Analyzing a Process Profile for Very Small Software Enterprises

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Abstract

Small software enterprises have become interesting for international standardization. An example is the emerging standard that defines profiles for software lifecycle processes in very small enterprises. We analyze the structure of the process model used in the profiles and present the results as class diagrams. The analysis points out some issues related to balance, consistency and traceability. We present a possible solution as an enhanced meta-model to support modeling of the processes. The aim of the meta-model is to provide a complete, clear and unambiguous mapping between the profile processes and the reference process model. Results of this study can be used in developing methods and tools for e.g. process assessment and improvement.

1. Introduction

International standards are becoming more and more important in Information Technology business due to the growing interest in global markets and outsourcing. Companies want to show compliance with common business rules by investing in adherence of internationally acknowledged standards for both their products and services to penetrate the market. Especially within small and medium-sized enterprises (SME), the primary strategy in response to tighter competition is to increase quality [10].

The key player in providing international standards is the joint technical committee of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), named Joint Technical Committee One (ISO/IEC JTC 1). Importance of small software enterprises to the whole industry has been recognized also by the international standardization efforts. Therefore, one JTC 1 subcommittee has set up a working group to develop standards for software lifecycle profiles to help very small enterprises (VSE) to enhance quality of their processes and products.

In this context VSE are organizations, departments or projects having less than 25 employees. The framework will attempt to ease the use of ISO/IEC 12207 Software life cycle processes and ISO9001:2000 Quality management systems, and reduce the conformance obligations by providing VSE profiles (VSEP). [6]

Software Lifecycle Profiles for Very Small Enterprises (VSEP) are specifications that use subsets of other standards. The first developed VSEP is the so called Basic Profile that contains project management and software development processes considered to be of the utmost priority when software VSE initiate their quality systems. Later on, further Profiles will be developed to enable a step-wise approach towards the ISO 9001:2000 requirements.

The initial purpose of the paper is to analyze the structure of the VSEP Basic Profile to implement it as a process library. This would support the standard's future distribution by providing a user friendly and adaptable platform for the presentation of the standard. Secondly, we intend to implement the standard as a part of a knowledge base, where the elements of the standards are linked with the assessment criteria. This would concretely show how VSE can fulfill assessment criteria based improvement proposals in practice.

An additional goal was discovered during the analysis: the development of the evolving standard could be supported by harmonizing the concepts and structure used in the process model. Clarification of the process model improves the standard's usability both for end users and method developers. Especially when developing assessment models, the requirements for traceability with the reference models are important [9].

The second chapter presents the organization of standardization and the VSEP Basic Profile processes. The third chapter describes the results of the process model analysis as a process meta-model and explains the complexity of the relationships between basic process elements. Chapter four discusses the issues related to the existing VSEP process model and presents a solution to enhance the model. The summary of the paper and an outlook to future work is presented in chapter five.

This paper is targeted to an audience that has interest in the software engineering standards for SME. The results of the study might also benefit the developers of the VSEP standards. UML class diagram notation is used in most of the figures

2. A Standardized Process Profile

The scope of the work in ISO/IEC Joint Technical Committee One [2] is defined as "international standardization in the field of Information Technology". JTC 1 has over 500 published ISO standards that typically are revised in every five years. Currently 40 countries participate in JTC 1 and additional 42 countries are observers. Approximately 2100 technical experts from around the world work within JTC 1.

Table 1. ISO/IEC JTC1 SC7 working groups

WG 2	Systems and software documentation
WG 4	Tools and environment
WG 6	Software product measurement and evaluation
WG 7	Life cycle management
WG 10	Process assessment
WG 19	Open distributed processing and modeling languages
WG 20	Software engineering body of knowledge
WG 21	Software asset management
WG 22	Vocabulary
WG 23	System quality management
WG 24	Software life cycle profiles and guidelines for very small enterprises
WG 25	IT Service management
WG 26	Testing
WG 42	Architecture

Work under JTC1 is organized in 18 subcommittees, one of them is Software and systems engineering subcommittee seven (JTC 1/SC 7). Under SC 7's responsibility are 103 published ISO standards. SC 7 has 36 participating and 18 observing countries. To develop the standards SC 7 has 14 active working groups (Table 1.).

WG 24 was established in 2005 to develop software life cycle profile and guidelines for very small enterprises (VSE). Here a very small enterprise is defined to be a company or an organization with less than 25 employees. To obtain the needs of VSE regarding the use of standards a web-based survey was conducted. Total of 435 responses was received from 32 countries. Most respondents asked for more guidance and examples to use standards, and lightweight, easy to understand standards provided with templates. Almost 75% indicated the need to be certified or otherwise recognized in the market for adhering to international standards. [8]

The work is aimed to provide for VSE a set of existing ISO standards in a form that is easier to use and apply in their context. The most relevant standards are:

- ISO/IEC 12207 Software life cycle processes [3]
- ISO/IEC 15504 Process assessment [4]
- ISO/IEC 90003 Guidelines for the application of ISO 9001:2000 to computer software [5]

The working group has meetings twice a year to develop the standard, but working group members prepare the work mainly between the meetings. Countries participating the meetings include Australia, Belgium, Canada, Columbia, Finland, India, Ireland, Japan, Korea, Luxembourg, South Africa, Spain, Thailand, and the United States. All documents are subject to the JTC 1 balloting procedures before their publishing.

The working group will prepare a set of work products, technical reports (TR) and international standardized profiles (ISP), under the generic title Lifecycle Profiles for Very Small Enterprises (VSEP):

- TR 29110-1 Overview
- ISP 29110-2 Framework and Taxonomy
- TR 29110-3 Profile Assessment Guide
- ISP 29110-4.1 Basic Profile Specification
- TR 29110-5.1 Management and Engineering Guide for Basic Profile

WG 24 has just published for the general public the first drafts of the emerging 29110 standard. Considering deployment of the standard, part 5.1 is the most interesting as it defines in practice software implementation and management guide appropriate to VSE. The profile is composed of two processes: Project Management and Software Implementation. WG 24 plans to develop supplementary profiles to cover more of the life cycle processes in order to support VSE to achieve adequate process maturity for ISO 9001 certification.

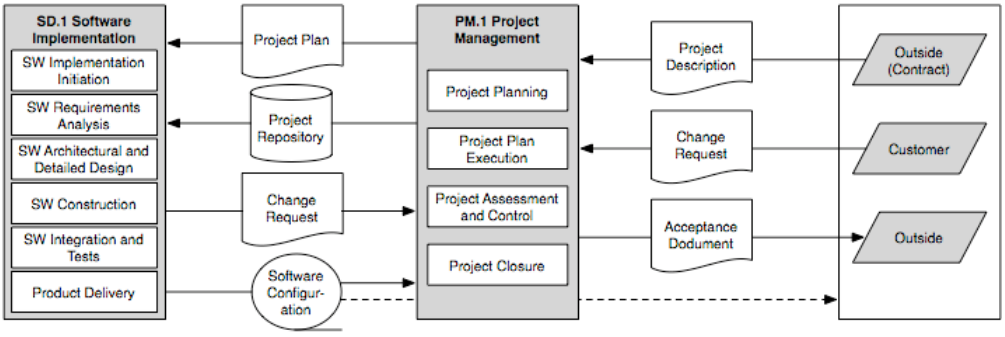

Figure 1. VSEP Basic Profile processes in their context

Figure 1 depicts the VSEP Basic Profile Processes in their context. Basic Profile has two processes: *Software Implementation* (SD.1) and *Project Management* (PM.1).

Software Implementation is further divided into six subprocesses, and in Project Management there are four subprocesses.

Project Management acts as the interface to the *outside* world. The opening document for a software project is *Project Description*, which is also the basis for project planning. Project Management generates a *Project Plan* to direct the software project and establishes a *Project Repository* to store project work products. During the execution of the project, Project Management process receives *Change Requests*, which might cause revisions to the Project Plan. The source of a Change Request is either one of the processes or *Customer*. The final outcome of the Software Implementation process is a *Software Configuration*, which includes, in addition to executable software and its source, all associated documentation. The customer acceptance is formalized by *Acceptance Document*.

3. Modeling the VSEP Model

The published public draft of TR 29110-5.1 Management and Engineering Guide for Basic Profile describes project management and software development processes. The two example processes reveal the elements used in process descriptions. The TR document is work in progress, but due to the nature of standardization, the early structural and conceptual solutions tend to prevail – typically terminology and contents are emphasized in balloting comments instead of modeling issues.

Later on, e.g. models and methods for assessment and improvement will be developed based on the standard. Therefore it's important to understand the used process model, and hopefully to clarify it as much as possible before the standard is approved. Also the strategy to use ISO/IEC 15504 based assessments in conjunction to this standard, sets certain requirements for traceability of the assessment model.

The Technical Report describes the structure and the elements of *processes* as follows [7]: *Title* conveys the scope of the process as a whole. *Purpose* is the high level objective of performing the process and the likely outcomes of effective implementation of the process. The implementation of the process should provide tangible benefits to the stakeholders. *Objectives* are specific goals to ensure the accomplishment of the process purpose. The objectives are identified as O1, O2, etc. *ISO/IEC 12207 Processes* and *Outcomes* are related to the Objective. *Input Products* is a list of products required to perform the process and its corresponding *source* and *Output Products* is a list of products generated by the process and its corresponding *destination*. *Internal Products* is a list of products generated and consumed by the process. *Subprocess* is the first level of decomposition of the process and it is described with: *Name*, Related Process Objectives, and Tasks. *Task* is a requirement, recommendation, or permissible action, intended to contribute to the achievement of one or more outcomes of a process. Each task has associated abbreviations of *roles* involved, task *number* and *description*, list of *input products* required to perform the task and list of *output products* of the task. Input and Output products may have associated a *status*.

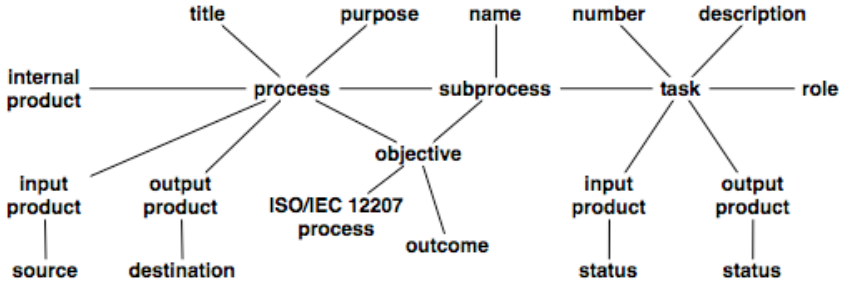

Figure 2. Map of VSEP Basic Profile concepts

The above mentioned concepts, emphasized in italic font, and their relationships are represented in Figure 2.

The basic elements in any process are activity, artifact, resource and role [1]. The elements form an internal structure and are related to each other. The VSEP Basic profile includes all the basic process elements (Figure 3). *Process*, *Subprocess* and *Task* represent a hierarchy of activities. *Product* stands for Artifact, which acts as inputs and outputs of Activity. *Resources* are for example tools and equipments, which are used by activities in producing output artifacts. *Roles* are the performers of the activities. In VSEP Basic Profile the resources are linked to subprocesses and roles to tasks.

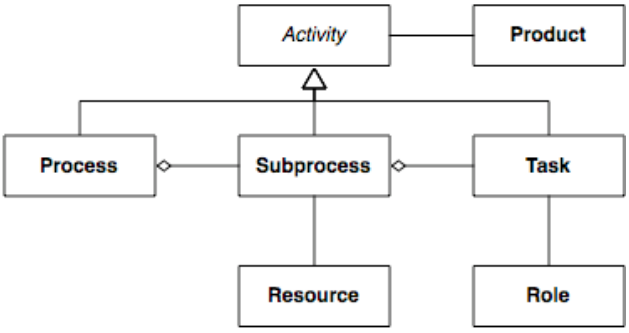

Figure 3. Basic process elements in the Basic Profile

Figure 4 shows a meta-model of VSEP Basic Profile processes in their context. *Process* is related to *Product* by three kinds of associations. A product is acting as an input, output or internal product of a process. When a product is related to a process as an output product, the

association defines also the product's *destination*, which is either another process or the *outside* world. For example, Project Plan and Acceptance Documents are output products of Project Management Process (Figure 1). Project Plan's destination is Software Implementation process while Acceptance Document goes Outside. The relationship between process and input product has thee types of sources. A product may enter a process from a process or outside but also from a *role*. For instance, the source of Change Request is either Software Implementation (process) or Customer (role). Project Description comes from Outside, which is *specified* as Contract. An example of Project Management process's internal products is Progress Status Record.

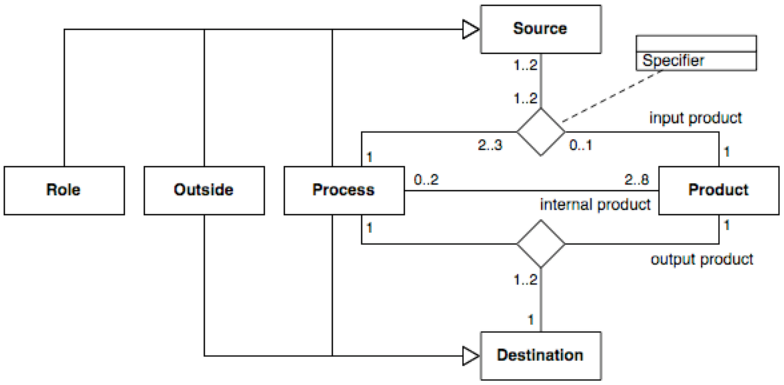

Figure 4. The relationships between Process and Product

Figure 5 presents the activity hierarchy of the VSEP Basic Profile and its relationships to the reference process model ISO/IEC 12207. Four levels of activities can be identified: *Process*, *Subprocess*, *Task* and *Step*. The all instances of Process and Subprocess are depicted in Figure 1, which also shows, how a process is characterized by *title* and a subprocess by *name*. Process has also a *purpose* and a set of *objectives*. An objective is linked to from one to ten *reference process outcomes*. The outcomes for a single objective may come from one or two reference processes.

Process objectives are also linked to subprocesses. Between Objective and Subprocess there is a many-to-many relationship. A subprocess contributes up to four objectives and an objective is contributed by zero to four subprocesses. In the Basic Profile a subprocess is associated to a list of items that the subprocess provides. *Outcome* in Figure 5 is such an association. The subprocess outcomes are not fully traceable to the reference process outcomes, because an objective is contributed by many subprocesses.

In the activity hierarchy the subprocesses are further broken down into tasks. A subprocess may include as many as eighteen tasks, but there are also subprocesses with a single task only. Some of the tasks specifically deal with verification or validation (*V/V Task*). The examination of task descriptions exposes the fourth level of activities. For example, Software Requirements Analysis subprocess has a task, Document or Update the Requirements Specification, in which the following four elements can be identified: Consult Information Sources, Analyze Requirements, Elaborate UI Prototype, and Generate Requirements Specification. Such elements in Figure 5 are denoted as *Step*. Like the subprocess outcomes, the tasks are not fully traceable to the reference process outcomes.

The complete process meta-model of the VSEP Basic Profile can be constructed by joining the views in figures 4, 5 and 6. While the focus of the view in Figure 4 is the context and Figure 5 depicts the activity hierarchy, Figure 6 shows the rest of the related process elements.

Product has a structure as well as *Process* that composes of subprocesses with tasks and steps. In Figure 6, *Parent Product* denotes the highest level in the product hierarchy. All products with an identifying number are considered here as parent products, of which examples are shown in Figure 1: Project Plan, Project Repository, Change Request etc. The total number of parent products in VSEP Basic Profile is 23. Some parent products have clearly identifiable parts. For example Project Plan is described (by bulleted text) to include 14 parts (*Product Part*). For instance "Identification of Project Risks" and "Delivery Instructions" can be regarded as product parts of Project Plan. The bulleted text, which is used in product descriptions, has two levels. Therefore the product parts can be thought to have even finer grained parts (*Product Subpart*). For example, Delivery Instructions includes Elements required for product release identified and Delivery requirements etc.

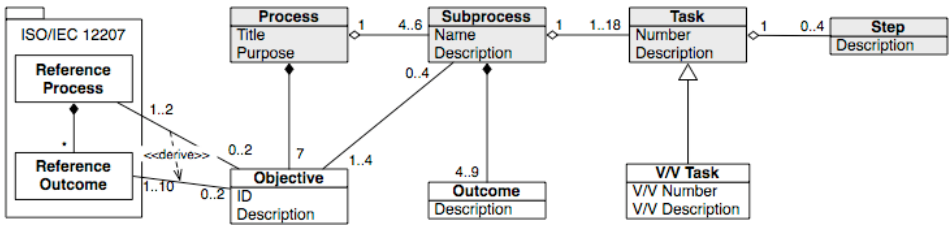

Figure 5. Basic Profile activity hierarchy and its mapping to ISO/IEC 12207

There are two special parent products, which are composed of other parent products: *Project Repository* and *Software Configuration*. Four of the parent products

are not included in a project repository: Project Repository itself, Project Repository Backup, Project Description and Software Configuration, whose absence can easily be explained. Project Description has four product parts, which are also included in Project Plan. A software configuration (software and its associated documentation) has a version of the parent products, while all versions are included in a project repository. A software configuration includes ten types of parent products, e.g. Requirements Specification and Test Incident Report. Before a product can be put into the project repository, there might be an associated approval procedure (V/V Task). For example, the Basic Profile suggests that a project plan, which is in the project repository, has been verified and validated.

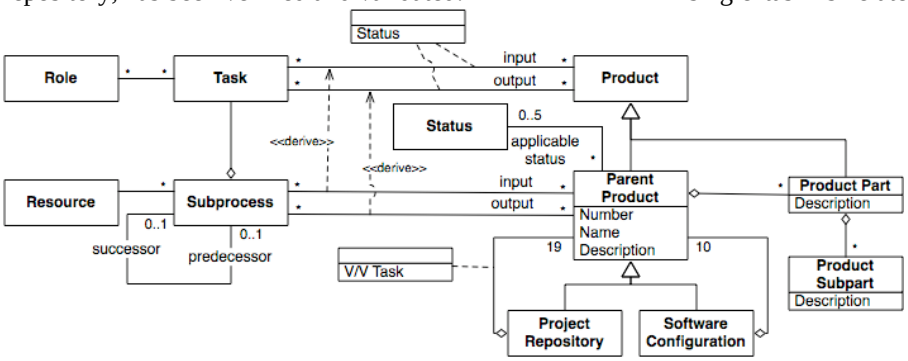

Figure 6. Process elements and their relationships

Product has two associations with *Task*. A product may act as a task's input or output product and possibly have a status. The status only relates to the parent products, which have up to six applicable statuses (*Status*). For example, Software Requirements Analysis subprocess has a task "2.7 Document ... User Manual ...", whose input is a validated Requirement Specification and output a preliminary User Manual. The other applicable statuses for requirements specifications and user manuals are verified and baselined. In Figure 6, Product is shown as an abstract class, which is the superclass of Parent Product and Product Part. Thus Task is associated both to Parent Product and Product Part. In the VSEP Basic Profile the links between subprocesses and products are shown in workflow diagrams with the predecessor-successor dependencies of the subprocesses. The derived associations between Subprocess and Product are on Parent Product level. As already shown in Figure 3, Role is associated with Task and Resource by Subprocess.

4. Enhancing the Meta-model

The analysis of the activity hierarchy of VSEP Basic Profile arose three topics for enhancements: balance, consistency and traceability. Issue of traceability is illustrated in Figure 7. There is an example with five sets of elements: Reference Outcomes of ISO/IEC 12207 processes, Objectives of VSEP Basic Profile processes, Subprocesses and their Outcomes, and Tasks of the Subprocesses. The links between the elements comply with the multiplicity constraints of the corresponding associations in Figure 5. The mappings e.g. between the tasks and the elements of ISO/IEC 12207 are not clear and unambiguous. According to the example, the reference outcome RO6 is linked to the objective O2, which is contributed by two subprocesses SP1 and SP2 with their corresponding tasks. It is impossible to say, if the both subprocesses are required to achieve RO6, or if only one is necessary. It is also unanswerable, how a single task is related to a particular reference outcome. For example, RO6 is linked through O2, SP1 and SP2 to nine tasks, and it is not clear, which of these tasks are required for RO6. The same problem exists to the opposite direction. Task T3 might be required to achieve any or all of seven possible reference outcomes. Additionally, it is unknown, if T3 is fully or only partially required for these reference outcomes, e.g. RO6. If it is partially required, it is still unclear, which steps of T3 are related to RO6.

In addition to traceability, Figure 5 raises also

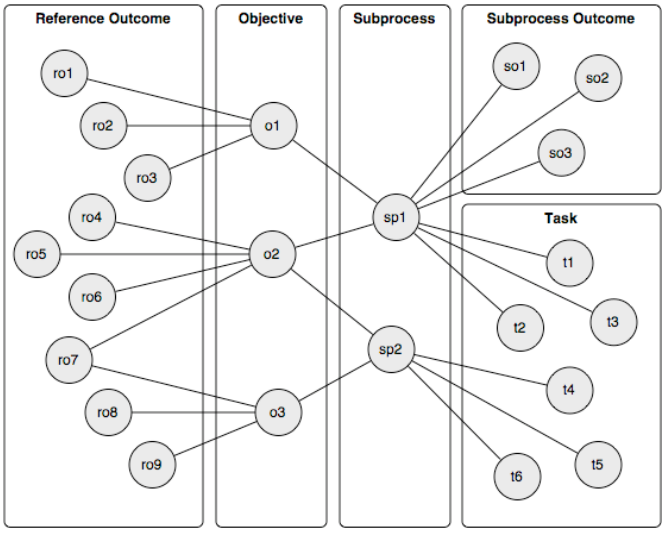

Figure 7. An example of mapping Basic Profile Tasks to Reference Outcomes

questions about the model's consistency and balance. To begin with consistency, there are four granular levels of activities: processes, subprocesses, tasks, and steps. They all can be considered as same kind of elements, yet the activities are characterized by different attributes. E.g.

Process has Title and Purpose, but Task is identified by Number and Description. Secondly, in the hierarchy of activities, subprocesses have quite different number of tasks. There are subprocesses with a single task only, but on the other hand, a subprocess may have even eighteen tasks. Most of the tasks are not divided further, but some of them clearly have (typically four) steps.

Figure 8 depicts a revision to the meta-model shown in

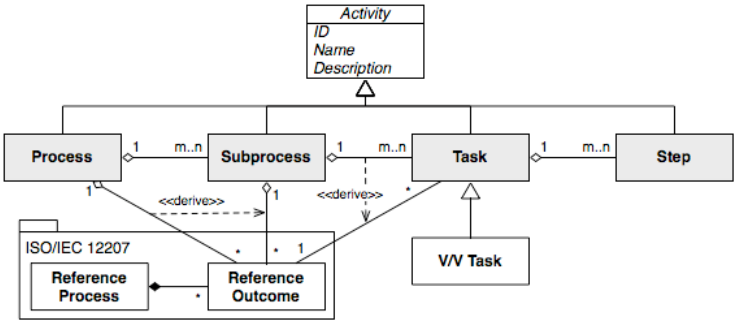

Figure 8. Enhanced meta-model for VSEP Basic Profile

Figure 5. The revised meta-model gives an example, how the issues related to the balance, consistency and traceability of the Basic Profile could be enhanced. First for consistency, the model suggests using the same attributes for all levels of activities. In Figure 8, there is an abstract class, Activity, with a set of attributes, which are inherited by all concrete activity classes (Process, Subprocess, Task and Step). Secondly for balance, the associations between activity classes are represented with multiplicity constraints, where m and n denote integers relatively close to each other. Finally for traceability, there is an unambiguous mapping from tasks to reference outcomes.

In the model shown in Figure 8, subprocesses are used to group appropriate reference outcomes, which are linked to tasks for achieving the outcomes. A process groups subprocesses according to one-to-many association and that is why the links between processes and reference outcomes can be derived. The same applies to the association between Subprocess and Task. In Figure 5, there are two parallel divisions for a process into its elements: subprocesses and objectives. The revised model omits the objectives as separate elements. It suggests that the structure of objectives follows the subprocess structure, in which case the objectives of a process can be equated with subprocesses.

5. Conclusion And Future Work

In this paper we presented a new standardization initiative by ISO/IEC Joint Technical Committee One supporting the use of software lifecycle processes in very small enterprises. The work is carried out by Working Group 24 under Subcommittee Seven (ISO/IEC JTC 1/SC 7 WG 24). The standard will contain process profiles for VSE. The first published draft is known as the VSE Basic Profile and it consists of processes for project management and software implementation.

The standardization is work in progress and therefore it is timely to analyze the presented process model. We present the results of the analysis as UML class diagrams and point out some issues related to balance, consistency and traceability within the present VSEP model.

The key result is the enhanced meta-model to support modeling of the processes. The aim of the meta-model is to provide a complete, clear and unambiguous mapping between the VSEP processes and the reference process model ISO/IEC 12207.

In the future, the results of this study can be used to clarify the VSEP process model with the WG 24 work. The results are also useful when developing methods and tools that use the VSE Profiles for e.g. process assessment and improvement. An example is a tool for disseminating the information about VSEP in a structured, easy to use format.

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