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Tailoring the Software Product Management Framework for Use in a Healthcare Organization: Case Study

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Abstract. Many reference models were developed for software process improvement. Each model, however, is an idealized prescription that is applicable in a limited set of situation only. This paper has investigated how an existing reference model can be tailored to a domain it has not been designed for initially. The tailoring approach is based on translating the reference model to the new domain and on inductive interviews for evaluating the translated model. The approach has been applied for assessing and improving strategic requirements engineering practice in a healthcare organization with a framework for software product management.

Keywords: reference model tailoring, inductive process improvement.

1 Introduction

A plethora of reference models have been developed for improving processes and capabilities. Models such as the CMMI [1] and ITIL [2] prescribe broad sets of best practices and have been successfully used for all-over-the board process improvement in software organizations. Lightweight models such as the software product management (SPM) framework [3] and the improvement framework for lightweight assessment and improvement planning iFLAP [4] focus on specialized processes and roles and were successfully used in practice for focused and cost-efficient process improvements.

Any model, however, abstracts and represents only a fraction of the phenomena that can be observed in reality, usually those that were perceived relevant for the creation of the specific model [5]. As a consequence, reference models and the processes and capabilities they encourage represent idealized guidelines for selected domains. Many situations are inconsistent with the assumptions behind these ideals, however. For example, the focus of CMMI on software development, rather than software use for service provision gave rise to the creation ITIL. Similarly, the strategic requirements engineering activities needed by product managers for planning software products gave rise to the SPM framework because CMMI was not specific enough to support these concerns.

Process improvement situations that are insufficiently supported by existing frameworks encourage researchers and experts to create new reference models. This

increases the number of standards that need to be known, selected, and applied in practice. Reference model tailoring represents an alternative to the creation of new models. Tailoring involves the interpretation and translation of an existing framework to a new context, which has been insufficiently supported previously. The resulting increased applicability of the existing frameworks limits the growth of the number of frameworks and improves the understanding of their validity.

This paper describes a case of tailoring an existing reference model to a new domain. It describes a simple two-step approach for translating the reference model and for evaluating the translation. As a result, existing process improvement knowledge can be transferred instead of being reinvented. The results contribute to a consolidation of software process improvement frameworks and enable the use of new domains to validate process knowledge.

The remainder of the paper is structured as follows. Section 2 describes related work. Section 3 describes the research methodology. Section 4 describes the translation results and section 5 the evaluation results of the reference model tailoring approach. Section 6 discusses the results. Section 7 concludes.

2 Related Work

Process knowledge is applied to so many different situations that no single model is able to capture all variability. Software process tailoring has been coined as a term to describe the adaptation of “off-the-shelf” software processes to meet the needs of a specific organization [6]. To enable such tailoring, situational factors have found their way into process improvement frameworks to account for an organization’s specific process improvement ambitions and for domain specialties [7, 8]. Companies can choose their desired level of maturity and omit practices and capabilities that they perceive excessive [1].

Variability exists also within an organization. Projects and organizational units are required to tailor idealized processes to make them practicable, efficient, and effective [9, 10]. Tailoring strategies include dropping, downsizing, adding, expanding, and refinement actions applied on resources, communication, decision-making, documentation, knowledge, and technology. Analysis of the gap between the planned process model and the process enactment allows steering and managing process tailoring and improvement [11]. Enactment of tailored processes results in real-world experimentation with results that enable learning in the organization [12].

For situations, where no process knowledge is available, inductive process improvement approaches have been proposed [13]. In a bottom-up fashion, critical issues are identified and solutions sought for addressing these issues [14]. When based on appropriate sampling of projects, roles, and practitioners the organization’s knowledge can be externalized and effective improvement results obtained [4]. The results of inductive improvements capture process knowledge that can be made available to the software industry, for example by building new or updated frameworks.

Many situations with no process knowledge available are still so similar to domains with existing reference models so that inductive creation of a new reference

model is ineffective. The organizational learning process would require too much effort and the results would be applicable to the concerned organization only. In these situations, more effective is the tailoring of an existing reference model and transfer the process knowledge it captures. Such tailoring provides the additional opportunity of understanding how domains relate to each other and of extending the validation of existing process knowledge.

3 Research Method

Our work aimed at understanding how to transfer an existing reference model from a known assessment domain to a new such domain while being confident that the weak points of the assessed processes are found and the most valuable changes identified. The here presented case study [15] was part of an improvement initiative in a Swedish health-care organization that uses IT solutions and embedded systems such as medical devices that it procured in a regulated market [16]. The effort aimed at improving strategic requirements engineering in the organization.

Due to the similarities of software product management [17] with the strategic requirements engineering needs in the healthcare organization, we selected the SPM framework as a basis for process assessment and improvement. In a two-step process, we tailored the reference model to the healthcare domain and evaluated the tailored version with inductive questions that we integrated into the practitioner interviews. The interviews were analyzed with content analysis [18] to identify correspondences and misalignments of the assessment framework. The results are two-fold. On a method engineering level, they show how to translate and evaluate an existing assessment framework into a new, initially unforeseen domain. On a method application level, they show how to assess strategic requirements engineering of a healthcare organization with the software product management framework.

To evaluate the fitness of the tailored SPM framework for strategic requirements engineering in a healthcare organization (SRE@HC) we posed the following initial research question. RQ1: *What are the correspondences between the SPM framework and SRE@HC?* The identified correspondences were used to build the SRE@HC framework that we evaluated with the following research question. RQ2: *What is the congruence of the SRE@HC framework with the SRE@HC domain?*

The research was performed in collaboration with one of the county councils in Sweden. It served a population of 150'000 people with one hospital and multiple primary care centers. The hospital was divided according to medical specialties and services, including orthopedics, pediatrics, radiology, and operating room departments. The county council was supported by an organization that included IT, procurement, and estate departments. The support organization ensures compliance with regulations such as WTO GPA. On top of the administration, a political organization took overall responsibility for healthcare delivery. Fig. 2 (right-hand side) gives an overview of the county council and its constituents. The county council is representative for other public-sector healthcare organizations, except that it does not include medical research departments that can be found at university hospitals.

The research was performed as a two-step process. Step 1 answered RQ1 by tailoring the SPM framework into the SRE@HC framework. Step 2 answered RQ2 by evaluating the application of the SRE@HC framework in the healthcare organization. Fig. 1 gives an overview.

Fig. 1. Research process (grey: previous work, black: step 1, white: step 2)

Step 1: RQ1 was answered by first identifying correspondences between the SPM framework and strategic requirements engineering in the healthcare organization and then validating the resulting assessment instrument with an expert responsible for strategic requirements engineering in our partner organization. The requirements engineering and healthcare experience of the authors enabled the first step. Correspondences were identified for organizational roles, activities, and artifacts. As a result of this mapping, a tailored questionnaire for SRE@HC assessment was created, which was reviewed internally in the research team as an offline evaluation that did not involve any outside experts [19]. The expert from the county council performed a practitioner evaluation by reviewing the questionnaire.

Step 2: RQ2 was answered by evaluating the SRE@HC instrument in real process improvement. 14 interviews were performed that lasted approximately one hour each. Questions about compliance with SRE@HC practices were used to identify the maturity of the organization from the perspectives of the interviewees. Questions about the rationales for compliance and non-compliance with SRE@HC practices and open-ended questions about total improvement potential were used to collect evidence about congruence of the SRE@HC framework with the SRE@HC domain. This evidence was analyzed by directed content analysis to identify agreements, disagreements, and omissions of the SRE@HC framework with respect to the SRE@HC domain.

Flexible research is confronted with the following threats to validity: reactivity, respondent bias, researcher bias, reliability, and generalizability [20].

Reactivity refers to the way in which the researcher's presence alters the behavior of the subjects involved in the research. One of the researchers had established trusted relationships with many of the interviewed practitioners in the healthcare organization during multiple years that preceded this research. The trusting relationship and the

inside-out knowledge of the organization reduced the likelihood of receiving biased information. The researchers without personal relationship assured neutrality of the research.

Respondent bias refers to the risks of obtaining answers that respondents judge are those the researchers want and of having information withheld that can be used against the respondents. This threat was the most critical threat in the presented research as the respondent's organizational units and activities were assessed. Risk-limiting was that all respondents perceived strategic requirements engineering to be a key area to improve and that they benefitted from the improvements launched on the basis of the obtained results. In addition, the results were triangulated between the individually interviewed subjects and member checking used with the responsible for strategic requirements engineering at the organization.

Researcher bias refers to the preconceptions and assumptions the researchers into a study. We used observer triangulation and an audit trail to address this threat to validity. Each interview was performed by two researchers. Also the analysis of the interview results was performed jointly. A record of the data collection and data analysis activities was kept during the study.

Reliability refers to how carefully the research was performed and how honestly the results were presented. Reliability was achieved by following the above-described research design, and by verifying the results with member checking. In addition, a chain of evidence was maintained.

Generalizability refers to how far the obtained results are applicable and valid both within the studied setting and beyond. For internal generalizability, we used a combination of purposive and stratified sampling. Interview partners were selected to cover the organizational units and roles needed for the assessment as well as possible. The responsible for strategic requirements engineering at the partner organization acted as a gate-keeper in the interview partner selection. All selected interview partners participated in the study. Concerning external generalizability, we used convenience sampling in the selection of the partnering county council. This decision reduced the reactivity threats of the study, but implied that the results are only generalizable to those parts of a healthcare organization that exclude research hospitals.

4 Step 1: Translation of the SPM Framework

The scope and structure of the SPM reference model are well described by its design decisions and creation process [3, 21, 22]. Product management was thought to interact with external stakeholders such as customers and supplying partners and with internal stakeholders such as a company board and various company functions. Professional software product management was interpreted as a matter of well-organized information collection, analysis, and decision-making about to the development and release of a portfolio, products, releases, and requirements for the market.

Strategic requirements engineering in the studied healthcare organization was strikingly similar. The hospital and primary care centers interacted with patients as customers and the support organization as a supplying partner. The support organization

did the same by considering the hospital and primary care centers as customers and by facilitating procurements from external suppliers. Decisions were made about the organization's portfolio, about services to be developed and assets to be procured, about projects to be performed for evolving services and assets, and about needs for investments.

Despite the similarities, many differences between software product management and strategic requirements engineering in the healthcare organization existed. They concerned the organization of supplies and services, the assignment of activities to roles, the approach to decision-making, and the concepts and terms used to refer to the entities that are managed. In comparison to a software product company, the healthcare organization was not only embedded in an external supply chain, but had in addition an internal supply between the healthcare core units (a hospital and primary care centers) and the support units (IT, medical technologies, and procurement among others). Fig. 2 gives an overview of the two types of organizations. To serve patients, each service delivering unit managed its own portfolio of services. The service units delivered equipment to the healthcare units. The units had shared decision-making for investments that were needed for maintaining and enhancing the service and equipment portfolios.

Fig. 2. Structures of a software product organization (left) and of a healthcare organization (right). The hospital and primary care centers represent the healthcare core business.

In the healthcare organization the SPM product management role was split and distributed over multiple roles. The medical director was responsible for the portfolio of services offered to patients. He delegated this responsibility to heads of department and heads of ward for each specialty in the hospital, such as orthopedics, and to the heads of the primary care centers. Each such head was then also responsible for managing the lifecycle of the equipment required to deliver healthcare services. Project leadership, for example for business process improvement projects, did not exist on the healthcare side and were delegated to the support units. Needs for investment were collected and specified by deputy managers.

The support organization was responsible for the assets needed to perform the healthcare services. The head of IT was responsible for the software solutions, and the head of medical technologies for equipment such as operations robots and radiology labs. For managing the portfolio and the investments they collaborated closely with the chief financial officers. Responsible for specific assets and investments for improving or replacing them were the IT architect, the head of support services for

healthcare equipment, and the head of procurements. Project managers performed procurement and system integration projects and managed the requirements.

The organizational differences implied that the SPM roles needed to be translated into the healthcare context. The translations affected the wording used in the SRE@HC assessment questionnaires and the roles that were interviewed. Table 1 gives an overview of these translations that accounted for the differences observed above. 4 of total 13 roles could be transferred without adaptation.

Table 1. Translation of SPM roles to SRE@HC healthcare and support roles.

SPM	Healthcare	Support
Market	Population	HC core units
Customer	Patient	HC core unit
Prospect	-	-
Partner	Other healthcare organizations	Supplier
Partner network	Association of county councils	Domain specific groups of interests
Competitor	Alternative	-
Company board	Investment council	Investment council
Development	Healthcare services and support units	Suppliers
Market research party	Regulator	Regulator

The differences between the software product, healthcare, and support domains implied also that SPM concepts needed to be translated. The translations again affected the wording necessary to make the SRE@HC assessment questionnaires understood by the interviewees. Table 2 gives an overview. 12 of total 23 concepts could be transferred without adaptation.

Table 2. Translation of SPM concepts to SRE@HC healthcare and support concepts.

SPM	Healthcare	Support
Product line	Assets of same supplier	Assets of same supplier
Product	Service (type of operation, treatment, etc.)	Asset, Equipment, Solution, Investment
Component	Asset, Equipment, Solution, Investment	Parts
Roadmap	Plan	Plan
Release	Project results (new service)	Project results
Release definition	Specification	Specification
Requirements	Needs (pre-project), requirements	Needs (pre-project), requirements
Partnering & contracting	Provision of access to services	Provision of access to assets
SLA	Quality guarantees	SLA
Pricing model	Pricing model (only dentistry)	-
Revenue	Revenue (only dentistry), Re-investment	Investment
Engineering capacity	Budget	Budget

The translated SRE@HC framework for assessing a healthcare organization was structured, packaged, and used alike the software product management framework.

5 Step 2: Evaluation of the SRE@HC Framework

Fig. 3 shows the maturity profile of the county council that was assessed with the translated framework. Each block represents a focus area with capabilities that are ordered from left to right according to increasing maturity. The portfolio focus areas were *population/HC core unit analysis*, *lifecycle management*, and *access provision* from left to right. The service and asset focus areas were *intelligence*, *service/asset planning*, and *equipment/component planning*. The project focus areas were *requirements prioritization*, *specification*, *specification validation*, *change management*, *project result validation*, and *launch*. The need focus areas were *need gathering*, *requirements identification*, and *requirements organizing*.

	Healthcare	Support
Portfolio	Medical Director	Head Medical Technology
	Head of Hospital Dept.	Head IT
	Head of Prim. Care Center	CFO
		CFO Dentistry
Service / Asset	Head of Ward	Head Investments
		Head Med. Tech. Services
		IT Architect
		Head Procurement
Project	-	Project Mgr.
Requirements	Deputy Head of Ward	Project Mgr.

Fig. 3. SRE@HC maturity profile of the county council (green/light colored: capability implemented, red/dark colored: capability not implemented).

The assessment of the capabilities was based on the translated roles and concepts. The capabilities suggested by the translated reference model were understandable for the interviewees, with the following exceptions.

Portfolio: The interviewees stated that they are in a controlled market that does not allow competition to the county council within the county. They acknowledged, however, that private organizations started to provide primary care and that county councils compete across the counties. All units except parts of dentistry could not specify pricing for their services. Their compensation was determined by a re-investment formula. The healthcare organization tried to achieve synergies across services and assets, but not with product lines. Instead they were interested of using product families from the same supplier. The first two exceptions were due to regulations of the healthcare sector. The third exception was due to the use instead of development of assets.

Service / Asset: The respondents stated that the make or buy decision was always a buy decision. The healthcare service units obtained assets from the support units, the support units procured them from external suppliers. The delegation to the service units was the key rationale for the organizational split of service and support units. The external procurement was due to political regulations.

Project: The healthcare service units performed only operations and delegated the projects to the support units. Revenue consideration was again not as important because of the re-investment funding approach. Instead, cost savings were important. This exception was due to the culture of the organization.

Requirements: All capabilities were understandable.

The answers to the inductive questions about improvement potential partially overlapped with the reference model. Fig. 4 gives an overview of the elicited challenges together with causes and consequences.

Fig. 4. Improvement potential based on induction: challenges, causes, and consequences

Congruent were the following findings. The organization had not defined any business analyst role. The observed lack of this role is congruent with the reference model that expects stakeholder needs to be collected and transformed into well-communicated and managed requirements. Organizational units were decoupled from decision-making. Such observed lack of integration is congruent with the reference model that expects stakeholder consultation. The organization requested transparency of decision-making. Again such transparency was also foreseen in the reference model, as part of requirement lifecycle management, prioritization methodology, and communication of plans.

The reference model was missing several improvements that were perceived critical by the interviewees. The interviewees requested a decision-making process that defines how the many parties should collaborate. The SPM activities that were assumed to be coordinated by a single product manager had to be translated into a concerted collaboration of managers for strategic requirements engineering and investment decision-making. Also, the interviewees requested impact evaluation of the investment decisions and the consequent project results. The reference model only

requested functional validation and certification. Finally, the organization looked for ways of improving prioritization of investment needs. The reference model foresees such prioritization only for services and assets, but not in sufficient depth for the whole portfolio. Such portfolio decisions would have been important for matching budget with investment needs.

A problem area that was completely excluded by the reference model was the difficulty of regulated procurements. The reference model did not suggest any practice for how requirements should be specified for such procurement and for how to reduce lead time.

Some of the expected capabilities of the reference model were not adequate. The reference model had too high expectations on the handling of intellectual property. None of the interviewees perceived such a practice to be critical. The reference model recommended collaboration with supplying partners. Such collaboration is prohibited by procurement regulations for fairness reasons.

The assessment based on the SRE@HC framework and the inductive improvement potential questions was effective. The healthcare organization perceived the assessment results to be credible and initiated improvement actions. Positions for business analysts were created and a first position already publicly announced. Organization-wide process definition was launched to improve collaboration across organizational units for investment decision-making. A tooling project was launched for tracking needs and requirements, for increasing transparency of decision-making, and for identifying bottlenecks that lead to long procurement lead times.

6 Discussion

The presented case has shown that it is possible to transfer existing reference models to a domain that was not foreseen by the authors of the original model initially. The tailoring is a kind of situational adaptation [8] for transferring knowledge from one domain to another: here from software product management to strategic requirements engineering in healthcare. Understanding of how to transfer reference models extends the ability of process improvement professionals to take advantage of existing knowledge. It discourages the reinvention of yet another reference model each time a new process improvement problem is encountered and encourages consolidation of existing models instead.

The case showed that the tailoring can be performed with two simple steps: translation and evaluation of the reference model. Translation was needed to adapt the reference model to the changed organizational structure, and the roles and concepts of the new domain. Expertise in the target domains, here requirements engineering and healthcare, enabled such translation. Comparison of framework-based assessment results with inductive questions about improvement potential enabled the evaluation of the translated framework. Capability requirements that were congruent with capability needs confirmed adequacy of the reference model. Concepts that are difficult to

understand, unnecessary capability requirements, and missed improvement needs indicated needs for further tailoring of the translated reference model.

The case represents a single transfer of a reference model into a new domain. Replication of such work is needed to better understand how existing results can be effectively diffused, how evaluation results can be integrated into original models, and when the benefits outweigh the cost in comparison to invention of a new reference model.

7 Summary and Conclusions

Many process improvement domains benefit from knowledge embedded in reference models that were designed for other domains. The paper has presented a two-step process for tailoring an existing reference model to such a new domain. The process is based on translating organizational structure, roles, and concepts and on inductive validation of the prescriptions that the reference model contains.

The process has been applied for transferring best practice from software product management to strategic requirements engineering in a healthcare organization. Application of the process in the case study showed feasibility and effectiveness of the tailoring. The evaluation results showed that important process assessment needs were congruent with the structure and scope of the initial model and that the missed improvement issues could be captured with lightweight inductive questioning.

The results are a rich, empirically grounded basis for improving strategic requirements engineering also in other organizations and for transferring the knowledge captured in the software product management reference model to even other domains. Such work should be the focus of future research.

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