Contextual Representations for Enterprise Model Application (C.R.E.M.A.)

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Abstract: Enterprise models help to make enterprise processes and services more transparent while also improving stockholders' abilities to analyze, optimize and control them. These models include every relevant element as well as enterprise processes, including their relationships with one another. the growing complexity of these models reduces their usability as well as user friendliness. the different stakeholders have different expectations towards the visualization and the relevant information being displayed to them. Therefore contextual representations of enterprise models allow the provision of the relevant information in a user oriented perspective by applying different visualization methods. This helps to manage the complexity and facilitates a sustainable application of enterprise models for various enterprise aspects such as quality management, strategic planning, reporting and operational control.

1 INTRODUCTION

Enterprise modelling can be defined as the systematical description of all the elements, business processes and the relationships amongst one another, which are relevant to a certain investigation objective (Schwermer, 1998). An enterprise model includes the structure, behavior and organization of the enterprise in order to provide a general understanding (Vernadat, 2002).

The application of enterprise models has increased dramatically over the recent years and their role is to support several business activities like business process management, quality management, production planning, strategic planning and resource management. This results in an exponentially increased size of such models to fulfill the requirements of describing the whole enterprise, including its processes, order information, products and resources like human resources, documents, IT systems, machines as well as equipment.

Another driver for the increased size is the overall approach to integrate information from different domains into one information backbone (e.g. product information - typically contained in a PLM system with processes – typically contained in an enterprise or business process model) or at least to interlink these information elements so that dependencies can be identified and described.

The increased size of enterprise models along with the approach of higher information integration results into an increased model complexity. On the one hand, this makes it more difficult for the modeler to maintain and update the model. On the other hand all stakeholders which are applying these models are facing the problem of fast and easy information retrieval. They are especially interested in extracting concrete information. In terms of enterprise models they are specifically interested in some elements like concrete production processes, quality related documents or they are looking for detailed information about the involvement of a single role within the whole enterprise. to put this into numbers: current versions of our customers enterprise models have more than 15.000 elements and consist of more than 220 partial processes (up to 6 levels). These already huge numbers are going to increase rapidly within the future. We're expecting to have enterprise models consisting of up to 50.000 elements and 500 partial processes within the next two years.

to meet the demands from our customers to offer methods and possibilities as well as tools to manage and apply such huge enterprise models in the future we present a framework for contextual model representations, which allow us to compile a suitable

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and applicable representation of the necessary model elements for the individual tasks of the stakeholders. Since the information types within an enterprise model are very heterogeneous we believe that a sustainable and practical usage can only be achieved by offering a wide set of representations and utilizing different visualization techniques for the respective information types. The rest of the paper is organized, so that in section 2, we will establish stakeholder needs and demands by looking into several studies. Section 3 will see us using these criteria to evaluate related research. In section 4 we will introduce our framework for contextual enterprise model representations. This will include an application of said framework. The conclusion will be stated in section 5.

2 REQUIREMENTS AND CHALLENGES

In order to satisfy stakeholder demands, it is important to identify these demands. Several studies have dealt with Business Process Management (BPM) and their results help us to identify the main requirements for BPM-systems. These requirements can be directly translated to enterprise models since they are ever increasing in importance. The following studies deal with certain aspects and criteria for BPM models, as well as enterprise models. At the end of this section, we will have identified five core requirements through the analysis of these studies.

The first study deals with the criteria themselves, in particular, how study participants define understandability. The study „Understanding Understandability of Conceptual Models – What Are We Actually Talking about?“ (Houy et al., 2012) shows a diverse collection of criteria and argues for a more unified approach to measuring understandability for which it offers some guidelines. The scope of this study does not allow for an in-depth analysis of the different criteria, but it is important to notice that different studies employ different criteria and degrees of understandability when they look at business- and process-models. This study thus serves as a cautious reminder that understandability can be an ambiguous term.

Bobrik has defined three foundational principles which can improve the understandability of process-visualizations (Bobrik, 2008). These principles can easily be projected onto business process models. the first principle is the “Notation“ of symbols: different shapes and colors can enhance user understandability. Secondly, the “Layout”, the organization and structure of elements within the model is identified as essential. The last principle is “Reduktion“(reduction) which deals with the aggregation of model elements. These principles can all be found in one way or another in each of these studies, as well as subsequent sections.

The next study focusses on understandability as well as how participants rate their own capabilities of understanding a process-model (Mendling et al., 2007). The study, conducted among 73 students of the field process management and several experts, offers two important results: personal characteristics as well as the size of the model (its complexity), are the two main factors for model understandability. Both results are equally apparent for students and experts of process models. Since this study is from 2007, we can assume that the process models that were used then, would be even larger now, making the size even more important. the size and complexity of models is a reoccurring challenge in every study and most research papers that deal with enterprise models and process management. It is thus a core stakeholder demand. Also, the individual preferences as an understandability criterion is important, as this will be addressed later in section 4.

The growing complexity of business and process models is also identified as the major issue by a study by Bearing Point (BARC, 2013). along with the growing complexity of the employees’ responsibilities, this study reveals that most companies use several process-models for different processes. a coherent, diverse, context sensitive business model would connect these different processes as well as save resources, thus we can again identify complexity reduction as a major requirement for a contextual representation of an enterprise model. Other aspects that are mentioned in this study are forecasting, making budget decisions and planning ahead. These aspects are reoccurring and will be collected under the umbrella term transparency as a requirement.

the last two studies offer two essential set of results, with the first one focusing on companies and the second one on individuals. the former (BearingPoint 2012) shows that the general importance and usefulness of sustainable BPM is accepted, yet there are still obstacles for companies to integrate process management. besides reluctance from management, the study identifies model complexity and the missing holistic nature of many BPM models as the main challenges. It can be assumed that, if the two aspects mentioned will be

improved, management would tend to be more supportive. The majority of companies stated that efficiency and standardization are their top demands for their BPM systems. These are also requirements we can apply to an enterprise model representation.

in the last study (Harmon and Wolf, 2014), which is also the largest we look at, we see that an increase in efficiency is the number one priority for most BPM user. Even more importantly though is the lack of innovation in the BPM world. The needs and demands have largely remained the same over the past 8 years. The study shows that the market is growing "slow and steadily", yet it is important to note, that many issues largely remain the same. So, the requirement we draw out of this study is the need for a more efficient process management, along with a unified, holistic enterprise model for the entirety of an enterprise. Furthermore, this study shows that the market is ready for, and in need of, innovation. a dynamic contextual representation for enterprise model applications could fill this void and improve enterprise modelling substantially.

The demand for a business process visualization that simplifies and individualizes process models is large, so is the potential for further research in this field. Contextual representations of enterprise/process models could be a feasible and practical way of dealing with the demands of all stakeholders. The texts introduced here represent the challenges and expectations researchers face today. out of them, we can deduct these five core requirements for our contextual representation for enterprise model applications (CREMA):

- Effectivity
- Standardization
- Transparency
- Holistic scope
- Complexity reduction

3 RELATED WORK

after reviewing stakeholder demands and needs, we can identify the increase of effectivity, standardization, transparency, and the holistic nature of an enterprise model as main demands, together with a reduction of complexity. We will now examine attempts to deal with these demands, while focusing particularly on context-based approaches.

in "Enabling a User-Friendly Visualization of Business Process Models" (Hipp et al., 2014), researchers are trying to find useful forms of enterprise model visualizations. the different types introduced in the paper do not differ significantly from more traditional process model visualizations, hence their use is limited concerning reducing complexity. Furthermore, the presented visualizations seem to be designed for smaller models; this further reduces their potential to tackle complexity. The paper also includes a study. This study is too small in scope and the participants are too homogenous to make a useful contribution. Different representations are needed when an entire enterprise model needs to be visualized, yet they have to offer real potential benefits.

"ISEAsy" (Santorum et al., 2014) combines video games and social media in order to use visualized processes and business-structures in a dynamic and accessible way. Though it attempts to present a holistic view of an enterprise, the actual visualization doesn't reduce the complexity as desired. The introduction of an internal social network will more than likely also reduce efficiency within a company. "ISEAsy" does allow for individual perspectives and has potential to provide contextual information, yet its visualization would have to be significantly updated, as it is quite conservative at this point in time.

Figure 1: ISEAsy Interface (Santorum et al., 2014).

The „PAIs"-Method (Kolb and Reichert, 2013) tries to solve the problem of complex process models by utilizing different, personalized views. The different perspectives are conceptualized as different levels of aggregation. These aggregations of process-elements are essential because of the aforementioned growing complexity of current business models. The automatic updates which Reichert and Kolb designed in their paper offer a large potential for business process modelling. This aggregation, and its automatization, could

significantly reduce complexity while also helping to standardize processes, yet it would not necessarily provide a more holistic representation of the company.

Reichert proposes a different tool in another paper, where he uses Google Earth as a template to create three-dimensional, contextual and user-friendly business process visualizations (Hipp et al., 2012). The implementation of the third dimension into enterprise models is still in its infancy and there is a lot of potential for further research. The Google earth approach is a first step in this direction. This approach looks at the same process with a varying degree of details, yet the perspective essentially remains the same. The method of zooming as well as panning seems like a natural fit for a comprehensive enterprise model, yet to estimate the actual applicability, a practical application of the concept would be useful.

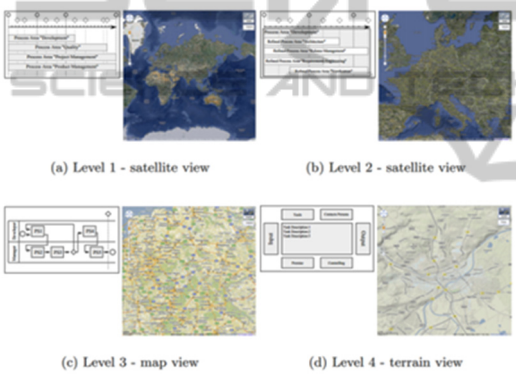

Figure 2: Google-Earth as business-model Visualization (Hipp et al., 2012).

The fast delivery of appropriate information to knowledge workers is an endeavour similar to the struggle to tackle the growing complexities of enterprise models: context-awareness is the key to both. the niPRO framework attempts to deliver timely information through a context analysis (Hipp et al., 2013). the approach itself seems to be feasible for mid-sized models at best though, since it demands a lot of parameter setting, which would be unpractical in a larger, more complex model.

The study of the semantics of enterprise and process models lays down another foundation for our own work, since it deals with the "language" aspect of enterprise and process visualization in depth (La Rosa et al., 2011). the diversity of possibilities when it comes to visualizations is important since a different context can call for a different form of visualization. These different visualizations can be linked within one model, which is essential for a holistic view on an enterprise. Mendling has worked on more studies which look into other aspects of business and process models. His work on the careful definition of process categories (Malinova et al., 2014), as well as the importance of hierarchical, modular models (Reijer and Mendling, 2008), are essential for our own research. The first one calls for particular attention in the crafting of categories and contexts, whereas the second emphasizes the need for abstraction within visualizations.

In "Business Process Modeling: a Multi-perspective Approach Integrating Variability" five process views are connected with a process contextualization (Saidani and Nurcan, 2014). the five perspectives (intentional, organizational, functional, non-organizational, non-functional) offer an incentive to think about the definition of perspectives within a process-model framework, since the universal applicability of these perspectives can be doubted. the inclusion of those perspectives within a contextualized framework is important for our own research, as different stakeholders demand different perspectives. Additionally, different perspectives that stakeholders can choose from, would allow for more standardization.

Under the umbrella of the IsyProM-project (Jochem et al., 2012), the goal was established to find a way to display context sensitive abstractions and perspectives which are based on one core model. This core model can be individually configured depending on role, assignment, phase or aspect towards a user. These contexts can be recognized automatically and applied to the user's interface. Munkhbadarch-Dietrich developed a context sensitive client for MO^{2}GO which allows for individual configuration of contexts (Munkhbadarch-Dietrich, 2012). This client changes the elements that are visible, but it does not go further in establishing real individual, context-based perspectives.

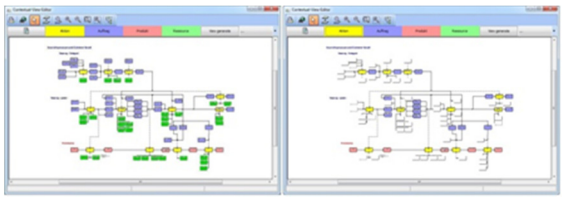

Figure 3: Process visualization without and with activated action-context (Munkhbadarch-Dietrich, 2012).

Parallel to Munkhbadarch-Dietrich, Gering (Gering 2012) developed a contextual view on the Process Assistant. It enables the creation of

individualized perspectives of the Process Assistant, giving the user a more limited, more understandable perspective. This is limited to the strictly textual framework of the process assistant though. Gering himself criticizes the missing link between the Process Assistant and MO^{2}GO. Both approaches, Munkhbadarch-Dietrich's and Gering's, exist independently from one another.

As this selection of texts has shown, there is still a need for an approach that allows a representation of an enterprise model, which addresses the most important stakeholder demands equally.

4 CONTEXTUAL REPRESENTATIONS OF ENTERPRISE MODELS

Current methods have seen success in creating perspectives which use certain filter criteria to simplify visualizations by aggregating them or by removing or adding certain elements, yet they almost entirely remain in the same visualization style which is graph based. The number of elements and the complexity of contemporary models demand other forms of representation. These forms need to cater to the individual needs and challenges of stakeholders and have to provide optimal support while also delivering information in a usable way.

Our Approach is to derive several contextual representations for the specific stakeholders to facilitate their specific tasks in the best way. Therefore we developed a framework for contextual model representation.

4.1 Framework for Contextual Enterprise Model Representations

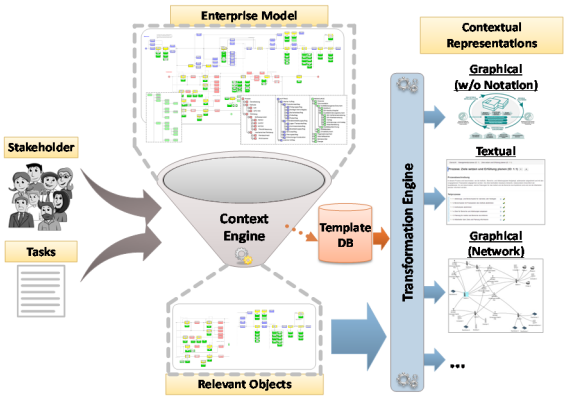

Figure 4: Framework for contextual enterprise model representations.

The framework for contextual enterprise model representations comprises of three main elements (see Figure 4).

The first element is the *Context Engine* which identifies all relevant model elements (information objects). to identify all relevant elements the context engine uses either a stakeholder (for instance a role) and/or a given task as input parameters. Based on this information, the existing enterprise model is analyzed and all relevant model objects were identified. This results in a partial model, where not all single objects need to have a relationship. a schematic example for that is given in Figure 5.

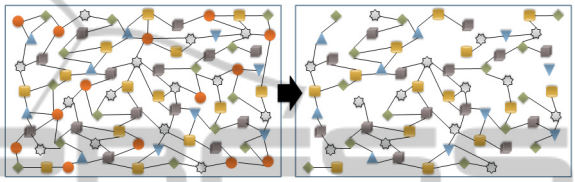

Figure 5: Schematic example for contextual filtering.

For the identification of relevant model objects we use different methodologies. One is the tagging of model elements with a common set of keywords. Another one is mapping algorithm which connects typical tasks with their related enterprise model object types. for instance if a stakeholder is looking for a specific quality related document the algorithm automatically maps that task to the documents class, which includes all quality documents. Furthermore we are using semantic networks to identify further related information (model objects) which will be included in the representation.

The second element is the *Template Database*. This database currently includes 8 different visualization templates for representing enterprise models:

- Textual
- Process Graphic (currently IEM notation)
- Tree-based
- Organization chart
- Graphical (without a specific notation)
- Network diagram
- Gant chart
- Swim lanes

The appropriate representation is preselected by the context engine based on its input parameters.

The last element within the framework is the *Transformation Engine*. Its uses the set of relevant model objects which is delivered by the context engine and builds the contextual representations. The context engine already preselected possible suitable visualizations according to the given stakeholder and/or task, but the final decision is

made by the transformation engine. This is due to the aspect that only the transformation engine can validate and verify if a visualization template can be applied for the given set of relevant model objects.

4.2 Application

A first application of this framework is implemented in the Process Assistant (PA), a web-based system for representation and analysis of enterprise models build with the Integrated Enterprise Modelling (IEM) methodology. Currently the PA supports already some of these visualization templates like the textual, tree-based and organization chart and process graphic (IEM notation).

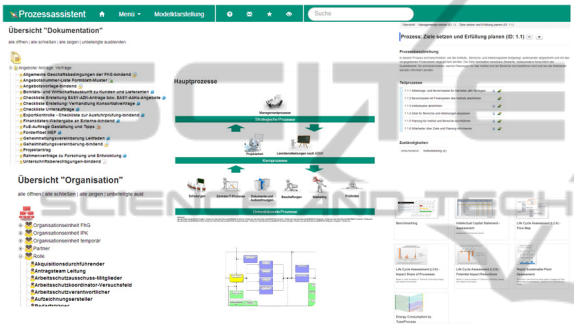

Figure 6: Application of the Framework for Contextual Representations within the Process Assistant (example shows graphical, process graphic, tree-based and textual representations).

5 CONCLUSION AND FUTURE WORK

The continuously increasing size and the resulting complexity of enterprise models require new methods and technologies for the management and application of said models.

This paper presents a framework for contextual enterprise model representations in order to provide different visualizations of the model content. These representations are derived from the enterprise model to meet the requirements of different stakeholders and their specific tasks. Therefore we use different visualization methods and techniques to provide all relevant information in the most an optimal and practical way. This fosters the wide application of large and complex enterprise models for different business activities.

For future work we are currently researching which visualization methods and techniques work best regarding usability, information content and mobile applications. Therefore we need to analyze further input factors which are influencing the choice of representations and/or the identification of model elements. Possible new input factors could be the user's device, his skills/abilities and personal characteristics. By allowing the user to select his or her own emphasis on certain aspects (for example: certain materials in the overall production or focusing on cost-intensive areas), we can satisfy the stakeholders need more individually. We also plan to implement a mechanism which helps to easily change the level of detail (e.g. as is possible with Google Maps). Furthermore we like to include an easy mechanism to allow the user to create his own personalized representations.

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