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A reference ontology for harmonizing process-reference models

Una ontología de referencia para la armonización de modelos de referencia de procesos

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Abstract

For a couple of decades, process quality has been considered one of the main factors in the delivery of high quality products. Multiple models and standards have emerged as a solution to this issue. However, for any company, the harmonization of diverse models with the aim at fulfilling its quality requirements is not an easy task to pursue. The difficulty fundamentally lies in the fact that there is a lack of specific guidelines, together with an evident inexistence of a homogeneous representation that could make the endeavour with regards to Software Engineering less intense. In order to address this challenge, this paper presents a Ontology of Process-reference Models, called PrMO. It defines a Common Structure of Process Elements (CSPE) as a means to support the harmonization of structural differences of multiple reference models, through the homogenization of their process structures. PrMO has been validated through instantiation of the information contained in different models, such as CMMI-(ACQ, DEV), ISO (9001, 27001, 27002, 20000-2), ITIL, COBIT, Risk IT, Val IT, BASEL II, amongst others. Both the common structure and the homogenization method are presented herein, along with an application example.

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A WEB tool to support the homogenization of models is also described, along with other uses which illustrate the advantages of PrMO. The proposed ontology could be extremely useful for organizations and consultants that plan to embark on the harmonization of multiple models.

---------- *Keywords:* Harmonization of multiple models and standards; homogenization; mapping; integration; ontology; processes; software engineering

Resumen

Desde hace un par de décadas, la calidad del proceso ha sido considerada como uno de los factores principales para la entrega de productos con alta calidad. Una gran variedad de modelos y estándares han surgido como solución a este problema, sin embargo, la implementación de varios modelos para que una empresa cumpla con múltiples requisitos de calidad no es una tarea fácil. La dificultad radica en la falta de directrices específicas y una representación homogénea que facilite el trabajo en esta línea de la ingeniería de software. Para hacer frente a esta situación, en este trabajo se presenta una ontología de modelos de referencia de procesos, llamado PrMO. Esta ontología define una Estructura Común de Elementos de Procesos (ECEP) como medio para apoyar la armonización de las diferencias estructurales entre múltiples modelos. La armonización se lleva a cabo a través de la homogeneización de las estructuras de procesos de cada uno de los modelos. PrMO ha sido validada a través de la instanciación de la información contenida en diferentes modelos, tales como CMMI-(ACQ, DEV), ISO (9001, 27001, 27002, 20000-2), ITIL, COBIT, RISK IT, Val IT, BASEL II, entre otros. Tanto la estructura común (ECEP) y el método de homogeneización son presentados junto con un ejemplo de aplicación. Asimismo, se presenta una herramienta web que permite apoyar la homogeneización de los modelos, esto permite ilustrar mejor las ventajas de PrMO. La ontología propuesta podría ser de gran utilidad para las organizaciones y consultores que planean llevar a cabo la armonización de múltiples modelos.

---------- *Palabras clave:* Armonización de múltiples modelos y estándares; homogeneización; mapeo, integración; ontología; procesos; ingeniería de software

Introduction

With the purpose of providing solutions that allow us to define suitable processes for addressing different needs, a wide range of models and standards have been developed (hereafter called reference models), which can be used as process reference models. E.g. International Organization for Standardization / International Electro-technical Commission (ISO/IEC) 20000-2, ISO/IEC 27001, ISO/IEC 9001, Information Technology Infrastructure Library (ITIL), Software Engineering Body of Knowledge (SWEBOK), Control Objectives for Information and Related Technology (COBIT), ISO/IEC 12207, Capability Maturity Model Integration (CMMI), and so forth. Besides these models, there are different assessment models, such as Standard CMMI Appraisal Method for Process Improvement (SCAMPI), ISO/IEC 15504-5, CMM-Based Appraisal for Internal Process Improvement (CBA-IPI), Systems Engineering Capability Model Appraisal Method (EIA/IS 731.2), Software Capability Evaluation (SCE V3.0 Method Description), amongst others.

This emerging mass of models and standards contributes to the fact that software organizations can assess and institutionalize new or improved processes, increasing their competitiveness and producing higher quality products. Additionally, this allows them to choose a particular model to cover a specific issue, or select several models to address different needs. Currently, there are a number of factors that may persuade an organization to consider the need to work with more than one model [1]. For example, (i) market niches with specific models, (ii) improvement of the practices from legacy process models, (iii) business positioning, (iv) leveraged or merger corporate (v) systematic search of the capability of the processes, (vi) business growth, and others.

Software organizations have found it difficult to work with more than one model at the same time. However, they often make a great effort to interpret them. This difficulty presents itself due to the fact that each model has been defined from different opinions, work groups, (cultural and political), interests and bodies. Individual models, therefore, carry within them their own perspective on quality. This is, each of them defines its own element process structure, scope, orientation, purpose, and other characteristics, making some problems in the use of the reference models arise. Some of them are: Formal description of process models; compatibility and transformability; benchmark of process attributes [2].

Taking into consideration all the above, this work has the points at offering a solution to the problem by defining a useful ontology which facilitates the harmonization of the process elements which have been described by different models. Our ontology identifies and makes use of the process elements which it is constituted by, and that are also common to any model. It can thus be used independently from the reference model to be harmonized.

Based upon the ontology, a common schema or Common Structure of Process Elements (CSPE) has been defined. This has allowed the homogenization of the process elements of some models, resolving their differences before performing any comparison, mapping, integration or unification. A prototype tool which makes use of the models information, homogenized through CSPE, has also been presented.

The rest of the paper is organized as follows. Initially an analysis of the related works is shown. Then the Ontology of Process-reference Models (PrMO), a Common Structure of Process Elements to support the homogenization of multiple models, and a homogenization method to support their application are described. Later the application of the common structure and homogenization of some process elements of ISO 20000-2, together with an overview of a supporting tool, is discussed. Finally, some conclusions and future work are presented.

Background

The systematic literature review presented in [1], shows a few efforts related to the harmonization of multiple models such as PrIME project of the SEI [3], Enterprise SPICE [4], IT Governance Institute (ITGI), and Office of Government Commerce (OGC), displaying the alignment of COBIT 4.1, ITIL V3 and ISO/IEC 27002 for Business Benefit [5], among other publications and works analyzed.

Very few of them, however, have proposed solutions to resolve the problems and structural differences arising between models that are being harmonized. Most of them hold mappings in a unilateral direction and thereby, the process structure of basis model is used as a main structure. Some examples to be listed are: The well-known mappings by ISO to CMMI [6, 7]. Nonetheless, this solution works only if the objective is focused on the instantiation of the good practices of the base model from the start. This is a situation impossible to be replicated when the organizations face different needs.

This issue raises awareness on the fact that the integration of models should be treated differently if we need to harmonize other models; for example, ITIL and COBIT or BASEL II and Val IT, in the case of banking models, together with others.

Some studies have focused mainly on the development of ontologies to represent the key elements of particular domains: Ontologies for representing the ISO and CMMI models; CMMI-SW [8]; CMMI and ISO/IEC 15504 [9, 10]; ISO 9001 and CMMI-SW [11]. In [12] is defined an ontology to link the similarities between several models. Moreover, [13] presents the engineering domain ontology developed taking SWEBOK as the basis, in conjunction with others.

These ontologies have been defined primarily aiming at understanding the structure of the process-based quality approaches. Further studies also focus on development ontologies for supporting business process integration, but this subject goes beyond the scope of this article.

Taking into account the situation above described, it possible to see that most studies have focused essentially on the development of ontologies to represent and/or support the key elements of particular domains. As a result, no proposal standard (that was independent and designed exclusively to support the homogenization of structural differences between multiple models before they are compared and/or integrated) was found. Moreover, in contrast to related works analyzed, our proposal intends to provide a more fine-grained level.

PrMO: an ontology of process-reference models

PrMO is a sub-ontology which extends one concept of H2mO [14], quality model. H2mO provides a formal and clear definition of the most widely-used techniques, methods and related terms in the harmonization of multiple models. PrMO complements H2mO, by means of establishing and clarifying the key process elements to support the harmonization of multiple models through homogenization of their process structures.

In this section, an overview of the process architecture ontology designed is depicted, followed by a general overview of such, along with its instantiation from information contained in different models -the CMMI-ACQ V1.2, ISO 9001 and others-. Correspondingly, this section offers the definition of a Common Structure of Process Elements (CSPE) and its application in the homogenization of Specific Goal (SG) 1 of Agreement Management of CMMI-ACQ, as well as an example of instance of CMMI based on ontology.

Concepts of PrMO

The generic process constructors of PrMO have been designed considering some process elements defined in the process structure of Software & Systems Process Engineering Metamodel Specification (SPEM) 2.0 [15]; e.g. task and product. Using these standard elements and not others (process elements of a particular model such as CMMI, ITIL, for example), a homogeneous deal is ensured, which is independent from the process structure of reference models used during their harmonization.

Along with process elements taken from SPEM 2.0, we have noted from our experience that it was necessary to add other process elements to give support to the homogenization of the process elements of other models with a higher degree of granularity or level of abstraction.

Some examples of elements, which are not described in detail in SPEM, are the process elements for resource, tool and process category. The process elements added have been identified from the analysis of a literature review concerning the commonly-identified process elements which are most widely modeled. These are presented in [16-23], and allow us to more clearly specify some already-existing process elements, as well as to decompose them better.

Additional auxiliary elements have been also incorporated: associated elements, along with some which decompose from other elements. As a case in point: steps of tasks, in-out artifacts, human resources, and time.

Decomposition of elements allows offering support to the homogenization of process elements of those models with a higher degree of detail, such as The Software Industry Process Model (*Modelo de Procesos para la Industria del Software MoProSoft*), COBIT 4.1, amongst others.

It must be stated that some concepts depicted herein had already been defined by other studies (Quality Model and Measure of other sub-ontologies to mention only one). Two of these concepts are Software Measure Ontology and Measurement Ontology, which are part of Software Measurement Ontology (SMO) presented in [24]. These sub-ontologies provide and clarify the key elements in the definition of software measures, as well as the terminology related to the act of measuring software.

The Representation Formalism for Software Engineering Ontologies known as Representation Formalism for Software Engineering Ontologies (REFSENO) [25], made viable the establishment of a basic cluster of concepts (classes), of terminal concept attributes (attributes) and nonterminal concept attributes (relationships) and, therefore, the representation of any reference model. Protégé-OWL [26] was used as the tool for the creation of our ontology.

Table 1 shows the glossary of the concepts within PrMO, according to REFSENO formalism. Due to space restrictions, the description of the terminal and nonterminal concept attributes has been omitted. On the other hand, and in an effort to support the homogenization of different models and the software engineering, some descriptions have been adjusted. A graphical representation of PrMO, both concepts and relationships, is shown in figure 1, using the UML (Unified Modeling Language).

Table 1 Glossary of concepts in the PrMO

Concept	*Super-concept*	*Descriptions*
Process Category	Concept	A Process Category comprises interrelated processes. [New concept].
Process	Concept	Coherent set of policies, organizational structures, technologies; procedures, purposes, objectives, and work products that are needed to design, develop, deploy and maintain a software product. [Adapted from [18].
Activity	Concept	Comprises a set of tasks or actions used to produce and maintain devices as well as to achieve the objectives of the process. The activity includes the procedures, standards, policies, and objectives to create and modify a set of work products. [Adapted from [16].
Task	Concept	Process element that defines the work done by roles. A task is associated with the input and the output products [Adapted from [15].
Product	Concept	The set of artifacts to be developed, delivered and maintained in a project is called the product. The products can be of input or output type; mandatory or optional. Products are in most cases tangible artifacts consumed, produced, or modified by Tasks. [Adapted from [[29] [15]]
Role	Resource	Describes a set or group of responsibilities, duties and skills required to perform a specific activity. [Adapted from [30]].
Resource	Concept	A resource is an asset a business needs to have. In the field of software engineering, there are two main resources of importance: the developers and the tools. [Adapted from [17].
Tool	Resource	The tools automate the execution of certain activities. [Adapted from [16].

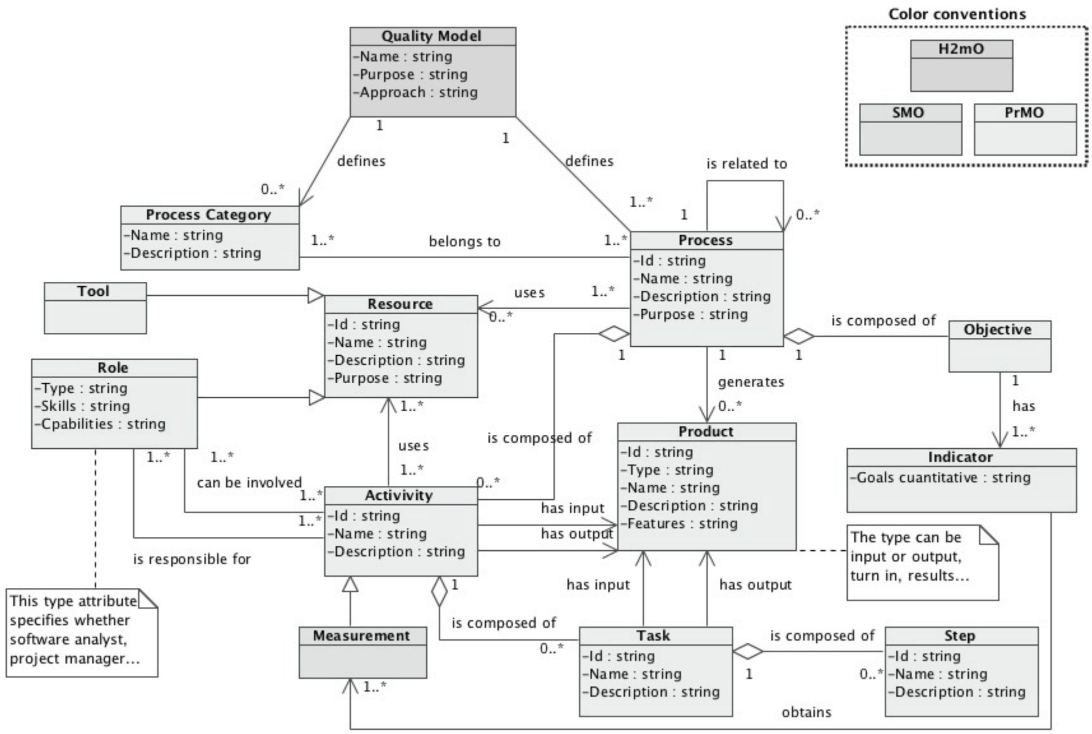

Figure 1 Representation of PrMO

As shown in Figure 1, in most cases, the hierarchies between concepts represent the fact that in every model all processes in different categories or process groups are congregated together. In the same way, each process is formed by a set of elements or characteristics, such as: activities, tasks, roles; products or artifacts, measurements, and more. The purpose is not to collect all characteristics of all models and existing standards, but rather only those that are the most common, as well as which are defined in the models analyzed, making its future adaptation and extension possible.

Instances of PrMO

Currently, ontology has been successfully applied and used in two real application cases within the context of: (i) a research project in the definition of a unified model for the banking sector and a consultancy organization to support the certification of ISO 20000 part 2 (ISO 20000-2), from efforts and institutionalized practices in ISO 27001 certificated companies.

Based on PrMO, it was possible to homogenize and build some instances and offer support to the information contained in BASEL II, VAL IT, COBIT, RISK IT, ISO 27002 and ITIL for the first case, and ISO 27001 and ISO 20000-2, for the second case. Due to space curbs, this section will focus on showing how ontology has been instanced and used in two models: CMMI-ACQ and ISO 9001.

Further factors such as the harmonization strategy, homogenization, comparison and integration methods; benefits, findings, and the harmonization process followed in the interest of harmonizing the models and the standards involved in the case studies, are presented in [27] and [28].

Figure 2 and Figure 3 show excerpts of the instances inside CMMI-ACQ V1.2 and ISO 9001:2008 using Prótegé-OWL. In Figure 2 it is possible to see that the Agreement Management (AM) is a process belonging to the Acquisition Category of CMMI-ACQ, and AM is composed of an Objective (Specific Goal (SG) 1 concerning Satisfy Supplier Agreements). It is also possible to see the Specific Practices (SP) related to this SG. Aspiring to improve the understanding of the figure, we have eliminated some concepts such as task and products, along with their nonterminal concept attributes.

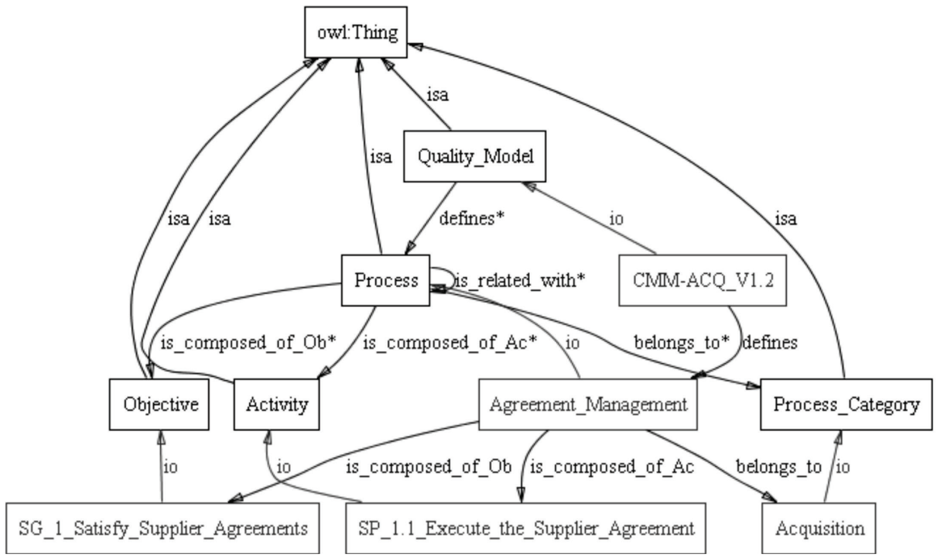

Figure 2 Instance of CMMI-ACQ V1.2 using PrMO

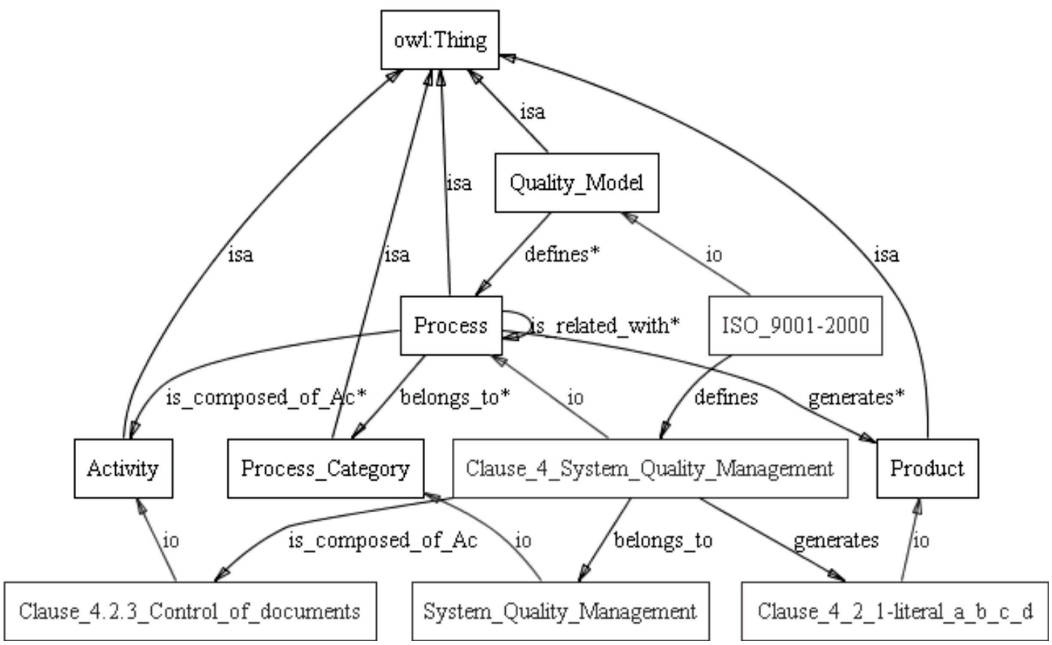

Figure 3 Instance of CMMI-ACQ V1.2 using PrMO

Figure 3 shows that Clause 4 System Quality Management has been considered as a process of ISO 9001:2008 that belongs to Process Category of the same name. It is also possible to observe one of its activities: Clause 4.2.3, concerning control of documents relating to the list, are demonstrated in letters a, b, c, d, e, f, g. The control set needed to carry out this procedure was to approve, review, update documents, in conjunction with others. Clause 4.2.1, concerning which products the documentation system of quality management should include, are mentioned in letters a, b, c, d and e of this clause.

PrMO does not only support reference models with a clearly defined process structure, but also the models whose elements are organized in less detailed structures. Therefore, PrMO can support other domains such as business where architectural models may vary (without such emphasis on a process dimension) like software and security, amongst others.

An example of homogenization of structures of several models by means of PrMO is presented in Table 4. Since each instance (of PrMO) was constructed in the same way, it was possible to map the models by means of similar process elements. CSPE thus allows us to resolve the differences between them and to prepare any reference model before effectuating any comparison, integration or activity with regards to harmonization of multiple models.

PrMO as Basis to Homogenize Multiple Models

Common Structure of Process Elements (CSPE)

From process elements defined in PrMO, a Common Structure of Process Elements or CSPE template has been designed. It allows us to have a means of facilitation and support for the harmonization of multiple models, through the homogenization of their process structures. CSPE has been divided into four sections:

- Part 1: Description (SD1). Includes the process category, process, objectives, activities, and related tasks;
- Part 2: Roles and Resources (SRR2). Includes the resources, tools, roles, and work disciplines defined to perform the process development, activities or tasks.
- Part 3: Control (SC3). It relates the artifacts, deliverables, results, goals, and measurements that serve as verification milestones in the execution of an activity or task.
- Part 4: Additional Information (SAI4). It involves related processes and methods required to obtain a purpose.

The following sections show the HoMethod and its application.

HoMehtod: A method for homogenization of models

In order to describe the process elements making use of the proposed structure, we suggest following a homogenization Method (HoMethod). The purpose of this is to guide the homogenization of multiple models, step-by-step. In furtherance of organizing and managing the people, activities and steps defined in this method, two roles -the performers and the reviewers- were defined. The activities and tasks involved in the HoMethod, and which make use of the proposed structure, are presented below:

i) Acquisition of knowledge about the models involved. Before carrying out the execution of the harmonization of models, it is suggested that an analysis of each model is implemented, according to some of their elements and/or attributes: approach, size (number of pages), the development organization, and others.

ii) Structure analysis and terminology. The analysis of the structure of a model can happen to be one of the initial implicit steps in the implementation or the improvement project process. Homogenization supports an exhaustive analysis of terminology, syntax and identification of specific words for the models.

iii) Identification of requirements. Once the analysis has been completed, the identification of requirements of software process to be homogenized is made possible. This allows us to define which information of the model will be matched and organized in the structure elements. An example of syntax defined to identify the requirements in the ISO models family is presented in table 2.

iv) Fulfilling correspondence: Such correspondence shows the models reorganized in the four sections of process elements described by the CSPE structure. The object of homogenization is to prepare the models for harmonization in multi-model environments.

v) Analyzing the results: This activity involves the tasks of resolving the any discrepancies within the performers' outcomes (by reviewers), together with verifying and validating these results (by reviewers).

vi) Presenting the homogenized model.

Homogenization of ISO 20000-2

This section presents a brief summary of the application of the steps described, implementing the common structure in homogenization of the ISO 9001:2008 standard. The semantic analysis of the standard was executed in accordance to the procedure followed in [6] and [7], where the requirements are identified by analysing the "Shall" and "Should" statements. Based on a syntax table to identify the requirements in ISO 9001 defined in [31], an analysis and the identification of both requirements, ISO 9001 and ISO 20000-2, were accomplished.

This syntax analysis allowed us to identify the practices required by the highest standards, thereby decreasing a large portion of the ambiguity and subjectivity involved in trying to understand them. Table 2 shows the syntax used to identify the requirements in ISO 20000-2. It has been extended and updated from syntax defined in [31], which did not include the analysis of input or output statements, and clauses, as possible work products. These are described in all ISO standards.

Table 2 Syntax to identify the requirements in ISO 20000-2

Syntax	*Descriptions*
Shall [verb]	This statement indicates the actions, activities, tasks or procedures that the organization in charge of its development it will have. It is probable that this statement will be used to describe one or several actions, or to derive processes.
Shall [verb] … and [verb]	
Begins with [shall] or shall [verb] that	Identifies a list of derived requirements from processes, procedures, activities or tasks.
Shall be [verb]	Indicates the characteristics associated with a process, or possible roles or work products.
Shall [include]	Indicates the details the organization must include in a process or work product
Shall be [verb] + [by], [to] or [on]	This syntax helps to identify details of some procedures or processes.
Documented, input, output	Indicates a possible work product. It might include some characteristics related to the work product.

Application of CSPE

This section describes the steps completed for the homogenization of models and requirements contained in ISO 20000-2. Table 3 shows an example of homogenization of clause 6.5 of ISO/IEC 20000-2, using the CSPE template and its application employing the HoMethod.

Table 3 Homogenization of clause 6.5 defined in ISO 20000-2

		Process 6.5 Capacity management		
SD1.1. Process Category		***6. Service Delivery Processes***		
SD1.2 Processes	ID:	6.5	Name:	Capacity management
	Goal	To ensure that the organization has, at all times, sufficient capacity to meet the current and future agreed demands of the business.		
SD1.4. Activity		***SD1.5. Task***		***SC3.1. Artifacts***
The Clause 6.5 refers to the capacity management		1. The current and expected requirements of the business in relation to service should be known in terms of what the business is going to need for it. 2. The business forecasts and estimates of workload should be translated to specific requirements and must be documented. 3. The result of changes in workload or environment should be predictable. 4. Current and historical data of the use of components and resources should be collected and analysed. 5. Management capacity should be the focal point for all issues of performance and capacity. 6. The process should provide direct support to the development of new services and modifications to these. 7. A capacity plan must be generated and this should be prepared annually, at least. 8. A good understanding of the technical infrastructure should exist together with its present and projected capabilities.		1. Capacity plan that documents the actual performance of the infrastructure and the expected requirements. 2. Documentation with the existing options, along with the cost involved in meeting the business requirements, and solutions recommended for achieving the service level objectives.
SAI4.1 Related processes		Clause 6.5 is related to clauses 6.1, 7.2 y 9.2.		

An example of the result of the homogenization is shown in Table 3. Clause 6.5 in this table relates to the capacity management defined in ISO 20000-2. It has been organized and structured according to the CSPE Template. Here, it is possible to note that there was no correspondence between all elements in the four sections of the common structure. This takes place because the standard "doesn't define" or unfolds detailed information for that correspondence.

ISO 20000-2 neither clearly defines nor documents many of the requirements that it suggests should be put into operation (activities, tasks and artifacts, and others). Correspondence and formalization of the information presented in it, with regards to process elements of structure, had made it more possible to understand the requirements associated with it. An example of this is the identification and correspondence of activities, tasks and artifacts. For greater detail about the original descriptions of models analyzed, the corresponding reference is suggested to be consulted.

The proposed structure has also been applied to other models and standards, such as CMMI (DEVelopment and ACQuisition); ISO 9001, COBIT 4.1, ITIL; Risk IT, Val IT, BASEL II; ISO 27001, ISO 27002; ISO 20000-2, Project Management Body of Knowledge (PMBOK), and MoProSoft. See [27, 31, 32].

Homogenization through a supporting tool

Within ontology groundwork, one of the functionalities of HProcessTOOL [33] was designed and developed. This is a web tool to manage harmonization projects by supporting specific techniques. It also supports the management which controls and monitors the resulting harmonization projects. When a user logs on to the HProcessTOOL, s/he can harmonize the models involved in a harmonization project through CSPE, which, as discussed earlier, is a template based on PrMO that takes some process elements defined in it, providing a way to support the harmonization of reference models.

The tool has been successfully used in case studies presented earlier, see [33]. The validation and demonstration that PrMO can be used on a WEB platform, has been made attainable. In addition, it is possible to say that, given the generality of PrMO, using the mechanism of inheritance and restriction to homogenize multiple models, has not been necessary. However, since each model uses different names to appoint its process elements -or simply because some of them are not defined- establishing a correspondence table with regards to the process elements defined in the ontology has been necessary. Currently, some models and standards have been homogenized through OPrM, such as CMMI (DEVelopment and ACQuisition), ISO 9001,COBIT 4.1; ITIL, RISK IT, VAL IT; BASEL II, ISO 27001, ISO 27002; ISO 20000-2, PMBOK, and MoProSoft. Table 4 shows the table of correspondence used, together with an example as to how to homogenize the process elements of some reference models: the CMMI (DEV and ACQ), the ISO (9001, 27001, 20000-2), and the COBIT.

Other applications of PrMO are as follows:

- The CSPE is being used to develop functionality: the possibility for the user to design, construct, apply and analyze, and to make appraisals from models stored in the HProcessTOOL. Since it will be supporting reference models stored through HProcessTOOL and CSPE, it will be flexible enough to support process appraisals in the context of global software development, and become adaptable to possible changes that may occur with such models. In that sense, it could be a useful tool, making quality assessment and improvement of the organizations' processes possible, at a global level.
- CSPE has demonstrated that it could be useful as a way to support the assessment of structural differences, and to determine the level of detail in the reference models involved in a harmonization project. This allows us to identify an initial set of differences that necessary to be solved before starting any mapping process.

Table 4 Correspondence of models according to OPrM

PE of CSPE	*CMMI-DEV* *CMMI-ACQ* *CMMI-SVC* *Example: CMMI-ACQ V1.2*	*ISO 9001:2008* *ISO 27001:2005* *ISO 20000-2:20011* *Example: ISO 9001:2008*	*COBIT 4.1*
Process Category	Categories, e.g. Support, Engineering, Process and Project Management.	Requirements, e.g. System of Quality Management.	Domains, e.g. Plan and organize.
Process	Process Areas, e.g. Agreement Management from CMM-ACQ.	Principal Clauses, e.g. clause 4 concerning System of Quality Management.	Process, e.g. PO1 concerning defining a strategic IT plan.
Objective	Specific Goal (SG), e.g. SG 1 Satisfy Supplier Agreements	Inherent Information	Inherent Information
Activity	Specific Practices, e.g. Specific Practice 1.1 Execute the Supplier Agreement.	Sub-clauses (IIb), e.g. clause 4.1 concerning the general requirements.	Activities, e.g. PO1.1 IT Value Management.
Task	SCiSPa, e.g. Numeral 5 concerning Monitor risks involving the supplier.	Information Not found	Information Not found
Artifact or Product	Information Not found	Clause 7.3.4, e.g. Include representatives of functions concerned with the design and development stages.	Rol & Responsibility Chart (RACI), e.g. Business Executive role.
Role	Information Not found	Clause 6.3. e.g. infrastructure includes, as applicable, a) buildings.	Information Not found
Resource	Information Not found	Information Not found	Information Not found
Tool	Typical Work Products and, e.g. Integrated list of issues.	Sub-clauses (IIb), e.g. Clause 4.2.1, describes the term "documented procedure".	Outputs, e.g. Strategic IT plan.
Measure	Information Not found	Information Not found	Metrics, e.g. to measure degree of approval of the IT strategic/tactical plans.

a. SCiSP: Subpractices Contained in Specific Practices, b. II: Inherent Information

Conclusions and Future Work

PrMO has been presented herein, being this an ontology of process-reference models designed to facilitate the harmonization of multiple models and standards. The way in that PrMO has been instanced in a clause of ISO 20000-2, has also been illustrated. Using the ontology, it has possible to develop a functionality which, through a Common Structure of Process Elements CSPE, allows supporting the homogenization of structural differences found between models. This is part of a web tool called the HProcessTOOL. We should also add that we are currently developing an appraisal tool, which permits the design, the construction, the application and the analysis of assessments to be performed inside an organization, using the homogenized models stored in the HProcessTOOL.

The homogenization of models is currently a manual task. Consequently, as future work, the next step in this study will involve the automation of the homogenization stage through development of specific algorithms which will lead us to extend the capability of our tools. It is not our intention to automatize all the tasks and activities involved. We do, however, wish to help users automatize the mapping step or any process elements that show correspondence with our CSPE.

It should also be said that, since PrMO has been used to instance different process and reference models, it has shown that it can also be used as a basis for supporting the design and building of organization's processes. That being the case, we hope to develop a functionality to support the definition of organizations' processes through our ontology and tool. The information stored will be able to be used as a benchmark of processes for other organizations, as well as to help them while defining their own processes.

Although PrMO has been applied in the homogenization of several models, in the quest to cover a wider range of needs, we hope to extend models and standards modeled through PrMO and stored in the HProcessTOOL.

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