation and validation requirements are shown in Figure 2.
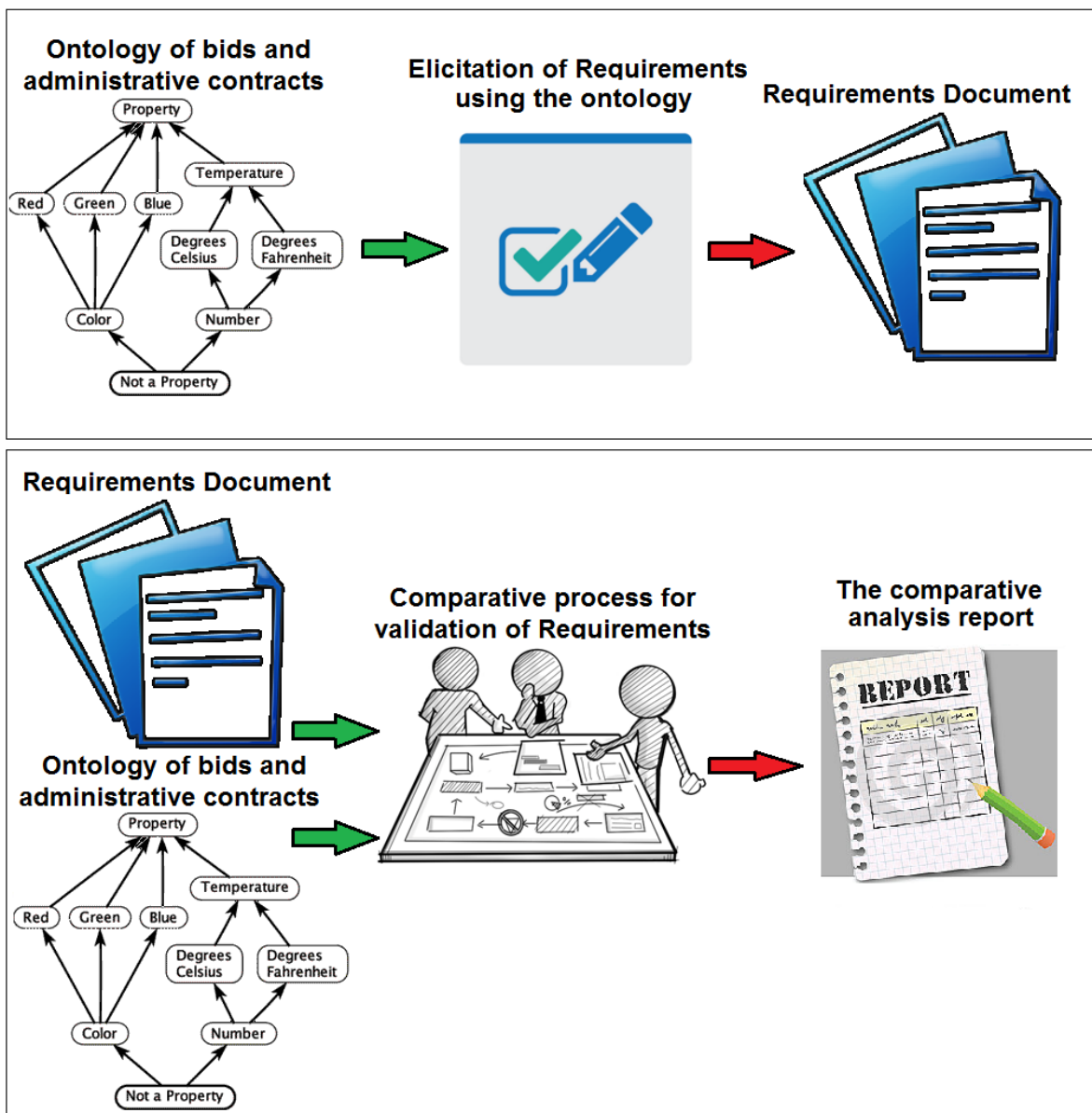
Figure2. Ontology application in elicitation and validation requirements.

To confirm the expectations of the proposed process, a software development team must implement the modules of bids and administrative contracts a portal of municipal transparency. During this development, the team will report all experienced situations, and at the end of the process, must present a descriptive report with the observations made during the execution of each of the activities of engineering requirements. This report will present evidence to confirm the benefits observed during the ontology application process.

5. Final Considerations

This work presents an ontology-based approach to the elicitation of requirements on transparency portals. With the use of the proposed approach is expected to confirm expectations that the ontology will solve many of the problems faced by professionals in the Requirements Engineering area. They will have the opportunity to meet the

modeling domain, facilitating the activities of elicitation and validation requirements for the development of municipal transparency portals or other useful software for public management.

Ontology has presented a standardization and semantic organization of information of bids and administrative contracts, which will enable interoperability of transparency portals with other information systems and other government databases. The built ontology will be available in specific libraries, allowing other professionals to reuse, enhance or complement.

This project does not end with the approach proposed in this work, because our goal is that the ontology can add new concepts, as well as the development of new ontologies that include other areas related to public transparency.

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