Advantages of Using an Ontological Model of the State Development Funds

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Abstract: Ontologies generated from the workflow of administrative procedures, can provide significant improvements and reduce the time of modeling, testing and integration in the process of building an information system of the public administration. In this paper we has analyzed the ontology annotation aimed to provide the groundwork for automatic generation administrative act. The proposed semantic representation of the administrative procedures enables use of the document templates, which are the framework for the automatic generation of an administrative act. This would be a result of the administrative procedures execution. The proposed approach is verified by a case study of building an ontological model of the administrative procedures for the Guarantee Fund of Autonomous Province of Vojvodina (APV).
Keywords: e-Government, ontology, services, information system.

1 Introduction

State development funds are an interventionist mechanism by which the state affects the development of small and medium enterprises. These are institutions set up by authorities of different levels (state, provincial, local government) and whose activity is aimed at stimulating the development of small and medium-sized enterprises while reducing risk and transaction costs related to the implementation of stimulating instruments (e.g. loans) of Small and Medium Enterprises. The following development funds are established in AP Vojvodina: Vojvodina Development Fund, Agricultural Development Fund, Capital Investment Fund and the Guarantee Fund of APV. There are two scenarios of use of ontologies in the development of information systems, depending on the type of information system that is being modeled [1]: Traditional information systems: semantic content described in the ontology is transformed into a standard component of the information system Ontology-driven information systems: the ontology is an individual component of the information system.

The ontological concept, which defines the administrative procedures and tasks, will be described and analyzed in detail. The course of generating ontology will be resting on the role of defined entity domains and the activities performed by those entities which are observed during the process of the state administration.

The model should meet the following conditions:

1. To describe structural aspect of public administration, administrative units (Funds) and their hierarchical relationship.

2. To provide an explicit representation of knowledge of administrative processes in Guarantee fund of APV.

3. To provide ontological representation of the participants and documents in the development funds.

4. To describe electronic services profiles those are providing the groundwork for automatic generation administrative act.

Our main intention is to reduce development time and effort in order to meet the demands of the information system based on knowledge of the administrative processes and documents. The core idea in our method is ontology annotations with user interface components in order to automatic generate user interface and modeling ontology of the electronic services that will provide generation of the final administrative act.

Main advantages of the model which will be described hereinafter, is a semantic representation of the administrative procedures business logic which, in the use of traditional techniques for developing information systems, are firmly integrated into the user interface code. [4] [8]

The paper is organized as follows: the second section provides an overview of the related work. The third section presents an ontological model of the Guarantee Fund of APV. The fourth section shows the detailed administrative tasks semantic representation and shows practical use of designed ontology. In the final, fifth section, concluding remarks and directions for further research are given.

2   Related work

This section will present research results related to two aspects of the problem investigated in this paper. The first aspect relates to the use of ontologies in modeling business processes of public administration, and the second aspect relates to the use of ontologies in the generation of the administrative act. A ontology is an information structure, which helps to acquire knowledge, share it, and check consistency within knowledge. Authors in [19] conclude that the ontology provides a better communication, reusability and organization of knowledge by decreasing language ambiguity and structuring data. Author [18] proposed a formal definition of ontology as a 5-tuple (N, R, D, F, T) where each element is defined as follows: N, a set of nodes. R,N is a set of relation Types. D, is a set of description logic sentences. Each sentence can use the elements in N and two variables subject and object. Indicating respectively the first and third element in 5-tuple in T. F is a function that maps each element from R onto one element in D. T is a set of relations which is defined as a set of 3-tuples where for each element consists of (s, r, o) where: s is the subject, an element of N, r is the relation, an element of R and o is the object, an element of N.

The authors in [2], propose a model of the system in which the procedures performed by each administrative unit in the decision-making process and the creation of administrative documents are described. The main component of the proposed system is ontology of the public administration. The proposed ontology comprises following aspects of the observed domain. Structural aspects of public administration represent administrative units and their hierarchical relationships. Textual aspect of ontology describes the documents that appear as a product of

the administrative unit described in the structural aspects of ontology. Procedural aspects of public administration ontology given in [2] are represented as an extension (specialization) to OWL-S. Service aspect is also represented by OWL-S. An ontology modeled in this way allows hierarchical control of the administrative units, control of administrative acts anticipated by legislation, communication between administrative units involved in the creation of administrative documents and calling of the procedures that trigger electronic services. The authors [5], [6], define three main reasons for the use of ontologies in generating user interfaces: 1. Improved visualization of UI; 2. Improvement of interactions between the system and users, 3.Improvement of the development process of user interface. In [3] the authors propose the creation of an ontology, which represents different aspects of service including administrative documents and legislation. This ontological model is focused on describing the electronic services of public administration. Basic concepts of the proposed ontology are Services, Service users, Organization, Administrative, Service implementation, Legislation, Form, Document, Event.

The ontological model created in this paper relies on the results of [2] and [3].

In a study of applying ontologies in the development of e-Government the authors presented a method of modeling ontologies in the domain of e-Government [15]. According to the authors of [9], each public service of eGovernment is semantically modeled and contains references that point to the required input data. Predefined values of input data or preconditions can be expressed with semantic rules. In this way, this allows automatic creation of (web) forms and interactive validation of input data. [13] According to the authors, the development of new applications and projects begins with modeling the ontology. When modeling the ontology, the authors used two types of classes and subclasses, by introducing the following assumptions:

Each class that contains a subclass is seen as an abstract class;

Each class that does not contain a subclass is considered a realistic class (the basis for the creation of form);

Electronic services accept only the instances of realistic classes as input data.

The presented rules and ways of modeling ontologies, according to the authors of [9], allow the unambiguous identification of e-Government services. The authors of [10] proposed the use of algorithm for the direct transformation from OWL to relational data structures. The authors of [11] also dealt with these problems. The basic idea is to transform the created ontology with the help of the transformation tools in the DLL script and thus preserve all relations, constraints, and information about the domain. DLL script is used to generate a relational database. Authors of [14] proposes a feasible implementation of a multi-agent environment which makes use of ontologies and ontology mapping to achieve semantic interoperability. Authors use an ontology model to facilitate semantic interoperability in a simulated multi-agent environment. The Authors in [16] exploits different semantic web technologies and builds a prototype of semantic web mash up functionality based on combination of RDF/OWL with SQWRL. The main scope is to improve decision-making processes. Sugumaran and Storey present a heuristics-based method for developing and creating ontologies [17]. They identify all the basic terms; this is done by using use cases and then revising synonyms and related terms manually or by an online thesaurus. In the next step they identify the relationships among these terms. They define three types of relationships: generalization, synonyms and associations. Generalization corresponds to an is-a-relationship. This paper will present the methodology of ontology construction and annotation of state development funds.

3   Creating an ontology

This section presents a method aimed at building an ontological model of state development funds. The basic administrative activities that are common to all development funds in APV

are as follows: Registration of participants of the competition, Analysis of the submitted documentation, Risk Assessment of funds placement, The decision on funds placement, and Type of placement. It is noticeable that the administrative activities are almost identical for all state development funds, regardless of the type of fund and type of placement. The authors in [12] propose the following four-level typology of administrative activities of public administration: Identification-identification of types of services offered to end users:

1. Specifications specifying administrative procedures and documents for the identified type of service;

2. Interaction specifying a communication protocol for the identified type of service (for example, signing a contract);

3. Transaction the realization of services (for example, issuing guarantees for loan).

This typology can be applied to state development funds. An important role in the development of ontology represents the conceptualization and organization of knowledge. The task of conceptualization is to transform informal knowledge into an ontological concept with the help of professionals in their field of ontology modeling. Figure 1 shows a simplified model of the activities of state development funds. [7]
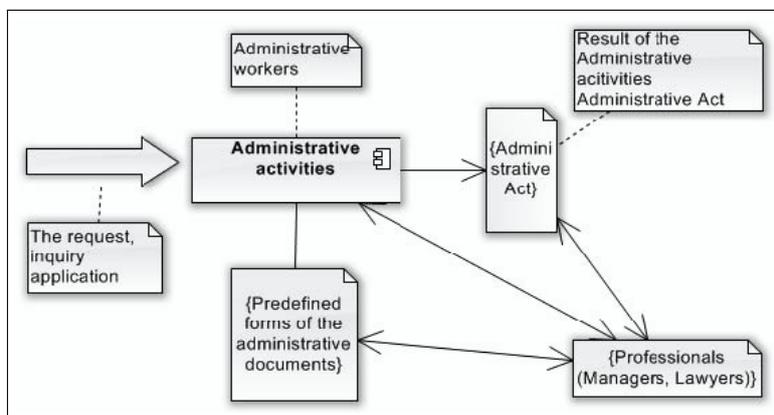

Figure 1: A simplified model of the activities of state development funds

Ontological descriptions of the administrative activities are generally applicable to all government development funds. Below is a detailed description of the ontological model of the Guarantee Fund of APV (GFAPV OM), which defines the administrative procedures and tasks.

3.1   Ontological model of the GFAPV

The public administration aspects given in [2] were taken as the basis for the creation of concepts in OM GFAPV. Ontology of public administration in [2] consists of two parts. In the first part of the ontology, two aspects are defined:

1. A structural aspect of public administration in which administrative units and their hierarchical relationship are described where hierarchical relationships between the administrative units were presented with properties (belongs to and supervised by).

2. The textual aspect of ontology describes the documents that appear as a product of the administrative units described in the structural aspect of the ontology. The textual aspect is presented in the ontology with four main classes as follows:

1. Administrative documents -presented as a product of administrative units;

2. Civil documents -all types of documents that people create and fill out in the course of communication with public administration;

3. The legal texts -the laws and secondary legislation;

4. Court decisions -decisions related to administrative actions and decisions of the Supreme Court.

In the second part of the ontology given in [2], both the procedural and service aspects are presented.

The procedural aspect of public administration ontology is presented as an extension (specialization) of OWL-S. The basic concepts of procedural aspects are tasks, procedures and full procedures. Tasks are atomic actions that cannot be further broken down and are executed by an administrative unit. Each task has input data that needs to be filled by the system administrator or worker. The result of executing the task is an administrative act. A procedure contains at least one informative task (i.e. it tries to find or notify some information from/to another unit) and only one executive task (i.e. it produces a single act). Thus, the procedures are composed of one or more tasks. Each task is executed within a framework of procedure. Full procedure represents a number of procedures intertwined. A full procedure may reflect to the provision of a service to one or several entities (property providedTo). Procedures may be sequential or in an acyclic graph. In this ontology, the control constructs of OWL-S are adopted. When defining the ontological model of OM GFAPV, the following elements of the domain were analyzed:

1. Participants. This aspect corresponds to the structural aspect of the model [2]. It represents internal funds structure and its position within the public administration, as well as actors who perform tasks defined in the business process and external participants to the process.

2. Documents. This part, which corresponds to the text aspect of the model [2], represents administrative acts appearing during the execution of tasks within business processes.

3. The business process logic, which corresponds to the procedural aspect of the model [2], is defined by business rules and operating procedures of the business system (state credit guarantee funds).

4. Electronic services are the services invoked in order to execute procedures implementing business process logic.

In the case of OM GFAPV, administrative procedures are defined as ontology concepts. Communication between administrative procedures and services is presented as atomic process. In the case of OM GFAPV each service belongs to only one procedure that is defined in the ontology. Services are described by service profile properties. The generalization (superclass-of) and specialization (subclass-of) of ontological concepts is represented by the taxonomy of the main concepts of the ontology of the Guarantee Fund of AP Vojvodina.

3.2   The taxonomy of the concept Participants

By this concept, all participants in procedures are represented. The concept Participants is shown in Figure 2.
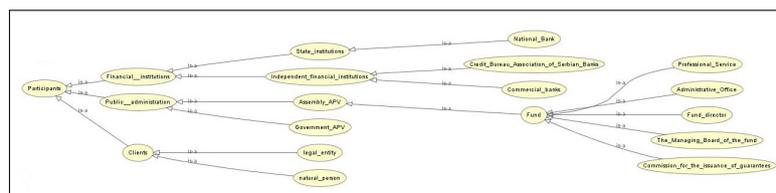

Figure 2: Participants-ontological concept

Three subclasses of the Participants class are defined in this way: Financial-institutions, Public- administration, Clients.

The Financial-institutions concept

This ontological concept describes financial institutions that cooperate with the Guarantee Fund as well as external participants in carrying out work procedures of the fund. Two groups of financial institutions were identified: 1. State institutions (The National Bank), 2. The Independent financial institutions (Commercial banks, Credit Bureau Association of Serbian Banks). The properties of these concepts are SubClassof and haveService. The property SubClass of describes the structural position of the concept, while the property haveService indicates the existence of external services that are invoked during the execution of procedures.

The Public-administration concept

The classes described by the concept Public-administration represent the organizational structure of state administration in AP Vojvodina and the place and role of the Guarantee Fund of APV in this organizational structure.

The Fund concept   The classes identified in the taxonomy of the Fund are, as follows: Managing Board, Fund director, Professional Service, Administrative Office, Commission for the issuance of guarantees.

The Clients concept

The classes described by the concept Clients represent participants who are allowed to apply to Fund open competition. The classes identified in the taxonomy are: Legal entity and Natural person

3.3   The Documents concept

The concept Documents is created by analyzing all of the documents identified in the Guarantee Fund of APV. Figure 3 shows the taxonomy of the Documents concept.
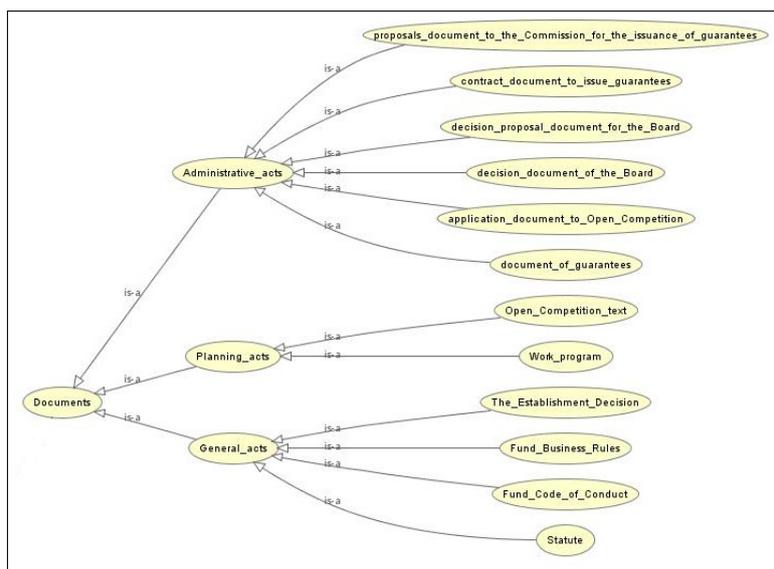

Figure 3: Taxonomy of the Documents ontological concept

Three groups of documents were identified: Administrative acts, Planning acts, and General acts.

The Administrative-act concept

As defined above, administrative documents are the product of administrative tasks within business procedures. Semantic descriptions of documents that have been identified as a result of the execution of administrative tasks are given below. If we look at the documents as a product of administrative tasks in the case of the Guarantee Fund of APV, the following documents that appear as a result of the execution of administrative tasks in the business process of issuing a guarantee can be identified:

The application document to Open Competition;

The proposals document to the Commission for the issuance of guarantees;

The decision proposal document for the Board;

The decision document of the Board;

The contract document to issue guarantees.

The document of guarantees Administrative-act concept is a subclass of the Documents concept. In addition, it is associated with the property Producedby that describes it in terms of administrative procedure which produces the document of Administrative-act type, and the property FillBy which determines the entity from the Participants taxonomy who fills out a pre-defined form of the document of Administrative-act type.

The Planning-act concept

Documents belonging to this group are created each year. This group includes the following documents: Work program, and Open Competition text. Apart from their property SubClass of which defines hierarchical relations among documents, they are associated with properties that describe them in terms of creation and approval:

Createdby defines the entity from the Participants taxonomy that created the document.

Acceptedby defines the entity from the Participants taxonomy that approved the document.

The General-acts concept

The documents that determine the legal framework of the fund belong to this group. In the case of the Guarantee Fund of APV, these are the following documents: The Establishment Decision, The Statute, The Fund Business Rules, and The Fund Code of Conduct. Apart from their property SubClass of which defines hierarchical relations among documents, they are associated with properties that describe them in terms of creation and approval:

Createdby defines the entity from the Participants taxonomy that created the document.

Acceptedby defines the entity from the Participants taxonomy that approved the document.

3.4   Procedures concept

The Procedures concept represents taxonomy of the administrative procedures of the fund. This taxonomy is created based on operational procedures for issuing guarantees and procedures relating to the creation of planning acts of the fund. In addition, the taxonomy contains procedures related to utilization of the documents that define legal and regulative framework of funds within the state administration. The taxonomy is shown on Figure 4.

The taxonomy of the Procedures concept consists of following classes: Planning-procedures, Operative-procedures.
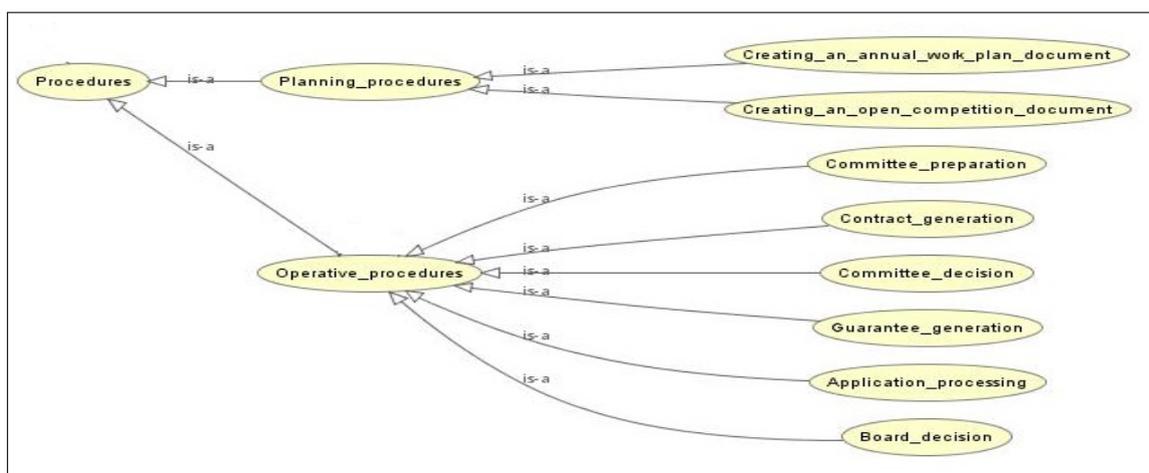
Figure 4: The Procedures taxonomy

Planning-procedures concept

This concept describes the procedures aimed at planning annual activities of the Fund. The outputs of these procedures are various documents that contain activities to be performed in a calendar year and related financial resources. The following procedures have been identified: Creating an annual work plan document, and Creating an open competition document. The properties of classes describe these procedures:

SubClass of identifies the structural position of the concept within the Procedures taxonomy.

HaveOutputDoc -identifies the document that results from performing general administrative procedures.

PerformedBy -identifies the perpetrators of the procedure.

GeneralActsReferenced identifies all General-Act concepts, which are legal/regulative basis for the created planning document.

Operative-procedures concept

Basis for creating the Operative-procedures ontological concept are: Task, Procedure, and Full Procedure as defined in [2]. Each task is executed within a Procedure. Each task has input data that an administrative worker or system should fill out and the result of the execution of the task is an administrative act. The Procedure contains only one task with the corresponding input and output data, which is filled out by an administrative worker or system. Full-Procedure is composed of one or more procedures, while Operative- procedure is composed of one or more tasks. In the case of the Guarantee Fund of APV, the Full-Procedure is the procedure of issuing the guarantee. Analyzing Operative-procedures concept the following classes are identified: Application-Processing, Committee-Preparation, Committee-Decision, Board-Decision, Contract-Generation, and Guarantee-Generation. Figure 5. depicts Application-Processing class, and properties and relations of the Operative-procedures concept.

Services that call the specified Operative-procedures during their execution are presented by their profiles (Pservice-A-P, etc.). Communication between these procedures and the service can be defined as an atomic process since the action of the service can be performed in a single interaction with the service.
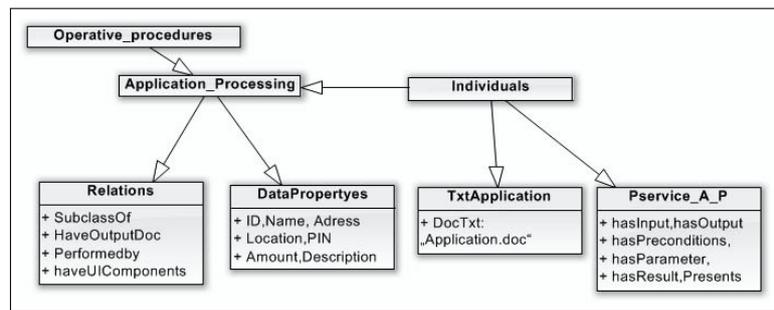
Figure 5: Properties and relations of the Operative-procedures concept

3.5   The Services concept

Classes of internal and external services that are invoked for executing the work procedures of issuing guarantees are described in this taxonomy. The following classes are defined: InternalServices and ExternalServices. Internal Services are the services that are provided by the Fund, while External services are those that are provided by third parties like banks, other administrative bodies, etc. Both have same properties SubClass of and availableOn. The property SubClass identifies the structural position of the concept within the Services taxonomy, while the property availableOn indicates service provider URI. Members of the class InternalServices (Service-A-P, Service-C-P, etc.) are presented by the PresentedBy property. This property points to the service profile that presents the service and the operational procedure that uses this electronic service.

4   The semantics of the administrative task

As described above, in our model, an Operative-procedure is composed of one or more tasks. We call these tasks Administrative tasks. Figure 6 shows the ontological representation of an Administrative task.
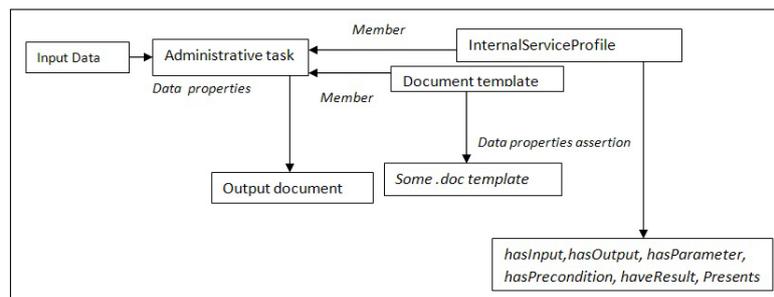

Figure 6: Ontological representation of an Administrative task

Each class and subclass of the ontology within the concept of the Operative-procedures has input data. Properties dataProperties describe input data of each Operative-procedures class. An administrative worker or service fills input data into pre-defined Document template(s) corresponding to an Administrative task. Document template is an active document that contains a code aimed at invoking a service presented by InternalServices profile. It serves as a starting point for a new document creation. Individuals of each Operative-procedures class represent corresponding service and corresponding document template that are filled with input data during the execution of an administrative task. Result of an Administrative task execution is a

custom administrative act Output document (one or more in general, because the ontology allows it). Output documents of an administrative task have their corresponding Object Properties. These properties describe all relations between an Administrative task and concepts Documents (Producedby, FillBy) and Participants (Performedby). Figure 7 shows the ontological model of the administrative task aimed at processing applications on open competition.
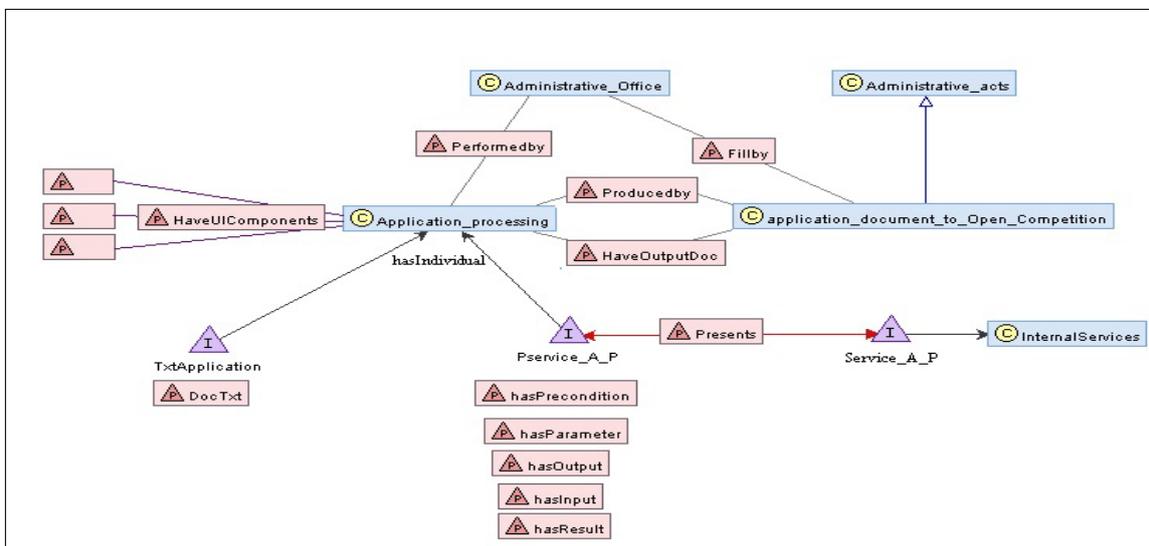

Figure 7: Ontological model of the Administrative task

Semantics of an administrative task can be described as follows: The procedure Application-processing is executed by the Administrative-Office. The document application-document-to-Open-Competition is the result of the execution of Application-processing procedure. The procedure for application processing has a unique document template TxtApplication. The service profile Pservice-A-P describes the electronic service invoked by the procedure Application-processing.

4.1   Application of the ontology of administrative task

The annotation of the ontology with elements of user interface is based on the rule that administrative tasks have input data. As shown in Figure 7, input data is a series of variables that are filled with the resulting document template of the administrative task. The names of the input data are represented with dataProperties of the observed task. The descriptions of input data are defined in dataProperties isDefinedBy property in the following form:

```
<Control>Component_type</Control>...(Type of the UI /database component )
<Data>data_type</Data>.(Data Type (string), (integer))
<Order>X</Order>.(Component index order on the form)
<Label>Component_label</Label>.(Label of the Component)
<Id>unique_name</Id>(Unique name of the defined Component)
```

Individuals of each class denote the template of the document that is filled with input data The feature Data-Properties-assertion references a document that represents the template.

Data-Properties-ID defines the order of execution of the administrative procedures and/or tasks.

An algorithm for a direct transformation of the semantic description of the administrative task in the user interface components is shown in Figure 8.
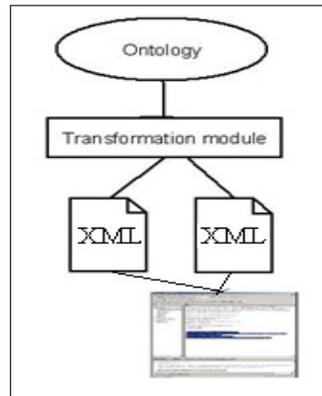
Figure 8: Transformation ontology into user interface

Module for semantic content transformation: The requirement set in the introductory section of this paper is that the created ontology should enable automatic generation of information system components. The basis of this procedure is the transformation of the created Administrative Task ontology represented in OWL format in two XML documents witch enable creation of the user interface. The module for transformation of semantic content represents the application that loads the created ontology and executes SPARQL queries. Parsing the query results generates two XML documents (OntoClass, OntoForm).

Administrative tasks sorted in the order of execution within the administrative process are presented by a Tree View component. For each administrative task, it is necessary to load the descriptions of the components of the information system from the property DataProperty - isDefinedBy.

The first XML document is a representation of classes and subclasses of the ontological concept Procedure that represents an ontological description of the administrative business processes. OntoClass.xml is an XML document, which represents a workflow of the defined administrative procedures. The second XML document represents components that are extracted from the semantic description of the administrative task. As shown in Figure 8, our model proposes the application of ontologies for the representation of administrative processes defined in workflows and extraction of information system components from the generated ontology. Figure 9 shows the user interface of the module for the transformation of semantic content.

The module for semantic content transformation provides the following functions:

Selection and loading of the desired ontology;

Entering the names of basic classes of the ontology that describe the tasks of the business process;

Generating the first XML document;

Entering the name of an administrative procedure for which it is necessary to generate user interface components;

Generating the second XML document;

Generating user interface for the selected administrative task.

As described, annotating administrative task ontology with user interface components, enable automatic creation of the User Interface for each procedure defined in the ontology. Depending on the application, the appropriate XSL file provides mechanisms of transformation and formatting OntoForm.xml and OntoClass.xml documents into user interface components.

Ontological representation of the administrative task contains the resulting document template of a selected task. Listing 1 displays the SPARQL queries by which we extract the name of the resulting document template of the chosen procedure.
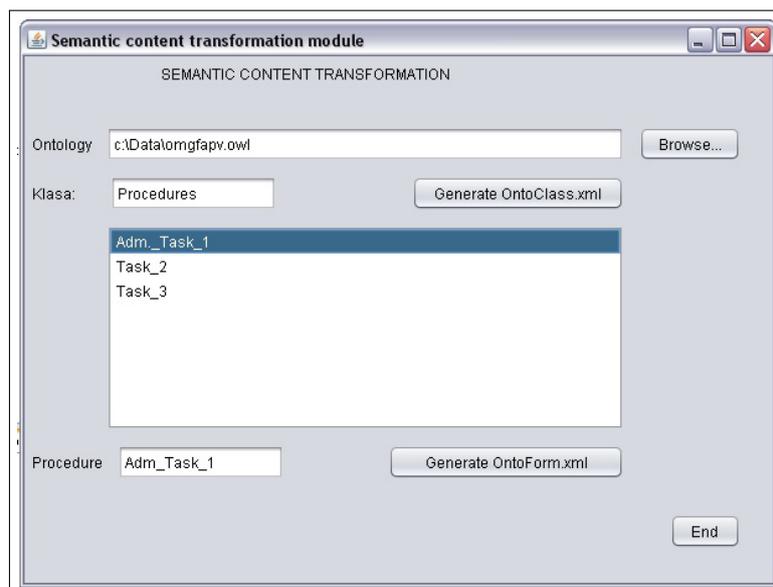
Figure 9: The module for semantic content transformation

```
Listing 1. Query code for the template extraction
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX gf: <http://localhost/GFontologies/2011/8/19/Ontology1316412802796.owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?x ?y WHERE {
  ?x rdf:type gf:Adm_Task_1
     ?x gf:DocTxt ?y
}
```

4.2   Using document templates

Each administrative task has exactly two ontological individuals: a corresponding service and a corresponding document template to be filled with input data during the execution of the administrative task thus generating the final document of this administrative task. IT and legal experts are responsible for creating document templates and corresponding electronic services based on the semantic annotation of the administrative task. An example of executing Application-processing procedure, which illustrates the flexibility of the administrative task representation achieved by the proposed administrative task semantic description and use of document templates, is shown in sequel:

When a user select desired administrative task (on the generated user interface Application-processing Figure 10) and fill out all the required fields, corresponding service generate document template shown on Figure 10. Document template acquires application data from the generated User Interface and enable generation of the final administrative act.

Figure 10: Functionality of the created document template

5   Conclusion

eGovernment solutions represent a major challenge in redefining the role of public administration agencies and organizations. Creating and using ontologies of knowledge of administrative processes and modeling and controling systems that would speed up and automate the work of state administration, constitute prerequisites for technical and organizational interoperability of different government agencies.

The proposed method reduces development time and effort in order to meet the demands of the information system based on knowledge of the administrative processes and documents. In this paper, we presented a methodology for ontology creation and annotation utilized to describe knowledge of the administrative task.

In this paper, we have proposed an ontological model of state development funds. The proposed model enables document templates creation, which are the framework for the automatic generation of an administrative act as a result of the administrative procedures execution. The proposed approach is verified by a case study of building an ontological model for the Guarantee Fund of APV. When defining the ontological model of OM GFAPV, the following elements of the domain were analyzed:

1 Participants, represents internal funds structure and its position within the public administration, as well as actors who perform tasks defined in the business process and external participants to the process;

2 Documents, represents administrative acts appearing during the execution of tasks within business processes;

3 The business process logic, is defined by business rules and operating procedures of the business system (state credit guarantee funds);

4 Electronic services are services that are invoked in order to execute procedures implementing business process logic.

The generalization (superclass-of) and specialization (subclass-of) of ontological concepts are represented by the taxonomy of the main concepts of the ontology of the Guarantee Fund of AP Vojvodina. An atomic process presents communication between administrative procedures and services. In the case of OM GFAPV, each service belongs to only one procedure that is defined in the ontology. Services are described by service profile properties. Following the proposed ontology, semantics of an administrative task is described in details. Finally, an example illustrating usage of the proposed ontology for implementation of Application-processing procedure is presented. Further research should focus on the development of ontologies of administrative

processes within the domain of state bodies. Such ontologies could serve for fast and efficient creation of interoperable eGovernment applications.

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