Exploring Ontologies for Semantic Documentation in Project Management

Erick Casagrande Bastos, Monalessa Perini Barcellos, Ricardo de Almeida Falbo

Ontology and Conceptual Modeling Research Group (NEMO), Department of Computer Science, Federal University of Espírito Santo– Vitória – ES – Brazil

{erickcasagrande, monalessa, falbo}@inf.ufes.br

Abstract. *Although there are several tools devoted to support project management, documents are widely used as an instrument to record information regarding projects. However, retrieving information from documents is usually not trivial and depends on human effort. In this paper we discuss the use of semantic annotation of desktop documents in the project management context. The main results of a study that investigated initiatives involving semantic annotation to support project management aspects are presented, as well as an ongoing work in which we explore a software project management domain ontology to annotate desktop documents and extend a semantic document management platform.*

1. Introduction

Documents are an important instrument to record and share information in the project management domain, since they provide useful information for communication between people and for an effective understanding about the project [Bruggemann et al. 2000].

There are several tools to support project management, but they are not used by all organizations. Spreadsheets are widely used for organizations that have limited access to sophisticated tools to support some project management activities, such as schedule and budget planning and control [Villalobos et al. 2011]. Furthermore, project management supporting tools often do not eliminate the need of using desktop documents (e.g., text documents and spreadsheets).

One disadvantage of using documents is the difficulty of obtaining consolidated information from them. The access to their contents typically depends on human intervention, since they were originally designed to be read by humans, not to be manipulated by machines. As a consequence, retrieving and analyzing document content can be unproductive and sometimes inefficient. Besides, gathering relevant information from different documents can be so wearing that people may tend not to do that [Arantes and Falbo 2010].

In the Semantic Web community, researchers have defended that ontology-based metadata can be added into web contents so that these contents become available for machine interpretation. The act of adding ontology-based metadata into syntactic information resources making them semantic information resources is named *semantic annotation*. Ontologies are an ideal vehicle for describing the vocabulary for metadata statements, providing a rich formal semantic structure for their interpretation. Therefore ontology is often used as basis for annotation [Sicilia 2006].

Semantic Web principles can be applied to documents rendered by desktop tools (e.g., text and spreadsheet editors), giving rise to *Semantic Documentation*, which aims at making document content interpretable by computers. In this context, several tools have been developed to support semantic annotation, such as the Infrastructure for Managing Semantic Documents (IMSD) [Arantes and Falbo 2010], PDFTab [Eriksson 2007] and KIM [Kiryakov et al. 2004], which use domain ontologies for semantically annotating documents and provide a set of general features for managing semantic documents (e.g., documents annotation, storage, indexing and retrieval), being applicable to several domains. These tools provide only general features and do not explore the specific conceptualization provided by the domain ontologies. In order to provide a more effective support to domain-specific tasks, it is useful to explore the ontology elements (concepts, relations and properties) and use them to develop domain-specific functionalities [Falbo et al. 2014].

In this paper, we explore the use of domain ontologies for semantic documentation in Project Management. First, we started by carrying out a systematic literature review (SLR) to analyze initiatives that support project management aspects by using semantic annotation. The use of semantic annotation in the Project Management domain can help project managers to get consolidated information from data stored in different documents and to make decisions based on it. Taking that into account, we aim at extending IMSD to explore specific features to support project management.

This paper is organized as following: Section 2 talks briefly about semantic documentation and project management. Section 3 addresses the performed SLR. Section 4 presents a fragment of the Software Project Management Ontology we developed and discusses its use to extend IMSD. Section 5 concerns related works. Finally, Section 6 presents our final considerations.

2. Semantic Documentation and Project Management

In organizations there is a considerable amount of work done by using desktop tools. Semantic Documentation is a key for tackling the lack of semantics in desktop documents. Semantic documents provide services such as advanced search, reasoning using document metadata, and knowledge management services, like document repositories and document management [Eriksson and Bang 2006].

The problems related to accessing and managing document content clearly occur in the Project Management context, since text documents and spreadsheets are frequently used as instruments for recording and sharing information among project members. In this sense, semantic annotation has potential use in this area.

Project management involves the application of knowledge, skills, tools and techniques to project activities aiming to meet project requirements [PMI 2013]. According to the PMBOK [PMI 2013], there are ten knowledge areas (KAs) related to project management, i.e., there are ten KAs to be managed, namely: Integration, Scope, Stakeholder, Human Resource, Time, Cost, Risk, Quality, Communication, and Procurement.

Project management comprehends three main interactive phases [Pressman 2011]: planning, execution, and monitoring and control. During project planning it is established a plan to the project, including the project scope, allocated human resources, schedule, budget and risks, among others. Execution consists of running the plan, i.e., execute the project following the established plan. In this phase the project results are produced and most of budget and efforts are spent. Monitoring and control aims to compare the plans with the execution, identify problems and present solutions. During this phase, performance indicators can help the project manager to understand the project progress and performance based on the project scope, schedule and budget.

During a project, relevant information regarding planning, progress, monitoring and control is recorded in text documents and spreadsheets (e.g., project management plan and status reports). If information is structured and annotated, computers can help to handle it. Besides, semantic annotation could help store and retrieve the knowledge acquired in a project and reuse it in other projects.

3. Systematic Literature Review

Aiming at identifying and analyzing initiatives involving semantic annotation to support Project Management, we carried out a systematic literature review. According to Kitchenham et al. (2011), systematic literature reviews are secondary studies used to find, critically evaluate and aggregate all relevant research papers on a specific research question or research topic. The methodology is intended to ensure that the literature review is unbiased, rigorous and auditable. The study followed the review process defined by Kitchenham and Charters (2007), which involves three phases: planning, when the research protocol is defined; conducting, when the protocol is executed and data are extracted, analyzed and recorded; and reporting, when the results are recorded and made available. Next, we present the main parts of the protocol used in the study.

3.1 Research Protocol

Research Questions: The main research question is *(RQ1) What are the initiatives involving semantic annotation that support project management aspects?* From this general question, two more specific were defined: *(RQ2) How semantic annotation is addressed?* and *(RQ3) Which are the aspects of project management supported?*

Search String: The search string has two groups of terms joined by the AND operator. The first group aims at capturing studies that deal with semantic annotation and semantic documentation. The second group aims to capture studies related to project management. Within each group, the OR operator was used to allow for alternative terms. The following search string was used: *((("semantic documentation") OR ("semantic annotation") OR ("semantic-document") OR ("semantic document")) AND (("project management") OR ("project planning") OR ("project controlling") OR ("project control") OR ("project monitoring") OR ("project tracking")))*.

Sources: Five digital libraries were searched, namely: Scopus (*www.scopus.com*), Engineering Village (*www.engineeringvillage.com*), ACM (*dl.acm.org*), IEEE Xplore (*ieeexplore.ieee.org*) and ScienceDirect (*www.sciencedirect.com*).

Publications Selection: the object of analysis are articles published in scientific events or journals. Publications selection was done in four steps: the 1st step (S1), *Preliminary*

Selection and Cataloging, consisted in applying the search string by using the digital library search mechanism. Publication language was limited to English, and the search scope was limited to title, abstract and keywords. At the end of this step, publications indexed by more than one digital library were identified and duplications were removed. The 2nd Step (S2), *Selection of Relevant Publications – 1st filter*, involved reading the abstracts of the publications selected in S1 and analyzing them considering the inclusion criterion IC1 - the publication presents some proposal involving semantic annotation that supports aspects related to project management, and two exclusion criteria: EC1 - the publication does not have an abstract; and EC2 - the publication is not a primary study. The 3rd Step (S3), *Selection of Relevant Publications – 2nd filter*, consisted of reading the full text of the publications selected in S2 and analyzing them considering IC1 and other three exclusion criteria: EC3 - the study was published only as an abstract; EC4 - the publication full text is not available; and EC5 - the publication is a copy or an older version of an already selected publication. Finally, in the four step (S4) we performed *Backward Snowballing* [Webster and Watson 2002], investigating if among the references cited in the selected papers, there was some useful to the study.

3.2 Data Synthesis

The systematic review was finished at the beginning of 2015 and considered publications until December 31st 2014. As a result of S1, 39 publications were obtained (21 in Scopus, 13 in Engineering Village, 5 in IEEE). No publication was returned by applying the search string to ACM and ScienceDirect. After duplication removal, 24 publications remained. 21 publications were selected in S2 and 4 in S3. None new paper was selected in S4. The selected papers were published during the last decade, meaning that the research topic is recent. In fact, we expected to find only recent publications, because semantic annotation was applied to semantic documents only in the 2000's. The small number of publications selected shows that, in addition to be recent, the topic has not been much explored. Next, a data synthesis to each research question is presented.

RQ1. What are the initiatives involving semantic annotation that support project management aspects? Four initiatives were found:

- **Semantic Annotation based on Software Knowledge Sharing Space (SKSS)** [Lu et al. 2008]: SKSS is a system that aims to improve knowledge sharing among software development team members. It allows annotating documents produced during projects, creating a network that facilitates accessing and sharing information about the project.

- **Content Management for Inter-Organization Projects (CMIO)** [Nakatsuka and Ishida 2006] : CMIO is a system to manage content of inter-organizational projects. Project content is semantically annotated, and when a project member creates, modifies or manages content in a project, automatic emails are sent to the other project members, communicating explicitly what has changed in the project.

- **Collaboration in Public Policy Making, Implementation and Evaluation (CPPMIE)** [Loukis 2007]: CPPMIE consists of a structured electronic forum in which participants opine about programs, projects, tasks and deliverables related to public policies. A Public Policy Ontology is used for semantically annotating posts, allowing organization, indexing, integration and querying of the posts recorded in the forums.

- **Semex** [Talaš et al. 2010]: Semex is a module of a project management system. It is responsible for semantic annotation of wiki pages. It supports creation, sharing and publication of collaborative content in projects, providing a common environment that allows project team members to access information and contribute to discussions.

RQ2. How semantic annotation is addressed in the initiative?

In this question, we analyzed the semantic annotation approach used in each study, considering aspects such as semantic annotation type, annotated files, ontologies and technologies involved. Regarding semantic annotation type, it is manual when annotations are made by the user. It is automatic when automation components are used to provide suggestions for annotations or make them automatically [Uren et al. 2006].

In SKSS, semantic annotation is used to connect information recorded in different documents. Word, Eclipse, VS.Net and Adobe Reader documents can be annotated. Annotation is manual and based on Project, Annotation and Document domain ontologies. A framework composed of three components is used: the *sensor* component is a plug-in embedded into tools (MS Word, Adobe Reader, Eclipse and Visual Studio) that adds semantic annotations and connects information recorded in different documents; the *service provider* component deals with knowledge publishing, ontology management and query; and the *database* component stores annotation instances, ontologies and documents, and supports version control.

In CMIO, semantic annotation is manual and made by using an application named Project Organizer, which allows for annotating web pages, PDF files and text documents using a Project domain ontology as a basis. CMIO uses e-mail metaphor, i.e., it semantically annotates documents, connects information recorded in different documents, and when document content is created, modified or managed, automatic emails are sent to project members communicating the changes. A RDF database is used to store content, metadata and associations.

CPPMIE annotates web documents and electronic forum pages. The annotation is manual and based on a Public Policy domain ontology. A structured electronic forum based on the ontology is used to record posts about public policies projects and programs. Information semantically annotated in posts is retrieved and an XML file containing relevant information is produced.

Semex annotates wiki pages, allowing for browsing pages containing project content and selecting information related to the projects (e.g., projects that share a certain human resource). Semantic annotation is manual and uses a Project Management and Presentation domain ontology as a basis. Semex uses RDF triple to annotate wiki pages and RDFLib library (*www.rdflib.net*) to work with RDF.

RQ3. Which are the aspects of project management supported by the initiative?

Aspects related to four KA are supported by the initiatives: Scope, Integration, Communication and Stakeholder Management.

Communication Management KA covers communication planning (definition of what information should be available; how, when and where it should be recorded; who is responsible for recording it; and who can access it), management (communication plan execution) and controlling (comparison between planned and executed, and

corrective actions execution). Three proposals support this KA, mainly in aspects related to communication management, which occurs during the project execution phase. In SKSS, semantic annotation helps information recording and sharing. For instance, documents produced during the project can be annotated and related one to others in a knowledge network. As a result, when a document is accessed by a project member, she also gets its related documents. In Semex, a common knowledge base is shared between projects and supports information sharing. Semantic annotation allows for browsing pages containing project content and selecting information related to the projects (e.g., projects that share a certain human resource). CMIO supports project content creation, modification and management, and sends automatic emails to project members communicating the changes made. By doing this, CMIO also supports aspects related to Integration Management that includes, among others, integrated change control, consisting of recording the project changes, their reasons, and performing the necessary actions in an integrated way.

CPPMIE supports Scope and Stakeholder Management aspects. Scope Management concerns the definition of the work to be done in the project, while Stakeholder Management involves identifying and managing project stakeholders, their expectations and involvement. The CPPMIE forum is used to define the public policies and requirements to be addressed in projects, i.e., the project scope. Moreover, the forum helps to interact with stakeholders, encouraging the appropriate involvement of them in project activities.

3.3 Discussions

By analyzing the selected papers, we noticed that, except by Semex, the proposals were not conceived aiming to support project management. Thus, although the proposals support aspects related to project management, this is not their main concern.

Regarding the semantic annotation approach adopted, all proposals use domain ontologies as a basis for annotating documents or web pages. Spreadsheets are not annotated in any proposal. Also, all proposals adopt manual annotation. According to Uren et al. (2006), automation is a desirable requirement in semantic annotation proposals. Manual annotation is an additional burden, because human annotators are prone to error and non-trivial annotations usually require domain expertise. However, there are research challenges in this direction, related to the extraction of relations for semantic annotation.

As for the project management aspects addressed, the proposals support some ones related to Scope, Integration, Communication and Stakeholder Management. Since Communication Management is related to information recording and sharing, and semantic annotation supports them, it was expected that Communication was among the main supported areas. The other knowledge areas that are supported by the proposals usually produce documents as results of their activities (e.g., requirements document produced in Scope Management). Time and Cost Management, which are important areas in project management, are not supported by any proposal. Semantic annotation could help relate and sequence the project activities and control the schedule. Besides, it could support cost and quality control, for example, by establishing relationships between costs and activities, and between changes and deliverables. However, these

KAs are typically well supported by project management systems (e.g., MSProject). This can be one of the reasons why these areas have not been target of semantic annotation initiatives. Besides, the use of semantic annotation in project management is very recent. Thus, there are still many aspects to be explored.

As limitations of this systematic review, we highlight the small number of selected publications. Although five digital libraries have been used, only four publications were identified and only one of them is truly devoted to the project management domain. This fact shows that the research topic is recent and has not been much explored. Since documents are still an important instrument to record and share information regarding projects, we believe that the use of semantic annotation on project management is a relevant topic, and there are opportunities of research in this area.

4. Using Semantic Annotation to support Project Management

In order to explore the use of semantic annotation in the project management context, we extended the Infrastructure for Managing Semantic Documents (IMSD) [Arantes and Falbo 2010]. IMSD provides: *(i)* a way to semantically annotate document templates; *(ii)* a mechanism for controlling versions of semantic content extracted from semantic document versions, and therefore providing a way for tracking the evolution of the data embedded inside a semantic document; and *(iii)* data visibility to end-users allowing searches and data change notification subscription to aid developers to get an up-to-date information about something they are interested in.

IMSD supports the use of templates in text format. Since spreadsheets are very useful for recording data regarding projects (e.g., schedules and budges), we decided to extend IMSD to work with spreadsheets, expanding the scope of files used as data sources. Moreover, in order to annotate document and spreadsheet templates with metadata related to software project management, we developed the Software Project Management Ontology. Thus, we explored its conceptualization in domain-specific features to support project management activities.

4.1 The Software Project Management Ontology

The Software Project Management Ontology (SPMOnt) was developed based on the Software Process Ontology Pattern Language (SP-OPL) proposed in [Falbo et al. 2013]. SPMOnt includes concepts, relations and properties related to scope, time and costs planning and execution. Regarding costs, currently, only costs associated with human resources are considered. Figure 1 shows a fragment of SPMOnt with some of the concepts related to time and cost planning and execution. SPMOnt is represented by using OntoUML, a UML profile that enables modelers to make finer-grained modeling distinctions between different types of classes and relations according to ontological distinctions put forth by the Unified Foundational Ontology [Guizzardi 2005].

There are two types of processes defined to a **Project**: **General Project Process** and **Specific Project Process**. The first one is the global process defined to the Project. It is composed by specific process, allowing defining **sub-processes**. Specific Project Processes are composed by **Project Activities**, which can be **Simple Project Activities** or **Composite Project Activities**. Once a general project process is defined to a project, it is possible to plan duration, start and end dates, and cost of the process, their sub-

processes and activities. The definition of duration, dates and cost to a Project Process gives rise, respectively, to **Process with Planned Duration**, **Scheduled Process** and **Process with Planned Cost**. Similarly, the planning of duration, dates and cost of a Project Activity gives rise to **Activity with Planned Duration**, **Scheduled Activity** and **Activity with Planned Cost**.

A **Human Resource Allocation** is the assignment of a Scheduled Activity to a **Human Resource** to perform a **Human Role**. The cost of a Human Resource Allocation is based on the cost of the allocated Human Resource, which is established in the **Employment** of that Human Resource.

A Project Activity can cause **Activity Occurrences**, which can be **Simple Activity Occurrences** or **Composite Activity Occurrences**. **Human Resource Participation** refers to the participation of a Human Resource in an Activity Occurrence.

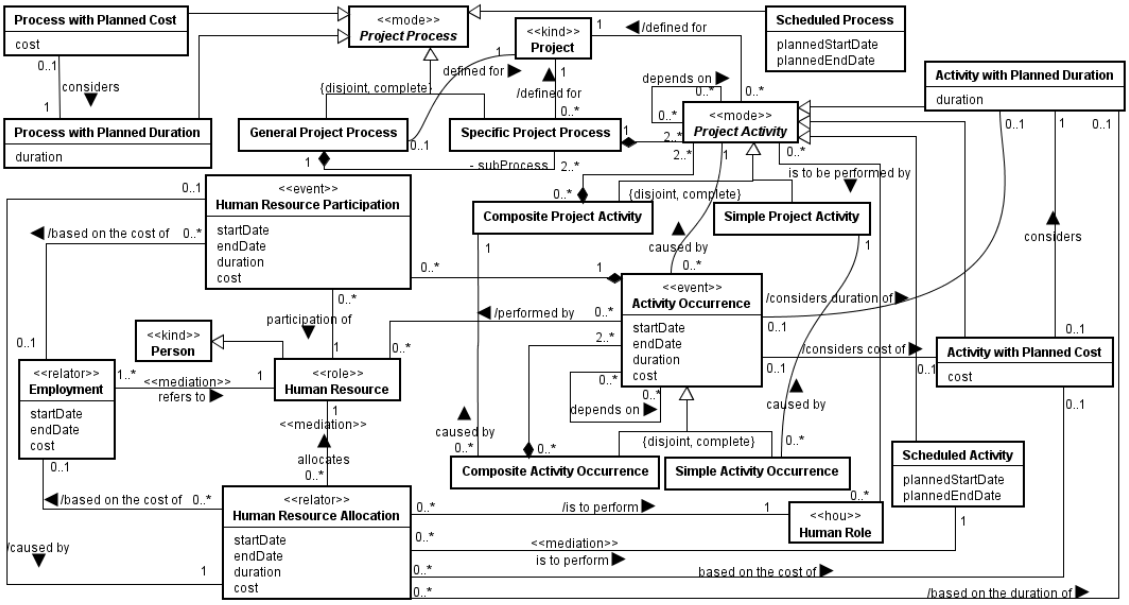

Figure 1 – A fragment of the Software Project Management Ontology

4.2 Supporting Project Management with Semantic Annotations in Spreadsheets

In order to explore the use of semantic annotation to support project management aspects, we first extended IMSD to work with spreadsheets and then we used SPMOnt as a basis to annotate spreadsheet templates related to the project management domain. The annotations are added into the templates that, when instantiated, give rise to semantic spreadsheets. Thus, once annotated the templates, the spreadsheets produced using them are also annotated and can be used as data sources to IMSD. Spreadsheet templates were developed using the Open Document Format [Oasis 2015], since it is an open format, with great span. Specialized annotations for cells were produced using Open Document Spreadsheet (ODS) in LibreOffice Calc.

For spreadsheets annotation, the syntax and instructions for annotating text fragments provided by IMSD are used to capture the cell content. Instructions can be used to create instances, relations and properties based on the ontology. The syntax of the instance creation instruction is *instance (arg ,concept, accessVariable)*. This instruction

creates the instance *arg* of the *concept* of SPMOnt. The SPMOnt was implemented in OWL and its URL is also informed in the *concept* field. The instruction result is a reference to the created instance and it is set on the *accessVariable* for later use. The syntax to create a relation is *property (arg1, prop, arg2)*. This instruction establishes a relation *prop* between the instances *arg1* and *arg2*. This instruction is also used to create properties and, in this case, it means that the value *arg2* is set as the property *prop* of the instance *arg1*.

For annotating templates and allowing the capture of the spreadsheets content by IMSD, in the LibreOffice Calc, *Custom Properties* option is used to annotations recording and *Styles and Formatting* option is used to allow for application of annotations to cells. The first thing to do when creating a semantic template is to create a custom property named *Semantic Document* and set its value to *True*. This way, IMSD can identify that the spreadsheet is a semantic document and searches for semantic annotations. Each annotation must be recorded in a new custom property whose value is the annotation instruction. For each annotation, a formatting style must be created and it must be related to the custom property in which the annotation is recorded. Thus, when a formatting style is applied to a cell, the cell is annotated according to the annotation instruction recorded in the corresponding custom property.

Three templates related to project management were developed and annotated: *WBS*, which is a text document that describes the project deliverables and work packages; *Project Status Report* (PSR), which is a spreadsheet that contains information regarding project planning and execution; and *Human Resources Costs* (HRC), which is a spreadsheet that provides information regarding the costs of human resources allocated to the project. Figure 2 shows the template of the *Project Status Report*, which contains information about project activities, dependencies, human resources allocated and participants, WBS items related, and planned and executed dates and duration. As examples, the annotations related to cells of Human Resource and Duration columns are shown. The first part of the human resource annotation creates instances of the *Human Resource* concept and stores in *hr* variable. The second part establishes the relationship *allocates* between instances of Human Resource and an instance of Activity, like in SPMOnt, in which the relation *allocates* connects a human resource to an activity, meaning that the human resource is allocated to perform the activity. The *break* tag means that one or various human resources can be related to one activity and they are separated by comma. In duration annotation, the tag *completeText* indicates that the instruction refers to the complete text stored in the cell. The instruction means that the cell content will be set as the property *Planned Duration* of an instance of Activity.

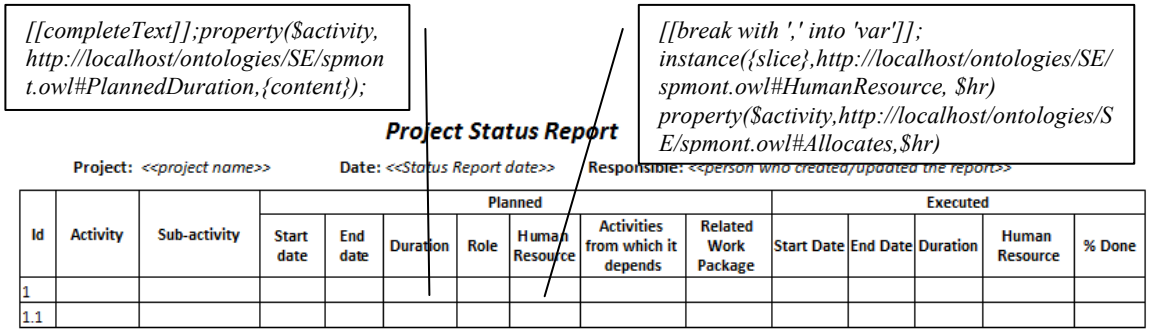

Figure 2 – Project Status Report template

The spreadsheets produced using the annotated templates are submitted to IMSD, which extracts data from them and stores in OWL files, allowing searching and retrieval. IMSD also performs version control of the spreadsheets and notifies users about changes. Annotation, indexing, storing, retrieval, version control and changes notification are general functionalities, which can be applied to any domain.

We argue that project management aspects can be better supported by exploring the conceptualization provided by the domain ontology. In this sense, some domain-specific functionalities were identified from the SPMOnt concepts, relations and properties, and have been implemented to extend IMSD: *(i)* the dependency relation between activities and between activities and WBS items (not shown in Figure 1) can be used to extract and relate data recorded in Project Status Reports and WBS document and represent them in dependency matrices that are useful to analyze the impact of changes in the project; *(ii)* the relation between activities and project cost with the human resource allocations cost can be explored to, based on activity duration, human resources allocations and human resources costs, define the project budged; *(iii)* relationships between activities with planned duration/cost and the real duration/cost of the activity occurrences caused by them can be explored to track planned and executed values, determine their adherence, and also calculate Earned Value Analysis indicators and estimates about the project conclusion, helping project managers to understand the project progress, monitor it and make adjustments when necessary; and *(iv)* indicators calculated to several projects can be represented in graphics allowing project managers to have a global view of the projects and make comparisons among them.

5. Related Works

As discussed in Section 3, there are some initiatives involving semantic annotation that support project management aspects. There are some similarities between our work and the proposals found in the systematic review. However, there are also differences.

As for similarities, like IMSD, all proposals use domain ontologies as a basis to annotations and provide general features for managing semantic content (annotation, storage, indexing and retrieving). Based on the semantic content, SKSS [Lu et al. 2008] creates a knowledge network of documents. Similarly, IMSD uses semantic content and creates graphs in which information recorded in documents are related one to another. CMIO [Nakatsuka and Ishida 2006] and IMSD send automatic emails notifying users about modifications on semantic documents.

The main differences between our proposal and the ones found in the SLR concern the types of annotated files and the project management knowledge areas supported. Regarding types of files, the proposals annotate web pages, electronic forums, pdf and text documents. IMSD also annotates text documents, but it is the only one to annotate spreadsheets.

As for the knowledge areas supported, as discussed in Section 3, the proposals support aspects related to Scope, Integration, Communication and Stakeholder Management. IMSD, in turn, deals with aspects related to Scope, Time and Costs Management. Thus, IMSD differs from the cited proposals mainly due to the features to support project management activities, obtained by exploring the SPMOnt conceptualization in functionalities that help managers to plan, monitor and control

projects. Although the proposals support some project management aspects, the domain ontologies used do not address aspects that allow for comparing project planning and execution. Also, none proposal provides indicators or estimates to help project managers to monitor projects. Summarizing, by exploring the SPMOnt conceptualization, domain-specific features are provided by IMSD, better supporting project management activities.

6. Final Considerations

In this paper we discussed the use of semantic annotation in project management. The results of a systematic literature review that investigated initiatives that support project management aspects by using semantic annotation were presented. We also discussed an extension of the IMSD [Arantes and Falbo 2010] that enables it to semantically annotate spreadsheets with concepts, relations and properties of the Software Project Management Ontology to provide features supporting project planning and tracking.

At this moment, we are concluding the implementation of the ISMD domain-specific functionalities. As future work, we plan to conduct experiments to evaluate the extension of IMSD in the project management domain. Moreover, we intend to integrate project management tools (such as MS-Project) with documents and spreadsheets semantically annotated by IMSD. By doing this, organizations that use these tools can also benefit from IMSD functionalities. Finally, we intend to improve cost management features by considering costs relate to software, hardware and other cost elements that have not been currently considered.

Acknowledgment

This research is funded by the Brazilian Research Funding Agency CNPq (Processes 485368/2013-7 and 461777/2014-2).

References

ARANTES, L. O. and FALBO, R. A. (2010) "An infrastructure for managing semantic documents", In: Joint 5th International Workshop on Vocabularies, Ontologies and Rules for The Enterprise (VORTE) - International Workshop on Metamodels, Ontologies and Semantic Technologies (MOST), p. 235-244.

BRUGGEMANN, B. M., HOLZ, K.-P. and MOLKENTHIN, F. (2000) "Semantic documentation in engineering", Eighth International Conference on Computing in Civil and Building Engineering, California, USA, p. 828-835.

ERIKSSON, H. (2007) "The semantic-document approach to combining documents and ontologies", International Journal of Human-Computer Studies, v. 65, n. 7.

ERIKSSON, H. and BANG, M. (2006) "Towards document repositories based on semantic documents", Sixth International Conference on Knowledge Management and Knowledge Technologies (I-KNOW), Graz, Austria, p. 313-320.

FALBO, R. A. et al. (2013) "Organizing Ontology Design Patterns as Ontology Pattern Languages", 10th European Semantic Web Conference – ESWC 2013, France, p. 61-75.

FALBO, R. A., BRAGA, C. E. C. and MACHADO, B. N. (2014) "Semantic Documentation in Requirements Engineering", In: 17th Workshop on Requirements Engineering (WER 2014), Pucón - Chile,

GUIZZARDI, G. (2005) "Ontological Foundations for Structural Conceptual Models", University of Twente, The Netherlands.

KIRYAKOV, A., POPOV, B. and TERZIEV, I. (2004) "Semantic annotation, indexing, and retrieval", Web Semantics: Science, Services and Agents on the World Wide Web, v. 2, p. 49-79.

KITCHENHAM, B. and CHARTERS, S. (2007) "Guidelines for performing systematic literature reviews in software engineering", (EBSE-2007-01)

KITCHENHAM, B. A., BUDGEN, D. and BRERETON, O. P. (2011) "Using Mapping Studies as the Basis for Further Research - A Participant-Observer Case Study", Information & Software Technology, v. 53, n. 6, p. 638-651.

LOUKIS, E. N. (2007) "An ontology for G2G collaboration in public policy making, implementation and evaluation", Artificial Intelligence and Law, v. 15, n. 1, p. 19-48.

LU, Q., CHEN, M. and WANG, Z. (2008) "A semantic annotation based software knowledge sharing space", In: IFIP International Conference on Network and Parallel Computing (NPC), China, p. 504 - 509.

NAKATSUKA, K. and ISHIDA, T. (2006) "Content management for inter-organizational projects using e-mail metaphor", International Symposium on Applications and the Internet (SAINT), Phoenix, Arizona, USA, p. 202-205.

OASIS. Open Document Format for Office Applications. Visited in: July, 9th 2015, https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=office.

PMI (2013), A guide to the Project Management Body of Knowledge (PMBoK), Project Management Institute, 5.

PRESSMAN, R. S. (2011), Engenharia de Software, McGraw Hill, 7th edition.

SICILIA, M. (2006) "Metadata, semantics and ontology: providing meaning to information resources", International Journal of Metadata, Semantics and Ontologies, v. 1, n. 1, p. 83-86.

TALAŠ, J., GREGAR, T. and PITNER, T. (2010) "Semantically enriched tools for the knowledge society: case of project management and presentation", Third World Summit on the Knowledge Society, Greece, p. 322-328

UREN, V. et al. (2006) "Semantic annotation for knowledge management: requirements and a survey of the state of the art", Journal of Web Semantics: Science, Services and Agents on the World Wide Web 4, p. 14-28.

VILLALOBOS, J., SANABRIA, S. and CACERES, R. (2011) "Activity scheduling through gantt charts in an ms excel spreadsheet", Revista Facultad de Ingenieria, n. 61, p. 132-145.

WEBSTER, J. and WATSON, R. T. (2002) "Analyzing the Past to Prepare for the Future: Writing a Literature Review", MIS Quarterly, v. 26, n. 2, p. 13-23.