Semantic Application for the Internationalization Audit of Higher Education Institutions

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Abstract. Institutions are getting increasingly motivated to participate in an internationalization audit because the competitiveness of higher education institutions resides not only in the number of qualified students employed by organizations within a given period, but the Internationalization is also a crucial point in the evaluation. The aim of an audit is to help institutions with detailed recommendations to increase efficiency and quality of their internationalization activities.

The present paper aims to provide and elaborate a semi-automatic application, which can be used to perform the internationalization audit of higher education institutions. The guidelines must be adapted by institutions are articulated in unstructured texts shaped into Erasmus+ Programme Guide, but business processes are formalized into business process models.

This paper presents an information system that is capable of extracting business process elements from unstructured texts. Process ontologies store these extracted elements and actual business process elements as well for providing a unified base to execute compliance checking investigation between actual and reference business processes.

Keywords: Higher education · Internationalization · Erasmus mobility · Semantic business process management · Ontology matching · Compliance check

1 Introduction

In the globalized world internationalization became increasingly important in the strategy of higher education institutions. Reputation of higher education institutions is measured with their position in global rankings. Competitiveness of higher education institutions resides not only in the number of qualified students employed by organizations within a given period, but the Internationalization is also a crucial point in the evaluation. The international orientation, mobility activities, changing students and teaching and research products play significant roles in the mission of higher education institutions.

Mobility is an efficient tool for distributing knowledge, innovative results among students, researchers, teachers and administrative staff. It enhances collaboration and communication between higher education institutions. A mobility strategy was interpreted on the EHEA Ministerial Conference held in Bucharest in 2012 for promoting

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high quality mobility. Ten measures were determined for facilitating better implementation of the mobility aims. Internationalism, mobility targets, open higher education system, balanced mobility dismantled existing obstacles, usage of quality assurance, transparency tools and improved communication were emphasized among others [1].

Internationalization is part of the quality culture of an institution, as well. Hungarian higher education institutions are required to operate quality assurance systems.

Some of the Hungarian institutions take part in international accreditation. The objective of our work is to assist the institutions in producing well-based descriptions on their international activities and to increase the chance of their international accreditation.

The institutions are getting increasingly motivated to participate in an internationalization audit.

The basis of the qualification procedure is the internal evaluation the self assessment report. The most important product of this phase is a development plan and to give support to the institution in further development of the internationalization activities.

The present paper aims to provide and elaborate a semi-automatic application, which can be used to perform the internationalization audit of higher education institutions. The main goal is to investigate the alignment of process ontologies, based on ontologies derived from process models and regulations, guidelines. The applicability of our solution is presented through the Erasmus student mobility programme use case. The guidelines must adapted by institutions are articulated in unstructured texts shaped into Erasmus+ Programme Guide [2], but institution processes are formalized in business process models. This papers present an information system that is capable of extracting business process elements from unstructured documents. Process ontologies store these elements for providing a unified base to execute compliance checking investigation between actual and required business processes.

2 Theoretical Background

2.1 Semantic Business Process Management

Business process management (BPM) is now getting adopted by many organizations. BPM provides many possibilities to improve business processes. Modern BPM suites are evolving to automate the modeling, monitoring and redesign of complex, collaborative processes [3]. Conceptual model captures the semantics of an application through the use of a formal notation, but the descriptions resulting from conceptual model are intended to be used by humans and not machines. The semantics contained in these models are in a large extent implicit and cannot be processed. With the web-based semantic schema such as Web Ontology Language (OWL), the creation and the use of the conceptual models can be improved, furthermore the implicit semantics being contained in the models can be partly articulated and used for processing [4].

The usage of Semantic Web technologies like reasoners, ontologies, and mediators promises raising business process management to a completely new level of possibilities. This approach is known as semantic business process management (SBPM) [5].

When a new regulation is established the business process have to comply with this regulation. This means to start digging into the business processes to find all business functions handling this occurence. If the business processes have been documented in a BPM repository, this task is supported by visual navigation and search functionalities. It is the business expert performing this analysis.

In semantic business process management, the above mentioned scenario is simplified, because the business processes as well as the new regulation are defined in a way that a machine is able to understand them. Therefore, no manual work is needed to verify that the business processes comply with the new regulation.

The core paradigm of SPBM is to represent the business requirements view on the process area and the actual process area using ontology languages and to employ machine reasoning for automated or semi-automated translation. The basic idea of Semantic Business Process Management is to combine Semantic Web Services frameworks ontology representation, and Business Process Management methodologies and tools [6].

The SUPER project has been a big public research project which has been supported by the EU Commission. In the SUPER project, well known companies like SAP, IBM, and IDS Scheer have been working together with leading research institutes from all over Europe to achieve the vision of semantic business process management. A semantic application for compliance management has been elaborated. They presented five perspectives on compliance checking: design-time/run-time; forward/backward; active/passive; task checking/process checking or engine-based/query-based perspective [7].

2.2 Ontology Matching

The discrepancies between ontologies can be derived from different perspectives possessed by experts, granularity of expressiveness and related descriptive language used during the formalization process. Subfields of ontology methodology domain work with discovering, registering and handling these discrepancies. Ontology mapping defined by Su [8] means that "for each concept (node) in ontology A, try to find a corresponding concept (node), which has same or similar semantics, in ontology B and vice verse."

This definition was extended with additional parameters – an input alignment of A for future extension, matching parameters (threshold, weights etc.), external resources (common knowledge, domain specific thesauri) by Euzenat and Shvaiko [9] (Fig. 1).

Matching techniques can be distinguished by their focus points. Some techniques work at element level, focusing on matching entities and its instances without any information about their relationships with other entities and instances. It investigates these entities as strings, words or through the elements of their definitions with using external sources e.g. linguistic resources. Other ones – so called structure-level matching techniques - scrutinize not only matching entities but their relations with other entities and instances as well. These use different representation techniques e.g. graphs etc. to run matching procedures.

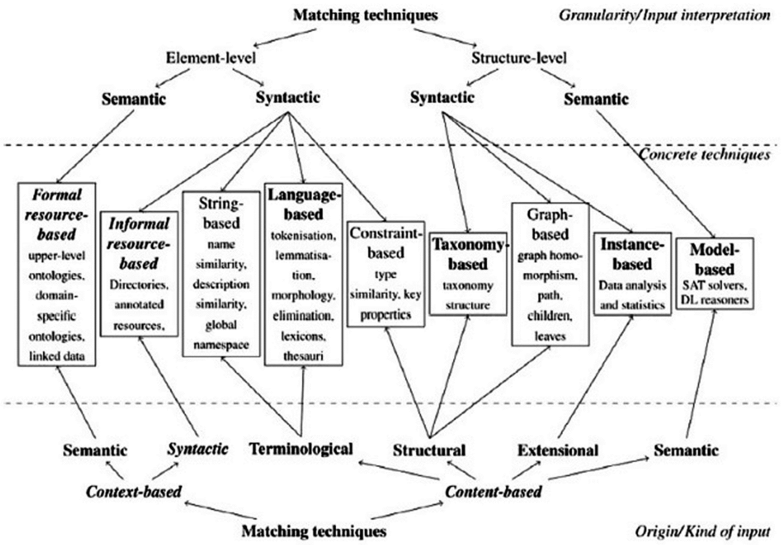


Fig. 1. Matching techniques classification by Euzenat and Shvaiko [10]

3 The 'Erasmus Student Mobility' Use Case

Our aim is to perform the internationalization audit of higher education institutions. The main goal is to scrutinize the matching of process ontologies, based on ontologies derived from process models and regulations, guidelines. We use the 'Erasmus student mobility' as a use case to demonstrate our approach. The guidelines must adapted by institutions are articulated in unstructured texts shaped into Erasmus+ Programme Guide, but institution processes are formalized in business process models.

The Erasmus+ Programme

Erasmus+ is the new EU programme for boosting skills, employability and modernization activities on Education, Training, Youth and Sport field. This programme supports transnational partnerships among institutions and organisations to enhance cooperation, knowledge sharing. It handling skill gaps by providing a bridge the worlds of Education and work [2]

Student mobility for studies, the centrepiece of the Erasmus+ programme, is an efficient tool for distributing knowledge, innovative results among students, researchers, teachers and administrative staff.

The objectives of student mobility for studies:

- "To enable students to benefit educationally, linguistically and culturally from the experience of learning in other European countries;
- To promote co-operation between institutions and to enrich the educational environment of host institutions;
- To contribute to the development of a pool of well-qualified, open-minded and internationally experienced young people as future professionals" [15, p. 1].

In 2013, Internationalization audit processes were conducted in the case of some of the Hungarian universities under the aegis of TÁMOP-4.2.4B/1-11/1 and TÁMOP-4.2.4B/2-11/1. The main goals of these audit processes are "to facilitate the external quality assessment process with elaborating the dimensions and indicators of internationalization" to assist the institutions in producing well-based descriptions on their international activities and to increase the chance of their international accreditation" [16, p. 4].

The following semantic compliance checking application can facilitate these endeavours by processing reference documents and providing reports related to these indicators based on actual processes of higher education institutions. The Erasmus student mobility process serves as a use case to present this system, but this system can be used for other processes on the internationalization domain as well, because it can also be customized for other processes.

4 Semantic Compliance Checking Application

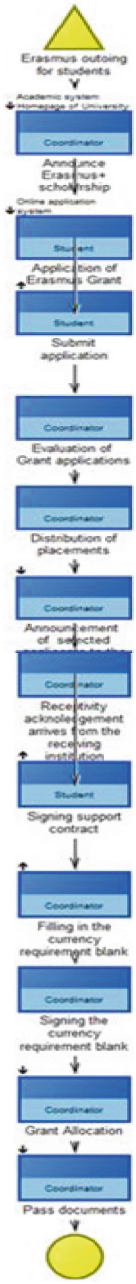
4.1 Business Process Modeling; Semantic Annotation

Business Process Modeling is the first phase of the Business Process Management lifecycle. The 'Erasmus student mobility' process of a Hungarian university was selected as use case, the business process models were implemented by using BOC ADONIS modeling platform [11].

There are several parameters that can be set or defined when modeling a business process. The vertical level in details of a business process model gives the focus point of the model: we can specify operational areas only, or process areas, process models, sub processes, activities, or even deeper; the algorithms. The horizontal level in details of a business process model gives the level of extra information modeled within the business process: organizational information can be specified in an organogram; the roles can be referred in the RACI matrix of the process model, the input and the output documents in the document model and the applied IT system elements can be added to the IT system model as well.

In our case, the business process models are used for their compliance checking with regulations and guidelines. To achieve this goal, during the modeling of business processes the following parameters have to be set:

- the logical shell of the business process model with the core objects (e.g. task);
- the organizational structure needed for the business process model, in working environment model;
- the inputs and outputs needed for the business process model, in document model;
- the IT elements needed for the business process model, in IT system model;
- name of activities in the business process models;
- description of activities in the business process models;
- the Responsible role for all the activities in the business process models;
- input, output, IT system information for all the activities in the business process models, where available.



Announce Erasmus+ scholarship
Description: Announce Erasmus+ scholarships for the academic year.
RACI: Coordinator (Erasmus Office)
Documents: Application Notice and Guide (Documents)
Systems: Homepage of University, Neptun

Application of Erasmus Grant
Description: Application of Erasmus Grant
RACI: Student (Erasmus Office)
Documents: Application data sheet (Documents)
Systems: Online application system

Submit application
Description: Print, underwrite and submit the application data sheet to EPI.
RACI: Student (Erasmus Office)
Documents: Application data sheet (Documents)

Evaluation of Grant applications
Description: Erasmus+ students are selected by their home higher education institution in a fair and transparent way. The final decisions will be made by an ad hoc committee. A ranking system is available
RACI: Coordinator (Erasmus Office)

Distribution of placements
Description: The distribution of placements will be determined at a separate distribution meeting. Applicants receive written notice of the results.
RACI: Coordinator (Erasmus Office)

Announcement of selected applicants to the partner institutions
Description: EPI/coordinator send „Application Form"/"Learning Agreement" -s to the partner institutions by fax and by post.
RACI: Coordinator (Erasmus Office)
Documents:Application Form (Documents), Learning Agreement

Receptivity acknoledgement arrives from the receiving institution
Description: Receptivity acknoledgement arrives from the receiving institution.
RACI: Coordinator (Erasmus Office)

Signing support contract
Description: Signing student support contract
RACI: Student (Erasmus Office)
Documents: student support contract (Documents)

Filling in the currency requirement blank
Description: Filling in the currency requirement blank
RACI: Coordinator (Erasmus Office)
Documents: currency requirement blank (Documents)

Signing the currency requirement blank
Description: Signing the currency requirement blank with the NKI manager and financial manager.
RACI: Coordinator (Erasmus Office)
Documents: currency requirement blank (Documents)

Grant Allocation
Description: Financial Managership
RACI: Coordinator (Erasmus Office)
Documents: currency requirement blank (Documents)

Pass documents
Description: Transcript of Records : Accomplishment document in the end - signed by foreign coordinator. Certificate : Grant certification; Certification ; Certificate Incoming Students : Acceptance certification in hungarian for professors.
RACI: Coordinator (Erasmus Office)
Documents: Transcript of Records; Certificate; Certification; Certificate Incoming Students (Documents)

Fig. 2. The 'Erasmus student mobility' process

The 'Erasmus student mobility' business process model and the main activities and parameters of the process can be seen in Fig. 2.

```
<xsl:if test="INTERREF[@name='Responsible role']/IREF">
<ObjectAllValuesFrom>
    <ObjectProperty IRI="#performed_by"/>
    <xsl:for-each select="INTERREF[@name='Responsible role']/IREF">
        <Class >
            <xsl:attribute name="IRI">#<xsl:value-of select=
            "functx:words-to-camel-case(@tobjname)" /></xsl:attribute>
        </Class>
    </xsl:for-each>
</ObjectAllValuesFrom>
</xsl:if>
```

Fig. 3. XSLT code mapping 'Responsible role' attribute to an ontology element (fraction)

4.2 Mapping the Conceptual Models to Ontology Models

In this section the mapping of the conceptual process models to process ontology concepts will be shown. The transformation procedure follows a meta-modeling approach. The links between model elements and ontology concepts have been established. The process ontology describes both semantics of the modeling language constructs as well as semantics of model instances [12].

In order to map the conceptual models to ontology concepts, the process models are exported in the structure of ADONIS XML format. The converter maps the Adonis Business Process Modeling elements to the appropriate Ontology elements in meta-level. The model transformation aims at preserving the semantics of the business model. The general rule we follow is to express each ADONIS model element as a class in the ontology and its corresponding attributes as attributes of the class. This conversion is done with an XSLT script. The converted OWL ontology in the structure of Protege/OWL XML format is imported into the editor of Protege 4.2 [13]. A sample part of the transforming XSLT code (mapping the 'Responsible role' to an ontology element) can be seen in Fig. 3.

To represent the business model in the ontology, the representation of ADONIS model language constructs and the representation of ADONIS model elements have to differentiate. ADONIS model language constructs are created as classes and properties and the ADONIS model elements can be represented through the instantiation of these classes and properties in the ontology. The linkage of the ontology and the ADONIS model element instances is accomplished by the usage of properties. The final ontology can be seen in the Protégé editor in Fig. 4.

5 Compliance Checking Module

This module consists of three main parts: process ontology building and matching engine and report generator

The **process ontology building engine** contains grammatical and semantic processing tools. It uses the actual process ontology converted from the actual business process

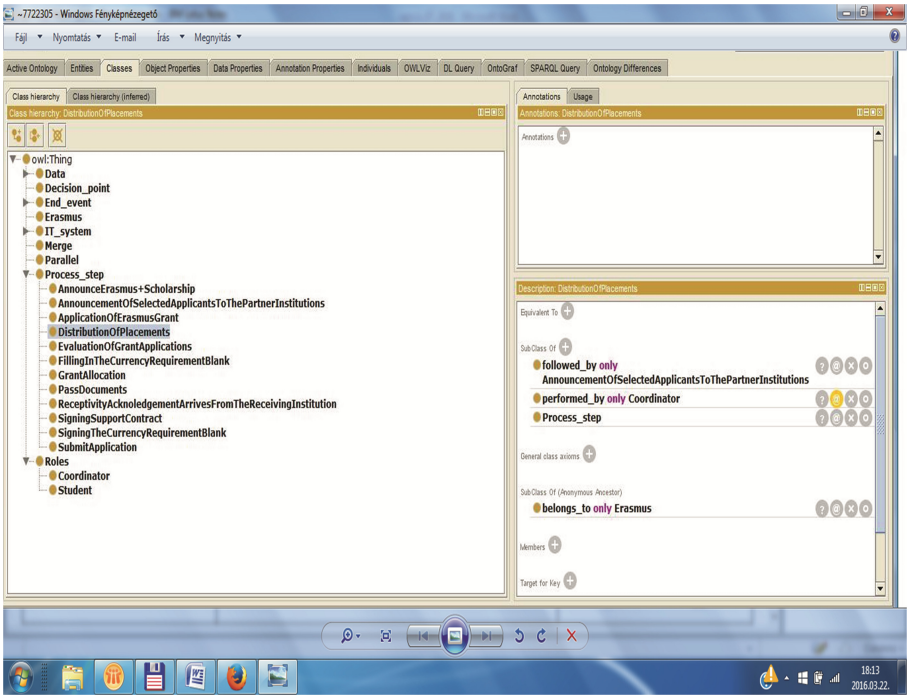


Fig. 4. The process ontology in Protege 4.2

model by using XSLT transformation for identifying process steps within the reference document. Grammatical processing tool was built in Rapidminer and is integrated into this engine. This is capable of collecting part-of-speech tags from texts. It picks every process steps from the actual process ontology in order to build a reference process ontology from documents. It splits these expressions into terms. It seeks them through texts and measure the frequency of their occurrence within a given sentence. The sentence providing the higher value will validate this process step. Semantic rules are used to search other process elements (like IT resources, roles, input/output documents). Having identified these elements, they are connected to a process step discovered nearby (namely within a given radius). The process ontology building engine creates the reference process ontology containing process elements from the reference document.

The ontology matching engine compares the actual reference ontology with the reference process ontology and collects similarities and differentiations between them into a technical report [14]. This report is processed by **a report generator** that is responsible for creating a transparent, user-friendly report required by the stakeholders in the respect of its content.

5.1 Audit Questions

This section will present how the system is capable of answering three audit questions [16].

What kind of documents are changing between the various levels managing the activities?

To answer this question requires to collect documents from the reference text. The next semantic rule is applied to achieve this goal. Rule is interpreted by X "verb" Y, form where verb ϵ {submit, provide, send…} and Y is equal to the required document. Having run this collection process used this rule for "submit", the next documents were extracted (see in Fig. 5).

Fig. 5. Extracted documents

Comparing them with the documents from the actual business process, it seems that reports are missing from it. Two superfluous documents were found like 'application accreditation' and 'more documents'. It can be derived from that the mobility reference document has broader scope than the student admission process has (Fig. 6). But we should consider to make the rules more punctual as well.

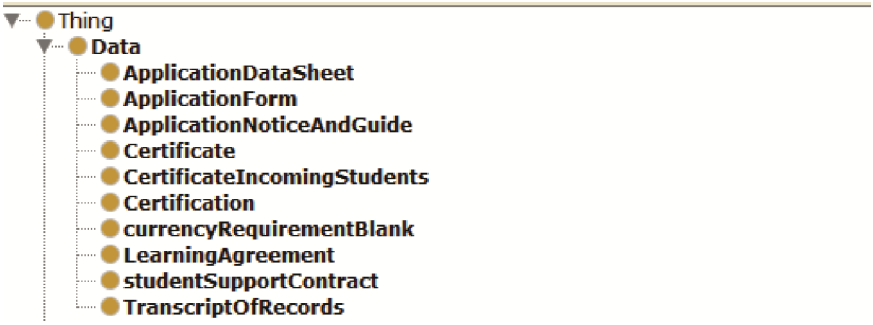


Fig. 6. Actual documents

These statements are derived from manual comparison. The next questions can be answered with generating a report by this system.

Are foreign students responsible for which activities? Which are missing from the actual admission process?

To get an answer we need collect roles and process steps similar to the actual process steps from the reference texts. The collection process uses X 'by the' Y semantic rule to get roles. Later it picks a process step and splits it into terms, searches these terms within the texts and choose them that provide maximum value of the occurrence of these terms. It puts the accepted actual business process steps into the reference ontology with texts validated it as comments. Connects these steps with the roles reside nearby (e.g.

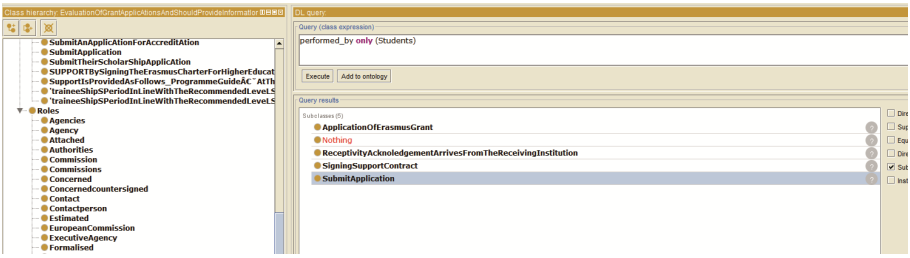


Fig. 7. Extracted process steps and roles

within a given radius). Accepted process steps without roles are put into the reference ontology as well. It may be considered as additional information not mentioned in the actual business process (Fig. 7).

Draft version of the Semantic Compliance Checking Report

created by Corvinno Technology Transfer Center

Actual business process	Reference business process
HEI	Erasmus Mobility Handbook
Report generated at 23-3-2016	

Process steps from the reference document are not in the actual business process

Process step	
elSendingOrganisatiOn-andBeforeSigningTheirLearningAgreement-allLearners exceptNativeSpeakerS BenefitingFromTheOnlineServiceWillCarryOutAnOnlineTesTToAssessTheir CompetenCesInTheLanguageTheyWillUseForTheirTraineeship	

Process steps that are not in the reference document

Process step	
AnnounceErasmus+Scholarship	DistributionOfPlacements
FillingInTheCurrencyRequirementBlank	GrantAllocation
PassDocuments	SigningTheCurrencyRequirementBlank

Same process steps, but performed by different roles

Process step	
ApplicationOfErasmusGrant	EvaluationOfGrantApplications
ReceptivityAcknoledgementArrivesFromTheReceivingInstitution	SigningSupportContract

Fig. 8. Semantic compliance checking report

The extracted process steps and roles will be reviewed in future in order to refine the algorithm. Having used this process ontology, the system is capable of creating a report that contains information about the discrepancies between the actual and reference process steps (Fig. 8).

Having used DL Queries the reference ontology can be filtered by only one specific role like Students (see in Fig. 7). In this case, this report will be provided for only tasks performed by students within the actual and the reference business process. This report shows that four process steps were adapted by the Hungarian university and six process steps were not mentioned in the Erasmus Programme Guide. The auditor get information about that which documents should be processed in order to get insight into the reasons of missing and surplus process steps.

6 Conclusion and Future Work

The internalization is an important activity for making competitive higher education institutions. The internalization process is regulated by the Erasmus Programme Guide within the European Union. The audit of the internalization of a given institution can be achieved an easier way if required information are collected easily by an information system. This paper presented a solution that can provide information for answering three audit questions. Its development is ongoing. Its algorithm will be reviewed after scrutinizing the actual results and it will be extended with new ones to collect new process elements for trying to answer other audit questions. This system was developed in Java and reused OWL API functions, DLQueryExample.java and SVN repository of Protégé 4 OWL Diff ontology matcher.

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