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Empirical evaluation of a decision support model for adopting software product line engineering

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ABSTRACT

Context: The software product line engineering (SPLE) community has provided several different approaches for assessing the feasibility of SPLE adoption and selecting transition strategies. These approaches usually include many rules and guidelines which are very often implicit or scattered over different publications. Hence, for the practitioners it is not always easy to select and use these rules to support the decision making process. Even in case the rules are known, the lack of automated support for storing and executing the rules seriously impedes the decision making process.
Objective: We aim to evaluate the impact of a decision support system (DSS) on decision-making in SPLE adoption. In alignment with this goal, we provide a decision support model (DSM) and the corresponding DSS.
Method: First, we apply a systematic literature review (SLR) on the existing primary studies that discuss and present approaches for analyzing the feasibility of SPLE adoption and transition strategies. Second, based on the data extraction and synthesis activities of the SLR, the required questions and rules are derived and implemented in the DSS. Third, for validation of the approach we conduct multiple case studies.
Results: In the course of the SLR, 31 primary studies were identified from which we could construct 25 aspects, 39 questions and 312 rules. We have developed the DSS tool *Transit-PL* that embodies these elements.
Conclusions: The multiple case study validation showed that the adoption of the developed DSS tool is justified to support the decision making process in SPLE adoption.

1. Introduction

A software product line is a set of software-intensive systems sharing a common, managed set of features that satisfy the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way [1]. Software Product Line Engineering (SPLE) is a systematic and comprehensive process that aims to develop and maintain product lines. SPLE aims to provide pro-active, pre-planned reuse at a large granularity (domain and product level) to develop applications from a core asset base.

Currently an increasing number of companies aim to adopt an SPLE approach with the goals of enhancing the quality of products, reducing time-to-market and optimizing production costs. The benefits for adopting SPLE have been extensively documented (e.g. [1–4]) and discussed in experience reports (e.g. [5–7]). On the other hand it is commonly accepted that transition to SPLE is not easy. In general, it requires large upfront investments and as such forms a serious risk if the desired return-on-investment is not achieved. To illustrate this situation, consider, for example, the following typical realistic scenario of a company:

> *The engineering group manager of an organization that builds simulation systems is in a junction. The organization has delivered a number of successful simulation system projects in the last few years. Even though the simulation systems have a lot of common features, traditionally these systems were implemented using a single systems development approach. The company is aware that the*

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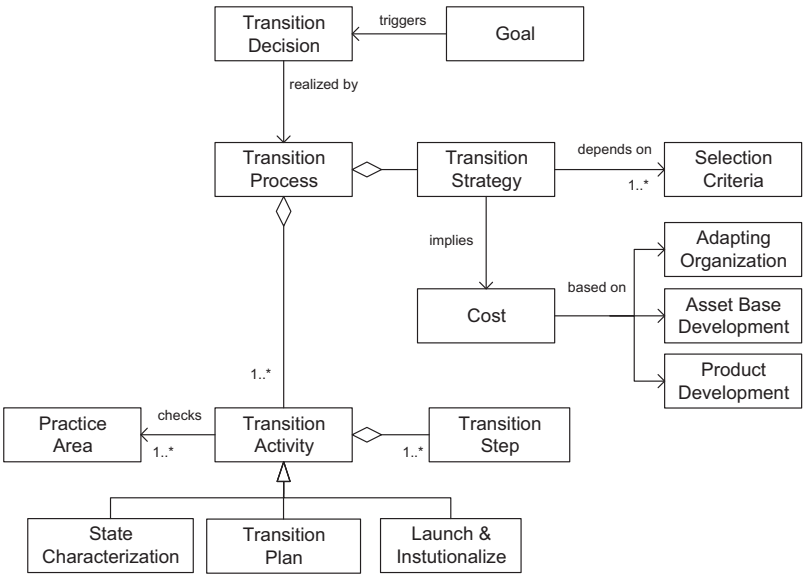

Fig. 1. Conceptual Model for SPLE Transition Process adapted from [8].

reuse potential is not used. Recently there is an increasing pressure to decrease the costs and time-to-market of these systems. The manager has heard about Software Product Line Engineering, which is adopted by some of his company's competitors and is aware of the potential benefits of SPLE. However, because of the risks associated with SPLE, it is not easy to provide a decision. After all, lots of investments need to be made and a wrong decision in this case could be dramatic. On the other hand, if a proper decision is made for the adoption of SPLE and the corresponding strategy, the risks could be mitigated and the expected return-on-investment could be achieved.

In the context of this scenario, two different decisions need to be made. First of all, it should be decided whether adopting an SPLE approach is indeed feasible for the organization. Secondly, if the adoption of SPLE is feasible, a decision should be made regarding the selection of an appropriate SPLE transition strategy. The SPLE community has provided several different approaches for assessing the feasibility of SPLE adoption and selecting transition strategies. These approaches usually include many rules and guidelines that can assist the decision maker to analyze the feasibility of SPLE adoption and select a proper transition strategy. Unfortunately, there are many different rules which are very often implicit or scattered over different publications. Even in case the rules are known, processing these rules manually is not trivial and requires lots of knowledge and experience. Hence, for the practitioners it is not always easy to select and use these rules to support the decision making process. To support the decision making process, it would be worthwhile to accumulate the rules and provide automated support to assist the decision makers.

In this paper we aim to systematically investigate and evaluate the impact of a decision support system (DSS) on decision-making in SPLE adoption. In alignment with this goal, we provide a decision support model (DSM) and the corresponding DSS, *Transit-PL*. In general DSS is a computer-based information system that supports business or organizational decision-making activities. *Transit-PL* is a DSS for supporting the decision making on product line adoption. Using *Transit-PL*, we present an empirical evaluation study that assesses the DSS via case studies. For this, we first apply a systematic literature review (SLR) on the existing primary studies that discuss and present approaches for analyzing the feasibility of SPLE adoption and transition strategies. Second, based on the data extraction and synthesis activities of the SLR, the required questions and rules are derived and implemented in the DSS. Third, for evaluating the impact of decision support on SPLE adoption and the selection of transition strategies, we have conducted a multiple case study approach with two case studies from the literature and a case study from an industrial company.

The SLR yielded 31 primary studies from which we could identify 25 aspects, 39 questions and 312 rules which are implemented in the DSS, *Transit-PL*. The case study design research includes two different types of cases related to SPLE adoption. The first type of cases is based on a retrospective analysis of two case studies in the literature; the second case discusses the qualitative analysis of a large size IT company, *CompanyX*.[1]

The remainder of the paper is organized as follows. In Section 2 we provide the background for SPLE adoption and decision support models. Section 3 presents the results of the systematic literature review for identifying the primary studies to extract the questions and rules for feasibility analysis and transition strategy selection. Section 4, presents the *DSS*, *Transit-PL* that we have developed. Section 5 describes the multiple case study design. Section 6 presents the multiple case study results. Section 7 reviews the related work and finally Section 8 concludes the paper.

2. SPLE adoption and decision support

The methodology and roadmap for switching to SPLE from a traditional way of software development is defined as adoption or transition, and an action plan for this process is called transition strategy [7]. To describe the concepts related to SPLE adoption process Fig. 1 shows the conceptual model that we have developed earlier [8]. In general, the SPLE adoption is triggered by a well-defined goal that can be either based on internal or external motivations. External motivation refers to purposes for external entities such as the push of customers to include additional features in a short time. Internal motivation for transitioning to a SPLE approach refers to improvements within the organizations, such as a need to improve the project management to meet a certain schedule. These transition goals may trigger the business unit to define the decision

[1] The name of the company has been withheld due to reasons of commercial privacy.