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Application of Process Ontology to improve the funding allocation process at the European Institute of Innovation and Technology

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Abstract. This studio explains the application through the application of the ProKEx architecture is used to improve the process of allocation of funding at the European Institute of Innovation and Technology (EIT). The mission of the EIT is to grow and capitalize on the innovation capacity and capability of actors from higher education, research, business and entrepreneurship from the EU and beyond through the creation of highly integrated Knowledge and Innovation Communities (KICs). This case offers the scenario of a complex application where a fragmented process with several actors is dealing with the different domains of knowledge of each KIC. Starting from the Business Process Model, applying text-mining techniques we extract the ontology elements from the activity description and converted into an Ontology of the process domain. By the critical analysis of the information contained in the model, we gain the relevant information to improve the current approach.

Keywords: semantic business process management, ontology matching, European Institute of Innovation and Technology, European funding

1 Introduction

Organization resilience in the Private and in the Public Sector
Organizations are subject, in the modern era, to continuous changes in their structure due to a reference environment very competitive. This is due to stress from the external market but also because is necessary to implement human resources policy that motivate and retain those resources that are important asset for the organization. Public Administrations are not exception to this phenomenon as the public service, as we know it today have different characteristics from the public administration model that prevailed at the beginning of the twentieth century including:

- Respect for the rule of law.
- A commitment to serving the public good.
- An expectation that public servants will exhibit integrity, probity and impartiality in serving the public trust.

The model was clear and simple - characteristics that continue to hold great intellectual appeal. Reality, however, is rarely as simple as theory. The classic model falls short of being able to address an increasing number of issues that reflect today's reality and other important element have to be considered:

- The need for flexibility.
- The interactions between politics and policies.
- New forms of accountability. (Bourgon, 2007)

Furthermore the more the business in which operate is knowledge intense, the more the need of leverage on human capital is important and the management of it is strategically critical for its success and subsistence.
One of the main threats is, in this context, the staff movement. The conduction of the changes is not exhaustive - only some parts are affected. The main challenge is the exhaustive knowledge articulation in order to provide the organization with up-to-date knowledge.

Business Process Modelling

The adoption of Procedures and Business Process Modelling are common practice in every organization that wants to increase its resilience, however is not clear to what extent such model is able to describe the knowledge necessary to operate the process in an efficient way.
Trough ProKEx[1] we propose a solution to overcame the dualism procedural approach versus Domain approach by providing tools where iteratively the two approach mutually feed each other. It provides a solution to extract, organize and preserve knowledge embedded in organizational processes to enrich organizational knowledge base in a systematic and controlled way, support employees to easily acquire their job role specific knowledge.

Structure of the article

In this article, we provide an overview of the ProKEx project and we illustrate the case study of the European Institute of Innovation and Technology.
We give a general overview of the project including overarching objectives, status of the arts of the technologies in this area, specific characteristics of the solution proposed and the constructions blocks.

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[1] The research is part of the ProKEx - "Corporate Knowledge Management Supported by Semantic Process Ontology Technology") project (EUREKA_HU_12-1-2012-0039, supported by Research and Technology Innovation Fund, New Szécsényi Plan, Hungary), this article recalls the main deliverable of the project.

In the case study, we will illustrate the application related to the process of "Allocation of funding" highlighting the motivation of studying this case in the context of Semantic Business Process Management.

2 The ProKEx project

2.1 General Objectives

According to the Lisbon Strategy the EU aims to become the most competitive and dynamic knowledge-based economy in the world. (European Commission, 2000) To achieve this goal the strategy outlines taking advantage of the growth and employment opportunities afforded by new technologies. Development and adoption of new technologies result in increased investment in knowledge, skills and infrastructure. Human capital is considered a crucial input for the development of new technologies and a necessary factor for their adoption and efficient use, but also a prerequisite for employability. (De la Fuente & Ciccone, 2002)

Complex organizations use to model and manage their processes using Business Process Management (BPM) tools. These applications help to describe the organizational processes, together with the required information and other resources (amongst other human resources) needed to perform each activity. Business processes are defined as sequence of activities. From the Human Resource Management view it is required to define unambiguously, who is responsible for the execution of each activity in terms of the RACI matrix (Responsible, Accountable, Consulted, Informed), bridging the organizational model and the process model. Usually BPM methodologies' requirements are satisfied with the definition of the type of job role, this is emphasized in the RACI matrix. The ProKEx approach explicitly differentiates between the task (as element of the process) and the job role (associated with, or assigned to the task). Job role is interpreted as a bridge between the task (to be executed) and the actor (in case of ProKEx always a human resource). Human resource always have at least to organizational attributes: position and job role, they may relate to each other several ways (1:1, 1:m, n:1, m:n). The knowledge (often cited as competences) relates to the job role, what is considered as content. The knowledge elicitation, extraction refers to the content, while the type of the job role has more organizational aspects than knowledge management. In order to include properly the job role knowledge into the process model, we use the extended RACI matrix, that is the description of task from knowledge perspective is added to the RACI, and this extension is processed later in the system. In brief, one of the overall objectives of BPM is the transformation of informal knowledge into formal knowledge and facilitates its externalization and sharing (Kalpic & Bernus, 2006).

The relevant and internalized knowledge is embedded and strongly related to the roles as building element of the organizational structure. In dynamic environment both the roles and required competencies are changing, therefore the knowledge elicitation[2],

[2] Knowledge elicitation is the process within Knowledge Capture where hidden or tacit knowledge is being articulated. Frequently but not exclusively selected experts are encouraged to articulate their knowledge

articulation cannot be independent from the permanently updated business process model; hence, the business process model is one of the most important ingredients of the knowledge to be captured.

The proposed solution is to extract the knowledge from information stored in the process model in order to articulate, externalize, represent and transfer (re-use) it. Since the business process models are often used for the execution of processes in a workflow engine, another very important source for gathering useful knowledge are real-time instantiations of the business processes, that are giving a view on the dynamic knowledge, usually represented in the form of different business rules. The expected impact is the preservation and efficient management of corporate intellectual capital, a better return on investment in human capital that will lead to the more efficient execution of processes and consequently higher profit. The expected impact is the preservation and efficient management of corporate intellectual capital, a better return on investment in human capital.

The goal of the proposed project is to develop a solution to extract, organize and preserve the knowledge embedded in organizational processes in order to:

– enrich organizational knowledge base in a systematic and controlled way,
– support employees to easily acquire their job role specific knowledge,
– help to govern and plan the human capital investment.

In order to achieve this goal a complex IT solution and method is developed which integrates:

- organizational process management tool,
- learning management tool,
- real-time data monitoring and processing tool,
- data and text mining tools for developing knowledge base (domain ontology) and
- the interfaces which are responsible for the communication between these components.

On-the-job training is put on the focus, since it increases productivity at the firm level and is a source of innovation and therefore long-term competitiveness of firms, too.

The novelty of this approach is based on the connection between process model and corporate knowledge base, where the process structure will be used for building up the knowledge structure. Common form of knowledge base is the ontology, which provides the conceptualization of a certain domain. (Gruber, 1993)

The main innovation lies in new algorithms for the extraction and integration of the static and dynamic process knowledge and a novel integration architecture that enables smoothly integration of the eLearning methods in the process execution models.

However, the capability of the ontology to describe the process knowledge domain is very much related to the way the model has been generated, therefore for this project we apply a Semantic Business Process Management approach.

The main challenge in Business Process Management (BPM) is the continuous translation between the business requirements view and the IT systems and resources. Semantic Business Process Management (SBPM) is a new approach of increasing the

level of automation in the translation between these two levels, and is currently driven by major players from the BPM, and Semantic Web Services area. The core paradigm of Semantic Business Process Management is to represent the distinct levels using ontology languages and to employ automated translation. (Török & Ternai, 2011)

The approach of this study will provide a paradigm to evaluate the level of alignment between process requirements and domain requirements and providing input to the domain expert to revise critically the process and to enrich the Business Process Model.

2.2 Technology state of the art

The various Business Process Management solutions offer different modelling approaches, but the basic logic behind the modelling methods remains the same. The different approaches include the definition of activities, descriptions, and responsible positions or roles for execution. To integrate the different approaches, the main market leaders agreed to create a standard modelling method, BPMN, which latest version is v2.0. (Object Management Group, s.d.)

Innovative e-learning solutions are combined with semantic technology to have solid knowledge base in knowledge elements structuring. Common form of knowledge base is the ontology, which provides the conceptualization of a certain domain. E-learning solutions started to include semantic interpretation of knowledge areas, ontology based adaptive testing. (Kismihók & Vas, 2006)

Real-time data processing has become very important recently since the number of the information that are produced daily (business transactions, process measurements, web activities, to name but a few) is growing constantly and the ability for processing them not only in the batch mode (once per week/day), but rather in the real-time is crucial for the competitive advantage. Currently, the real-time processing tools in the industry (like these from Tibco, IBM, Oracle) are not taking into account the connection between static and dynamic process data.

Moreover, existing solutions have not been integrated in the learning context yet, which gives us the chance to develop a very competitive and useful solution. In fact, the objective is to describe and manage data in a static context.

However, companies have to manage huge and growing volume of content. The amount of information that must be retained to comply with rules and regulations is expected to grow from 25% of the digital universe last year to 35% in 2012 (Wray, 2009).

To utilize the embedded knowledge of the content data, web and text mining solutions are applied, that is one of the reasons of their increasing popularity recently. Free software, like Rapid Miner and R are the more popular in data and text mining based on the KDnuggets Poll in 2013 (Piatetsky, RapidMiner and R vie for first place, 2013) However due to the introduction of commercial versions of those tools shows an increase of adoption of those software: 29% of the users used only commercial software, 30% only free software, and 41% both. RapidMiner, R, and Excel were again the most popular tools. W. European data miners had the highest percentage of free tool use, 35%, while E. Europe has only 29%. Ratio of the projects, which did not apply text analytics / text mining in the past 12 months is decreasing (33.7% in 2014, 34.7% in

2011 and 45% in 2010) (Piatetsky, How much did you use text analytics or text mining in the past 12 months?, 2014).

2.3 Characteristics of the solution

The proposed solution envisages a comprehensive procedure whose unique feature is the integration of different partial technologies, owned by the participants to the project[3], as business process modelling, semantic technology, real-time data processing, knowledge elicitation, representation and transfer; data and text mining technologies mainly support the knowledge extraction.

The technologies involved are mainly open source elements since the interoperability is a crucial pre-condition of the application. The added value comes from the realization and integration. While the case studies and scenarios are very different, the architecture is loosely coupled and, depending on the local circumstances, elements can be replace without radical changes in the structure and usability. The source of knowledge extraction is the business process model, including its instantiation on-line. The on-time data processing and analysis methods are used for the generation of the dynamic knowledge, e.g. in the form of business rules. The appropriate text mining solution produces the content and the structure that is then uploaded to the ontology-based application. For example, one of the business case aims to create an e-learning application based on the ontology instantiated, or an application to map knowledge gaps in an organization.

The proposed complex approach will cope with these challenges, through a semi-automatic solution, which applies the advanced text-mining technology for annotation that helps to identify specific activities, and the required competency areas. Text selection (e.g. job role description) is semi-automatic, controlled by the process structure. Text-mining solutions identify the relationship between the specific activities and job role specific competencies. The structure of the job role competencies and the structure of the organization and business processes should be mapped. The result of the analysis is a domain specific ontology that will be used as the basis of structuring the content. The domain ontology is always industry specific; therefore, industrial benchmark will be used to validate the results.

2.4 How does it work

The ProKEx solution is a composite infrastructure where different technologies are employed in different phases of the process as shown in **Fig. 1**. Despite of the specific business application there are four main elements that constitute the technology and that implement the iterative translation from the process to the ontology domain.

- A process model
- Translation to a domain model
- Content development and exploitation of the ontology

[3] Netpositive Ltd., Corvinno Nonprofit Public Ltd, Nissatech Innovation Center doo Niš

- Feed back to the process model

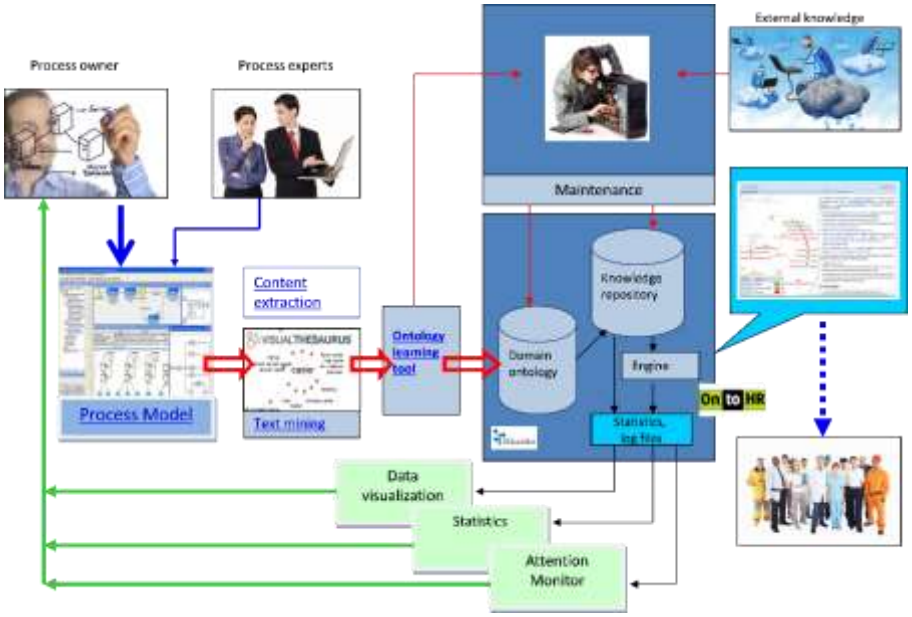

Fig. 1. The Big Picture

Business Process Modelling

Business Process Modelling is the graphic representation of an organisation's business processes. In this first phase, the business process is formalized using SBPM tools (in **Fig. 2** an example of modelling of one of the macro activities of the business case). Process modelling aims at graphically describing the process flow and providing information to company so that even complex processes remain transparent. Detailed processes are grouped in process groups and sub-groups; event-driven process chains are often used at the lowest level of the process hierarchy. By definition, each elementary task should have an organizational actor to perform it. A well-described process model contains all the relevant tasks and their description. (Ternai, Török , & Varga, 2014)

In the description of each task is stored the information about the content of the work. Relation with other task, roles, resources, input and output are contextualizing the activity role in the process. Supporting documents, (e.g. regulations) enrich the description of the activities.

Ontology Building

In the second phase all the relevant information extracted from the process models and related documents will be processed and analysed. Text- and data mining techniques are employed for knowledge extraction from the context data. Those knowledge elements will be the basis to create the new specific domain ontology.

The technology behind this phase is described more in details in the article "Process-based Knowledge Extraction in a Public Administrative Authority: A Text Mining Approach" is to create an ontology from the originating SBPM. (Gillani & Kő, 2014)

Content Development

The ontology created in the previous phase will be the basis for the development of the relevant contents. Corvinno's system called STUDIO will be used to store the content in the knowledge repository. The ontology will ensure that content is structured in a way that reflects to the unique features of the selected business models.

In particular, the contents created, will be used to feed an e-Learning platform (Kismihók & Vas, 2006) that will support the organization resilience.

Retroaction

The model generated in the second phase and the content developed in the previous, will be then re-elaborated in order to feed back in the Semantic Business Process Model.

The main type of retroaction envisaged are:

- injection of newly identified knowledge element to the related activities in order to enrich the model representation with more specific contents,
- improvement of the ontology to better fit the real domain,
- improvement of the process.

The improvement of the process can happen in different ways: direct expected benefit is improvement by increasing the match between workers knowledge and process required knowledge. Looking at the process in terms of knowledge exploitation, will help the process owners to identify waste[4] and areas of development for the existing process that could bring to a change of the approach or more generally to a process reengineering. Those improvements of the process can happen jointly with knowledge management tools that use the ontology generated within this project too.

3 The European Institute of Innovation and Technology

3.1 The Mission of the EIT

The European Institute of Innovation and Technology (hereinafter referred to as 'EIT') is a new independent community body established by Regulation (EC) No 294/2008 of the European Parliament and the Council of 11 March 2008 (EC Regulation 294/2008, 2008) and based in Budapest. The EIT aims at addressing Europe's innovation gap to rapidly emerging as a key driver of EU sustainable growth and competitiveness through the stimulation of world-leading innovations with a positive impact on economy and society.

[4] In this context with "waste", we refers to the Lean acceptation (also known as "muda"): any human activity that absorbs resources but creates no value. (Womack & Jones , 2010)

The EIT is a European Institute promoting and performing high-level programs in postgraduate education, research and wider knowledge transfer to industry and society. It acts as a catalyst of good practice for the European scientific and industrial communities by promoting an original European dimension from its very foundation and contributing to the structuring of the European Knowledge Area. (Rubele, 2006)

The EIT should be an institution, performing programs in the fields of education, research, and innovation – especially technological. It will be managed at the Union level making it fully an European undertaking, but actually built on knowledge communities typically seconded from existing organizations (Universities, research centers, companies) (EC, 2006) The mission of the EIT is to grow and capitalize on the innovation capacity and capability of actors from higher education, research, business and entrepreneurship[5] from the EU and beyond through the creation of highly integrated Knowledge and Innovation Communities (KICs).

The EIT and its Knowledge Innovation Communities (KICs)

Since it was founded in 2008, the EIT has sustained the first three KICs that have already trained more than 1,000 young entrepreneurs, incubated more than 100 new companies, and developed a wide range of new products and services.

Each kick have created productive partnerships among hundreds of companies, universities and research institutes mobilizing European capital to produce innovation on a large scale leveraging the initial EU investment to attract three times as much capital from partners and other funding sources.

The KICs are selected by means of a bid in which groups of educational, research and business partners comes together and commit to a long term strategic plan to achieve innovation impact in one of the defined areas that the Parliament decides. Once selected by the EIT Governing Board each KIC constitutes a legal entity and sign with the EIT a Framework Partnership Agreement for a period of 7 years.

Under the provision of such agreement, each KIC every year presents a business plan that is evaluated by the EIT Governing Board that will lead to the allocation of funding for the following year on a competitive base.

The continuous research of excellence

The EIT continuously face this challenge positioning in an area where the expectation is very high (Romeo, 2013), according to its Regulation the EIT shall seek to become a world-class body for excellence in higher education, research and innovation[6] (EC Regulation 294/2008, 2008).

The EIT have in focus the research of innovative practice to implement and simplify its processes and organization. In this context, EIT has initiate knowledge management program and a simplification agenda to overcome the limit of traditional funding approaches. (EIT, 2013)

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[5] Higher education, research, business and entrepreneurship are known as "knowledge triangle "too.

3.2 The process for the annual allocation of funding

The process for the "Allocation of funding" is lasting about one year (in terms of lead-time) and involves different actors: EIT Officers, Governing Board Members, KICs and experts.

The macro phases of such process are:

- Definition of policies and guidelines
- Analysis of KICs past performance
- Analysis of KIC annual business plan
- Hearings of the KIC in a multiannual perspective

This process is very critical because is the formal process that allocate most of the budget of the EIT. Compared to other similar programs, the allocation is made based on competitiveness.[7] The impartiality of the process and even more the equal treatment of the participant is particularly important, however the KICs are very different in terms of the expertise domain and strategy. A blended approach is therefore necessary that takes in consideration different aspect of those very peculiar projects. The novelty of the approach, the connatural experimental nature of this exercise, and the relative youth of the EIT as institution, result particular risk because the process scenario is very variable. However, the need of a qualitative and accountable process shall be guarantee. Furthermore the EIT is soon be growing its structure and have to understand what kind of resources it needs to better support its processes, what expertise should be in-house and what shall be externally procured.

Definition of policies and guidelines

In the first phase the EIT to guarantee the rules that will governing the competition among the KICs. The actors that mainly intervene in this phase are the EIT Headquarter and EIT Governing Board. The first provide a synthetic view of lesson learned from previous years' experience and the regulation that frame the relationship with the partners in order to propose to the governing board elements to the EIT steering body to discuss and define the criteria that will rule the annual exercise.

Based on those decisions the EIT shall draft the guidelines for the preparation of the business plan and the rules for the allocation of funding exercise.

Analysis of KICs past performance

To produce an assessment of the KICs past performance the EIT-HQ analyze the outputs of the assessment of the reporting for the previous years and give an evaluation based on the rules defined in the previous phase. In the analysis of the past performance the EIT Head Quarter and in particular the KIC Project Officers and Continuous monitor Officer evaluate the KICs past performance by taking in account also the previous assessment on the reporting performed by experts in the previous years and the infor-

[7] The EIT Governing Board defines the percentage of competitive funding yearly.

mation collected during the management of the relationship with the KICs. Other elements that concurs to the evaluation of the KICs past performance are the level of consumption of the budget allocated in the previous years and the competitive review of the contribution of the KICs to the overall objectives of the EIT by comparing their performance in terms of contribution to the Core Key Performance Indicators (KPI)[8]. The evaluation in this phase is mainly performed by EIT staff. EIT need to know if there are knowledge gaps that need to be filled.

Analysis of KIC annual Business Plan

Experts are contracted to evaluate the business plan presented by the KICs according to the three pillars (education, entrepreneurship and research) and to the merit of the thematic area of each KIC. Experts then provide an outlook of the quality of such proposal according to the rules defined by the EIT Governing Board.

Every year the KICs commit to specific objectives in terms of implementation of activities that will contribute to the overall strategy of the KIC.

In this phase, experts are selected and contracted to evaluate the activities that the KIC decides to carry out in the following year. The evaluators are assessing the business plan produced by the KICs according to the modalities that the EIT Governing Board has defined in the first phase by carrying out an evaluation according to the different domains. Although the process is quite stable, the EIT Head Quarter has to adapt it according to the decision of the Governing Board for the specific year[9]. The composition of the experts' panel in particular may be different by incorporating experts in other domains, such management, operations, finance or knowledge triangle integration… according to the areas the Board decides in the specific year is important to investigate.

In addition, the number of experts in each domain can change in order to moderate the dependence from individuals and to have a complete coverage of the domain in which the KIC operates and the specific contents of the proposed business plan.

This one of the areas where the adoption of the ProKEx platform will provide a concrete benefit in order to understand if the disposed knowledge is sufficient to perform an appropriate and independent assessment.

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[8] A Core KPIs is a KPI that the KIC measures and that concur to the achievement of the overall strategy of the EIT. The definition and the calculation modalities of such KPIs are uniform and commonly agreed by the KICs.

[9] The business case has been taking in consideration the 2014 Allocation of funding implemented in 2013.

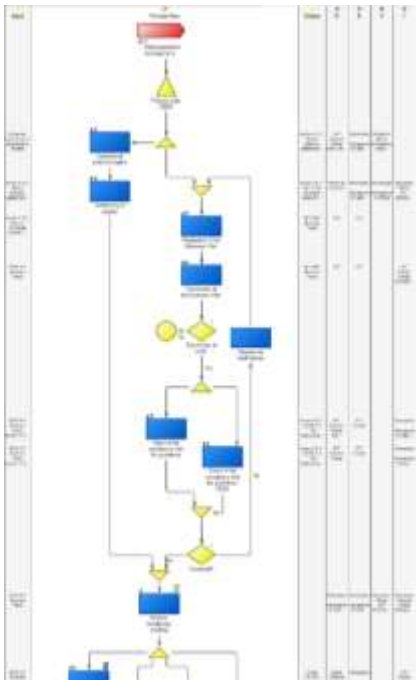

Fig. 2. Analysis of KICs Business Plan

Hearings of the KIC in a multiannual perspective

During the hearings of the Governing Board, the EIT present factual data about the evolution of the KICs on a multiannual perspective and each KIC's board is requested to illustrate and promote the annual plan in the context of the multiannual implementation of the activities of the KICs. The Governing Board members therefore provide their evaluation that is consolidated with the evaluation of past performance, of the assessment by experts of the business plan, and calculate the final funding that have to be allocated to each KIC. While the assessment of the business plan was focusing on analysing the contents of the business plan, the exercise of the assessment of the past performance address the capacity in implementing such a plan, with the hearings the KICs are evaluated in terms of the expected long-term impact. In preparation of the hearings the EIT Headquarter consolidate the figures about the activities of the KICs with a multiannual perspective and prepare a risk assessment report for the Governing Board. The EIT Governing Board is composed by high professional and successful managers in all three areas of the Knowledge triangle that have no necessarily competence in the domain in which the KICs are operating but with a broad experience in evaluating business cases. During the hearings, in particular, the KICs management is invited to explain the strategy they want to implement in the following year and how this is going to influence Europe in the long-term perspective committed with the KIC

Initial Proposal. This is another important point where the ontology can provide important support to contextualize information related to a domain to people that are not expert in the field.

The evaluation of the Board concurs together with the evaluation of the past performance and the technical assessment of the business plan to a final score that is used to elaborate the final funding to each of the KICs. The total funding is composed of a part of structural funding fixed and equal to each KIC and a part that is allocated in a competitive manner through this exercise. The Governing Board together with the final allocation also provide the KICs recommendations for the adaptation of the business plan. In fact, the business plan of the KICs have to be amended to reconcile, the final budget allocated, by taking in consideration those recommendations.

The EIT KIC Officers revise the new version of the business plan to secure that all recommendations have been receipt. With the finalised version of the document, the EIT and the KICs sign the Annual Grant Agreement that will rule the modalities for the funding disbursement.

4 Conclusions

Relevance of the business case

The business case is very interesting in terms of provisions to the ProKEx project for several reasons. First of all the process is very well documented (as it should be auditable) and is subject to different regulations (internal to the institute and coming from EU Financial rules) that are formalized. This is very helpful in the word expansion & matching phase that supports the translation from the process model to the domain ontology. To be a top-class process in this application, it requires a wide range and very specialized competences. Because this results in a process very fragmented in terms of activities and roles, the ProKEx project can have a complex scenario to address. The other element that make of the EIT allocation of funding process particularly enticing to test ProKEx is the extension and variety of the knowledge domain involved: there is the domain of the financial rules of the European institutions, the three vertical pillars domains, the thematic domain of the KICs and, of course, the process itself.

Benefit for the EIT

The EIT on the other hand will benefit of the process because can identify area of improvement and simplification of the process, in particular the selection of the resources necessary to perform the evaluation is where we expect the most important benefits. The EIT will advantage of an objective approach to the identification of the right mix of competencies necessary to provide a comprehensive and independent assessment that will secure and improve the guidelines. The KICs are different not only for the domain in which operate, but also in terms of organisation, history, value and culture. Using the proposed approach will help homogenise the diversities. In the evaluation of the process, furthermore the methodology will provide a unique compliance check with the several requirements this process is subject.

Benefit for the Public Administrations

By generalizing the concept, the adoption of Semantic Business Process Management applying the ProKEx framework in the public administration is a promising approach can provide the several benefits including:

- to improve compliance of the procedures;
- to increase the resilience of the organizations;
- to provide tools to evaluate a domain to non-experts;
- to reduce the fragmentation of roles and process or optimize the management of this level of complexity;
- to improve of the quality of the processes in terms of:

– guarantee high objectivity to the evaluation processes;
– developing efficiency even where diversity and variety is considered a value to preserve.

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