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Knowledge-based public service transactions: An intelligent model-driven approach in co-learning contexts

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ABSTRACT

Public administrations pursue the efficiency and quality of administrative services they offer as well as the reduction of time and operational costs in executing service transactions. However, some issues arise when trying to achieve these goals: (a) the lack of procedure formalization to describe public services, (b) a mechanism to guarantee services' obligatory compliance with frequently changing legal regulations, and (c) the efficient deployment of service transactions in e-government platforms. The aim of this work is to identify the phases of the development cycle of eGovernment transactions and provide the support to automatize them efficiently by using a model driven engineering (MDE) and knowledge-based approach. The main source of the knowledge extraction process comes from a collaborative learning environment where public servants share acquired domain knowledge. A web survey has been conducted to evaluate the approach acceptance degree by software developers and domain experts. The main conclusion is that 61% of the surveyed experts strongly agree that our approach improves actual eGovernment transactions practices and the phases needed to develop them.

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1. Introduction

The objective behind Information Technology (IT) projects in e-government contexts as argued in (Buhl & Löffler, 2011) are: simplification and realization of information, communication, and transaction processes within and between public administrations and citizens by using digital information and communication technology. Technologies that use workflow management have shown its effectiveness for the integration or automation of business and industrial processes using Enterprise Resource Planning (ERP) systems (Aalst & Hee, 2002). However, the procedure transactions automation in the context of public sector with the single use of workflow management may not be a suitable approach as discussed in (Yang, Tong, Ye, & Wu, 2006). The main reason to support this is that the administrative procedures essentially differs from business process in that the former requires intensive domain knowledge (Lytras & Pouloudi, 2006; Papavassiliou, Ntioudis, Abecker, & Mentzas, 2003). Moreover, these procedures have high probability

to change, disappear or evolve to new states over time since they are under the influence of political decisions that suffers frequently variations. These kind of procedures are characterized by frequent dependencies on domain knowledge like regulations that enclose certain rules to fulfill its tasks or actions; they can be classified as a set of high complexity procedures with a strong dependency on domain knowledge (Papavassiliou et al., 2003). At this point the knowledge extraction in e-government domain presents itself as a complex task. This complexity gets bigger when the rules that affect this domain are extracted from public regulations that control the execution of procedures. From the legal point of view it is difficult to comprehend and interpret the regulations by the public employees, even knowing the domain. Different interpretations are made coming from a single regulation that affects the same procedure, which is therefore executed in different ways at various public organizations. Taking this into account, there is a need to have a mechanism that formalizes the implicit knowledge involved in procedures transactions. Domain experts can be a very valuable knowledge source besides legal regulations. The domain expert's knowledge must be consistent with the tools it uses to do its work in procedure transactions. In conclusion, it can be said that it is necessary to formalize this knowledge in a comprehensible way for the expert that enable the extraction of the rules needed to automate procedure transactions.

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The use of Model Driven Engineering (MDE) technologies in the definition of procedure transactions models in e-government domain requires a close coordination between domain experts, developers and resources in order to create representative and accurate transaction models. Making the public employee the eGovernment domain expert and involving it in the process of the proper formalization of the procedures can be a suitable approach to accomplish the desired efficiency in administrative transactions. Procedure transaction modeling in e-government domain it is defined in this work as the task to formalize an e-government procedure from its late execution point of view going through the supervision of a domain expert. The transaction term in this context gets the meaning from the execution of certain automated administrative actions to achieve a procedure completion. Defined models' validation is also a critical activity as stated by (Bertolino, De Angelis, Di Sandro, & Sabetta, 2011) since models are the start point of many later transformations where deficiencies in the source models can have detrimental implications. In the case of eGovernment domain models (e.g. procedure transaction models), the accuracy which they have been defined determines the compliance with specific regulations or mandates as the context of their usage is usually the public sector. Therefore, models' validation becomes of crucial importance in this domain since it can prevent from failing in unlawful procedures. The goal of this paper is to provide an approach which leverages domain experts' knowledge as well as legal regulations in order to automatize the modeling, validation and deployment cycle of public services in e-government platforms. The proposal assumes that the automation of this cycle providing domain experts with an intelligent model based toolset can improve the efficiency and quality of public services and reduce operational costs since the time and effort from designing to deployment of services it's greatly reduced. In order to model e-government procedure transactions in a balanced way between the supervision of human actors and automated validation, we provide a knowledge base composed by a set of supervision rules integrated in a modeling environment and executed by a rule engine. Therefore, the approach enables public sector employees or procedure modelers to transform, validate and deploy knowledge based requirements models in platform specific-applications. Furthermore, software developers can benefit from this approach since its model driven nature fosters the code reuse and reduce the development effort.

2. Background and related work

Related work concerns various aspects of the problem we address, namely use of process modeling, knowledge-based systems, code generation, etc., for e-government transactions automation. Recent research in the field of process modeling and workflow management in e-government domain has raised a significant interest in scientific research community (Osterweil, Schweik, Sondheimer, & Thomas, 2005). In (Klischewski & Wetzel, 2002), the authors have modeled the services flow using Extensible Mark-up Language (XML) by identifying the points where the specific tasks supplied by the public administration are captured. As shown in (Osterweil et al., 2005), the use of Process Definition Language (PDL) can be useful to analyze the inconsistencies and errors in administrative processes such as a license renovation. Another proposal have been developed in eGov project, which is built as an e-government integrated service platform where services are specified, registered and deployed using Governmental Markup Language (GovML) (Tambouris, 2001). As shown in (Ciaghi, Weldemariam, Villaforita, & Kessler, 2011), process modeling in public administrations has mainly been performed with general-purpose languages. These modeling languages are flexible mechanisms to describe miscellaneous processes in many different

domains. However, they do not consider in particular public sector specific issues like: (1) services integration in transactions performed (e.g. interoperation with external services) to retrieve or send information required, (2) real modeling time validations and completion of modeled transactions, and (3) conformance to legal regulations (Wimmer, 2003). This results in the conclusion that these generic approaches are not suitable to represent all relevant aspects of this domain. Therefore, there is a need for a new, e-government transactions modeling language. Regarding to knowledge management in e-government domain there are various approaches that addresses this topic. Among them can be found SmartGov (Tambouris, Boukis, Vassilakis, & Lepouras, 2002), which have been developed as a knowledge based platform to aid public employees in online generation of transactions for electronic forms. It uses ontology to build the domain map associated with knowledge units that represents the regulations. The approach depicted by (Papavassiliou et al., 2003) leverages the potentialities of workflow and knowledge management to automate or semi-automate administrative procedures that requires domain intensive knowledge. In (Savvas & Bassiliades, 2009) the authors adopt a process oriented approach, through a web-based knowledge management system that provides an interpretation of legal framework. Other approaches that were taken into account in this work from the knowledge management perspective in e-government transactions were the knowledge sharing (Zhang, Vogel, & Zhou, 2012) between domain experts in public administrations and coordination among the former and software developers (Yuan, Zhang, Chen, Vogel, & Chu, 2009). These approaches emphasize in the importance of sharing the domain knowledge effectively among the experts of the domain and the tasks coordination with the IT experts of the organizations. This subject is also addressed in (Zhang, De Pablos, & Zhou, 2013) where the authors examines how the visibility of knowledge sharing impacts on incentive-based relationship in IT-based knowledge management systems. Although we consider the domain knowledge extraction from domain experts, our work essentially differ from the above in that we propose a formal representation and generic mechanism that can be integrated in actual and future e-government platforms. We keep this formal representation close to the domain as possible providing a modeling environment to express the information structures and rules that affect the execution of the procedures. Furthermore, we implement such rules using an intelligent mechanism that aids the adaptation of procedure transactions to new changes in legal regulations, this way administrations guarantee the constant updating of their already defined procedures.

3. Approach

This approach starts from the fact that every transaction in eGovernment domain is described by repetitive phases that may

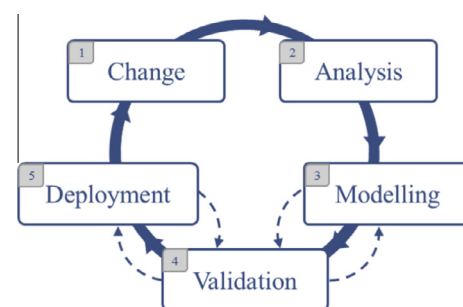


Fig. 1. Development cycle phases of eGovernment transactions.

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