A FRAMEWORK FOR SEMANTIC BUSINESS PROCESS MANAGEMENT IN E-GOVERNMENT

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ABSTRACT

Nowadays, the increasing complexity in government-related processes presents considerable challenges to achieve satisfactory services. In this study we will discuss the first results obtained in an ongoing project named "e-Government Innovation Center". We first identify typical semantic problems in e-Government, then introduce an e-Government semantic business process management framework and illustrate the building permit application as an example to strengthen how semantic web technologies could be used to design a new approach for exchanging and performing the processes and information in e-Government.

KEYWORDS

Semantic Web, Semantic Business Process Management, e-Government, Business Process Management, Process Ontology

1. INTRODUCTION

The increasing globalization and ongoing changes in institutional situations requires governments to adapt their processes in a flexible manner to satisfy the emerging requirements in the state and across borders. The concept of business process management was first introduced in the field of e-Government to manage government-related processes. However, the degree of automation of many business processes is still unsatisfactory. Even today, many system management tasks, such as business process analysis in public services, are often performed manually. This leads to a very time-consuming and error-prone process and as a consequence a waste of administrative time and resources.

The amount of information in the domain of e-Government has reached enormous dimensions, resulting in considerable challenges to achieve interoperability given the manifold semantic differences of interpretations of for example, law, regulations, citizen services, administrative processes, best-practices and so on (Klischewski, 2003). In emergency situations requiring the collaboration of multiple agencies, relevant resources are not always available and interactions among agencies are rather limited. Contrary to the nature of an emergency situation, the resulting response is very slow. As a result, the complexity in the government-related processes poses an enormous challenge to make it efficient and competitive.

To cope with these problems, semantic technologies, and particularly those related to the Semantic Web and its ontologies, have proven useful for many government related applications (e.g., Fonou-Dombeu and Huisman, 2011; Stojanovic et al., 2006a). According to Tim Berners-Lee et al. (2001), the Semantic Web is "an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation". Nevertheless, semantic business process management (e.g., Hepp et al., 2005a) is a relatively new research area and its application in e-Government is still very limited.

In the context of government and public services, Switzerland represents a special case given that local authorities have a high level of political self-determination power. Moreover, different languages should be respected within one state (e.g., Bern) and across regions (e.g., Swiss German versus Swiss French region).

Currently, Switzerland has adopted the uniform standard Business Process Modeling Notation (BPMN[1]) version 2.0 in the professional documentation of public services and processes (Lenk et al., 2010). In this paper, we will discuss this new approach and new possibilities it can offer. Therefore, our research question is: How could semantic web technology improve business processes management in an e-Government context in Switzerland ?

The remainder of the paper is organized as follows: in section 2, we review previous related works on semantic web technologies in the e-Government domain. We then seek to identify semantic problems in e-Government, followed by a discussion on e-Government in Switzerland. In section 4, we describe a framework of semantic business process management in e-Government. Finally we conclude and discuss directions for future research.

2. RELATED WORK

In this section, we provide a brief state of the art of related works on semantic web technology and its usages in e-Government to help us in answering our research question. There is increasing interest in the design and development of the semantic web technology in e-Government services (e.g., Fonou-Dombeu and Huisman, 2011; Goudos et al. 2007; Stojanovic et al., 2006). We will describe these studies according to different functional fields.

Some research has been conducted to examine public administration by using semantic technologies. For instance, Theocharis and Tsihrintzis (2012) described three hierarchy levels of ontologies for public administration: public administration, transaction and individual, where each class within one level is a superclass for classes on the next level. Goudos et al. (2007) employed the generic public service object model of Governance Enterprise Architecture (GEA), and present the Public Administration Service ontology using Web Ontology Language (OWL) as the knowledge base for e-Government semantic web applications. Moreover, they provided a sample application of this ontology for semantic discovery. Specifically, they used a citizen's profile as input and provided output in the form of a set of public administration services that match the specified profile.

Another interesting domain is change management. By defining four phases of change management processes, namely change representation, change preservation, change implementation and change propagation, Stojanovic et al. (2006a) presented a novel approach to consistency preservation that supports public administrators in managing and optimizing service descriptions according to their needs. The proposed approach incorporates mechanisms for verifying the consistency of a service description, as well as generating additional changes that resolve detected inconsistencies. Similarly, Stojanovic et al. (2006b) proposed a set of ontologies needed for a better management of e-Government services and highlighted its advantages of using such ontology-based change management.

Some other studies examined the interoperability issue. For example, Gugliotta et al. (2005) proposed a semantically-enhanced architecture to address the issues of interoperability and service integration in e-Government web information systems. In particular, they defined a conceptual model for integrating domain knowledge (Life Event Ontology), application knowledge (E-Government Ontology) and service description (Service Ontology).

Thus far, however, little is known about the possible integrations of semantic web technologies in business process management in e-Government. We believe that crafting an appropriate theoretical framework is necessary for a better understanding of the usage of semantics for e-Government. But before doing so, we will first examine the usage of semantic web technology and identify semantic problems in Swiss e-Government.

[1] Available at www.bpmn.org

3. SEMANTIC WEB FOR E-GOVERNMENT IN SWITZERLAND

Switzerland, despite being a small country, consists of 26 member states within the Swiss Confederation (known as cantons), each of which has a high level of political self-determination power. The cantons are further divided into communes. Until 2011, there were 2,551 communes[2], varying greatly in area and population. Accordingly, governments and administrations in Switzerland are organized on three levels, namely federal, cantonal and communal. The competences of the federal authority are restricted, while the cantons enjoy a great deal of freedom to make decisions independently in many areas. Like the cantons, the communes also take their own decisions, especially for local issues.

Recently, however, globalization and economic development require more cross-border services and these local variations have become a kind of barrier and make government services more complex. In addition, the diversity of actors involved in the process has challenged to achieve the efficiency of governmental issues. The SUPER project[3] represented the first large scale study aiming at bridging the gap between business and IT views by supporting Business Management automation. To achieve this aim, the SUPER project developed a semantic-web-service-technology-based architecture to support modeling, implementation, execution and analysis of business processes. In this section we will first discuss the current stage of e-Government in Switzerland and then seek to identify associated problems of the application for e-Government based on semantic web technologies.

3.1 E-Government in Switzerland

In early 2007, the Swiss Federal Council adopted a national e-Government strategy, which aims to carry out administrative procedures electronically, for authorities, the business community, as well as individuals. It defined the principles, procedures and instruments for the implementation of e-Government in Switzerland. Under this framework, several initiative studies have been conducted in Swiss administrative services over the past few years. For instance, the Framework Agreement on e-Government Cooperation in Switzerland ("Framework Agreement") governs the common approach taken by the confederation, the cantons, and the communes from 2007 to 2011. The eCH white Paper "Network Public Administration – Organization Concept for a Federal e-Government Switzerland" (Lenk et al., 2010) provided a basis for the architecture of e-Government in Switzerland.

There also emerged a numbers of centers of expertise for e-Government in Switzerland, including the eCH standardization organization, Swiss Society of Administrative Sciences (SSAS), Bern University of Applied Sciences - Competence Centre for Public Management and e-Government (BUAS). eCH is a standardization organization. It facilitates electronic cooperation between authorities, private individuals, companies, organizations, and research thus promotes the adaptation of e-Government standards in Switzerland. SSAS is the major important national association within Public Services. Not only does the network link administrations, universities and consultants of various disciplines, but it also increases communication between politicians, administration and citizens. BUAS is a scientifically independent service, research, and development institution for public management and e-Government, mainly engaging in projects on open government, e-participation and crowd-sourcing.

Switzerland's official web portal[4] serves as the "national gateway" for the public to access online information about the services provided by the different authorities (federal, cantonal and communal) in five different languages, including four official languages (German, French, Italian, Romansh) and English. Unfortunately, this portal is not widely used by the public. Three possible reasons may explain this phenomenon. First, as the information is published manually in the portal website, search results are not often optimal. Sometimes the search results include obsolete links and information, or the relevance of information is rather low. Second, the online information provided is not translated in practical terms, thus sometimes it is not easy for the public to understand. And last, the portal navigation model is not semantically structured, therefore it cannot be shared and reused across authorities.

[2] Available at www.swissworld.org

[3] Available at www.ip-super.org

[4] Available at www.ch.ch

3.2 Semantic Problems in e-Government

The main problem in implementing the e-Government strategy is how to construct understandable and accurate data and information both for computers and people. One major issue here is semantic problems. In the following, we will describe those barriers in Swiss e-Government.

First, the way information is presented and accessed: The official documents provided by the government, particularly legal documents like laws code and regulations, often contain semantic deficiencies that rule regulators are not aware of. The most common form is ambiguities, ill-defined modeling and inconsistencies (Freitas, et al., 2010). For instance, nowadays governments use their website to provide direct online access to information, including file downloads (e.g., documents, forms), online applications, and other services. Those services normally use life events as a structuring principle. However, they differ a lot in naming and structuring life events across cantons. This leads to ambiguities. Another example would be residence permits for foreigners in Switzerland. The residence permit B can be classified into two categories: student residence permit B and work residence permit B. However, these two categories of residence permit B are not distinct in many other regulations. This results in underspecification and inconsistency. Obviously, those kinds of deficiencies cause confusions in their usage because the intended meanings might be explained differently by different people. In other words, they are a source of semantic problems. In general, the more structured and clearer information is, the more easily the end users (e.g., individuals, organizations) can understand it and use its information to make knowledgeable decisions. The usage of semantic web technology may help check information consistency.

Second, the inconsistencies of semantic information among different agencies: One of the big challenges in e-Government is how to integrate information from various agencies while guaranteeing semantic accuracy (Klischewski, 2004). To explore the lack of interoperability problem, let us go back to life events such as a marriage case. After receiving marriage applications, the official at the civil office verifies the documents and confirms the suggested date for the civil marriage. After the marriage ceremony, the official enters the changes in the family status for the two married citizens. However, a series of public services should be invoked. For example, the bride may change her name, or change her place of residence. These changes require updating some personal documents such as her passport, work contracts (e.g., for tax purposes). However, the current stage does not allow different agencies to discover the changes and capture the information among different public authorities. Recently, the idea of a one stop e-Government (Wimmer, 2002) makes it possible for public services to act at a single point of access to obtain electronic services and information offered by different public authorities or private service providers.

Third, change management in e-Government business process: As Switzerland allows popular initiative referendums[5], the regulations have to be continually improved. Any changes of legal rules and regulations can cause an adaptation of processes in e-Government services. Such changes might result in (1) some activities of business processes becoming obsolete and hence needing to be removed; (2) new activities that have to be included; and (3) modified data/control flow sequence of the process (Tripathi and Hinkelmann, 2007). Accordingly, the implementation of change management includes the deleting process, creating process, as well as modifying process (e.g., sequence). Similar to the interoperability problems, changing one regulation may involve more than one process change from various public authorities. Therefore, change management is especially important for applications in e-Government services where changes are distributed over different systems.

Fourth, poor process management: Because professional knowledge has become increasingly diverse, the business management process in one department can hardly be used by another. In addition, a number of process activities, such as conformance checking activities, are surprisingly still centered on human labor. As a consequence, those business process-related activities are slow, costly, and imperfect.

[5] 100,000 citizens may demand a change of constitution by signing a form. The federal parliament is obliged to discuss the initiative.

4. SEMANTIC BUSINESS PROCESS MANAGEMENT IN E- GOVERNMENT

Switzerland has adopted the uniform standard business process modeling notation (BPMN) version 2.0 in the professional documentation of public services and processes (Leuk et al., 2010). Our focus in this section therefore lies in business process management and its interactions with semantic web technologies. Before considering the description of our framework, we briefly describe business process management and semantic business process management.

4.1 Overview of Business Process Management and Semantic Business Process Management

Business processes are supported by Information Technology (IT) which dramatically reduce human error and miscommunication. For the last few years, one of the main topics relevant to business processes in commercial information technologies is Business Process Management. It is defined by Van der Aalst et al., prominent researchers in this domain, as "supporting business processes using methods, techniques and software to design, enact, control and analyze operational processes involving humans, organizations, applications, documents and other sources of information" (2003, p.4). Business Process Management is usually supported by Business Process modeling Notation (BPMN) – one of the standards for model business process flows. By providing a graphical notation for specifying business processes, both business users and technical users can well understand the language. The benefit of adopting business process management includes increasing visibility and knowledge of a company's activities, identifying bottlenecks and potential areas of optimization, better defining duties and roles of stakeholders (Ko, 2009), thus enabling organizations to be more efficient, more effective and more capable of changes.

Nevertheless, today's intensified globalization forces organizations to apply more flexible processes in order to adapt to rapidly changing situations. As a consequence, traditional Business Process Management which still involves much human labor cannot accomplish the efficient organizational goals. This eventually gave rise to Semantic Business Process Management (e.g., Hepp et al., 2005; Wetzstein et al., 2007) – a new research area which combines semantic web technologies and Business Process Management by focusing on how the first could improve the latter. Semantic web techniques include ontology languages, reasoners, are expected to achieve automation of discovery, exchange and reuse business processes. Therefore, we propose a framework in the next section to describe how semantic technologies could be used in e-Government to improve business process management.

4.2 Framework for Semantic Business Process Management

Figure 1 shows four layers of our proposed framework for semantic business process management, namely data layer, process layer, semantic layer and presentation layer. The rationale behind this is that the proposed framework will prove that it is feasible to integrate semantic web technology in business process management.

4.2.1 Data Layer

The lowest layer of the framework is the data layer. It contains all the laws, rules, regulations and other legacy applications at different organizational levels of authority, including federal, cantonal and communal levels, and under specific situations. The data layer is quite complicated in Switzerland. As we mentioned earlier, the local authorities have a high degree of autonomy and enjoy independent control power in many areas. As a consequence, the data and information in this layer becomes "problematic" as it contains duplicate, confusing, inconsistent and sometimes conflicting records.

To better understand the framework, we take the example of building permit applications in the Anniviers commune in the Canton of Valais. For the purposes of environmental protection and following the building regulations, any new residences, residential alterations and additions require asking for a building permit in Switzerland. To simplify the procedure, we only consider the application at the communal level. The 7-page

file (see footnote[6]) describes the building permit application in detail. It defines the scope, the regulation, the procedure as well as a standard example of an application form. We will describe the text information of this document into a process model later in the process layer.

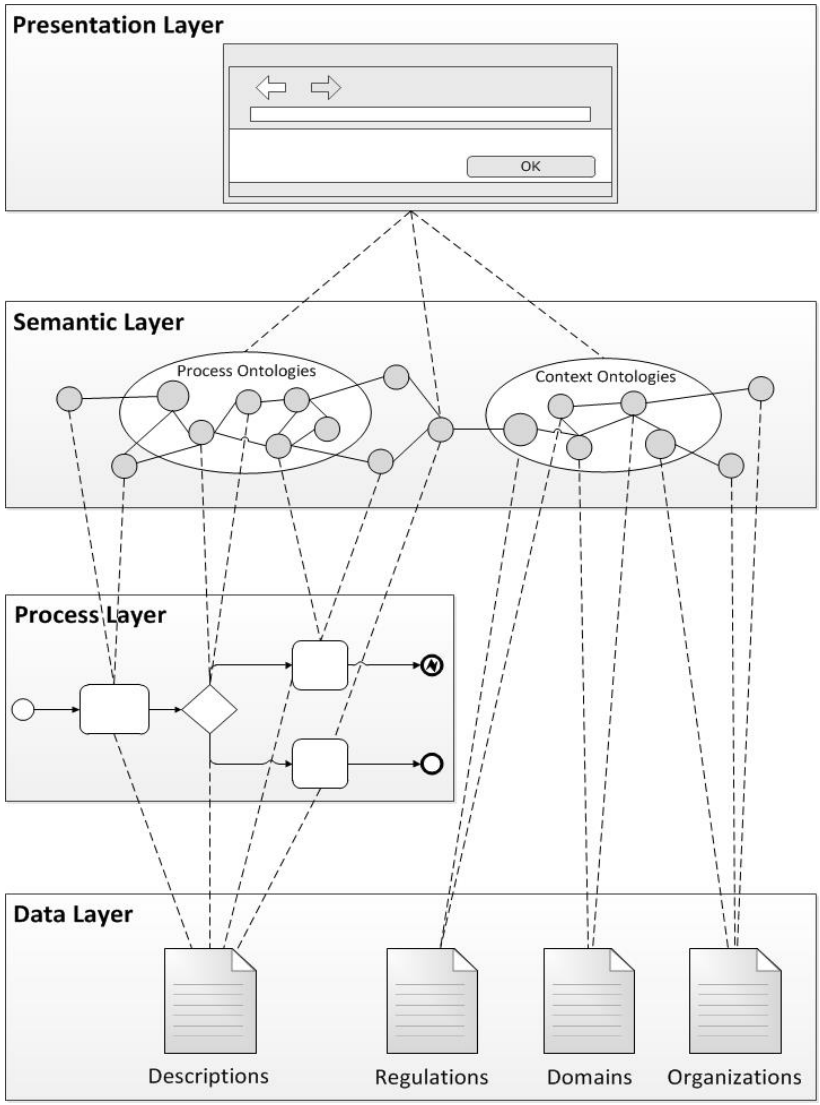

Figure 1. Framework for Semantic Business Process Management

4.2.2 Process Layer

In order to make a legal regulation simpler and more visual, it is necessary to draw conclusions from these regulation texts and to have a general view of the business process model. Consider the building permit issue again in session 4.2.1. Here we create a simplified version of the business process model according to the regulations of the Anniviers commune in the Canton of Valais. As illustrated in Figure 2, once citizens have submitted their building permit applications, two situations have to be distinguished:

- If the application form is complete, then the process will continue to the next step.
- If the application form is incomplete, then the process must stop, and the documents are returned to the applicant.

[6] http://www.anniviers.org/net/com/6252/Images/file/Constructions/Autorisation%20de%20construire%20-%20marche%20%20suivre.pdf, in French, available in 10th February, 2013.

For those applications with complete forms, the commune will then show the information to the public. In the next 30 days, two situations need to be identified:

- If there is no opposition from the public, then the building permit application will be accepted.
- If there is any opposition from the public, the oppositions need to be handled. Here there two situations again, depending on whether the opposition can be rejected:
    - If opposition can be rejected, then the building permit application will be accepted.
    - If opposition cannot be rejected, then the building permit application will be refused.

Compared to the text information in the data layer, this graphic process model is simple and visual. It is also easily understandable for both domain experts and IT experts.

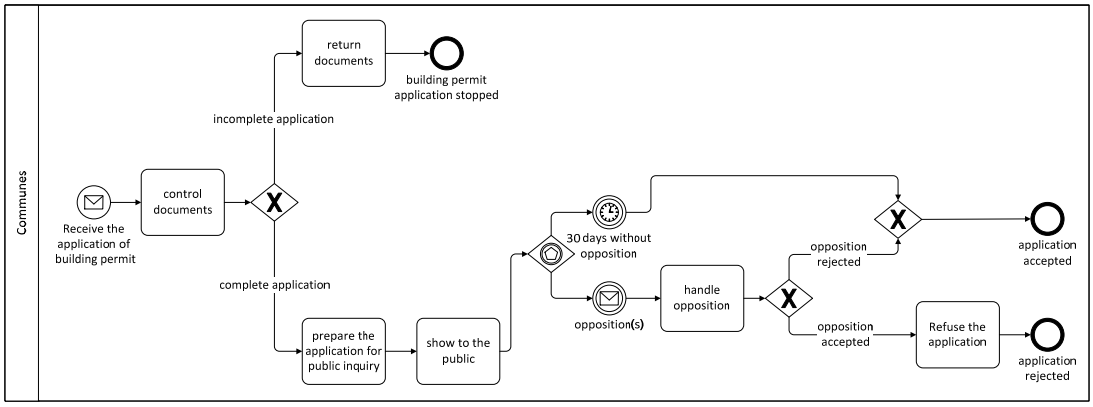

Figure 2. Business process model for application of building permit

4.2.3 Semantic Layer

The Semantic layer, also known as meta-data layer, provides support for the automated discovery, substitution, composition, and execution of software (Hepp et al., 2005) thus it is expected to be a powerful tool for achieving intelligent use of existing information and play an important role in the field of e-Government.

Different ontologies, including context ontology and process ontology, are created in this layer, which enable analyzing domain knowledge, sharing common understanding and reusing organizational knowledge. Governmental data stored in the data layer contains valuable information, but not a form that makes it easy to answer a practical question such as, “Why did my building permit application get refused?” To answer these questions, users need to understand the technical details of the data source as well as the meanings of the data. The semantic layer acts as an intermediary between the end users and the data sources. It simplifies the complex information of law and regulations in the data layer into common practical terms with regards to the applicants, allowing them to work with the data without requiring them to understand all the technical details. Thus knowledge of the mappings between domain fields and data fields resides in the semantic layer.

Moreover, based on the machine-readable languages, the integrated practical terms can also serve as a common source for generating, and reuse in, other business processes. Consequently, a change to the data layer and process layer can be handled in the whole system (i.e., detect the related regulations and processes that require alteration accordingly), without needing to revisit the report and the process and, if necessary, modify them individually. This is exactly what the semantic layer offers.

Our e-Government project will continue to explore the role of process ontology, create process ontologies based on BPMN 2.0 and implement them in the Swiss e-Government system. We adopted BPMN 2.0 ontology (Natschleger, 2011) which could be used as a knowledge-based meta-model to validate and helps us to define the semantics for concrete business process models. In fact, many different authorities have adopted similar regulations. However, the current system still requires each authority to enter the “repetitive” process individually. We aim to fill this gap and to exchange and reuse the process so as to achieve improved government services. The concerned semantic problems, including ambiguities in presenting the information, inconsistencies of information among different agencies, could be tackled in this layer.

4.2.4 Presentation Layer

The presentation layer is responsible for delivering and exchanging the information between the user, either individual citizen or business, and the system. It provides the user interface within an application and bridges the user and semantic layer. On one hand, this layer allows the users to "input" their data into the system. On the other hand, the system would indicate the effects of the user's manipulation as the "output". Therefore, semantic web technologies and domain knowledge are processed and presented uniformly within this level.

As the presentation layer allows the user to communicate with the system, its format should be user-friendly. Take a simple web application with a standard web browser as an example. Users can send their building permit application via the web. They can also freely select different goals according to their application steps, for example, create a new account, send a new building permit application or follow up the application status. Once the users submit the required data, the presentation layer will then format the data and send it to the semantic layer. After processing the data, the system will return a result to the user autonomously.

5. CONCLUSION

In this paper, we discuss the Swiss e-Government strategy and its implementations. We identify four possible semantic problems in the e-Government in Switzerland. They are: the inconsistency in the way of presenting and accessing information, the inconsistencies of semantic information among different agencies, semantic challenges from change management and poor semantic process management. Most importantly, we present a framework that integrates semantic web technology in business process management in e-Government. This framework includes four layers, namely the data layer, process layer, semantic layer and presentation layer. We explain each of them in more detail by using the building permit application as an example. Among those four layers, the semantic layer represents the key and plays a crucial role. It enables the computer to identify potential conflicts and interdependencies in e-Government services, and allows automatic processing in business process management. Therefore it is expected to provide effective solutions concerning a better exploitation of the information and managing knowledge in business processes. Although this framework is developed in the e-Government service sector, it is also applicable to other BPM and e-service sectors.

However, there is still a long way for e-Government to exploit all the potentials of semantic web technologies. While our proposed framework provides a good starting point to build semantic web technologies on business management process in e-Government, it is far from complete in practice. Future work should concentrate on enhancing the business process management in e-Government by creating new process ontologies in the semantic layer. The goal is to make use of the new technologies so that the process information could be shared and reused in other situations autonomously thus improving the effectiveness and efficiency of Swiss government services.

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