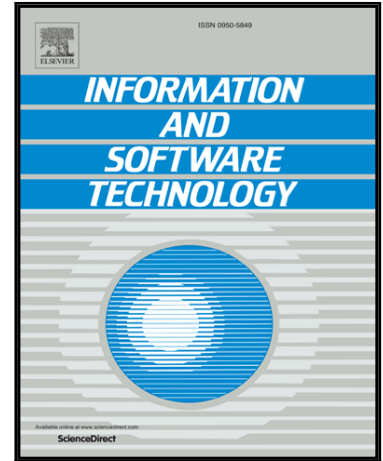# Accepted Manuscript

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Applying Process Mining Techniques in Software Process Appraisals

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Abstract

Context: Process assessments are performed to identify the current maturity of organizations in relation to best practices. Existing process assessment methods, although widely used, have limitations such as: dependence on the competencies of appraisers; high amount of effort and resources required; subjectivity to analyze data and to judge on the implementation of practices; low confidence in sampling and its representativeness. Currently, due to the increasing use of information systems to support process execution, detailed information on the implementation of processes are recorded as event logs, transaction logs, etc. This fact enables the usage of process mining techniques as a powerful tool for process analysis. It allows using a significant amount of data with agility and reliability for process assessments.
Objective: The objective of this paper is to present the development and application of a feasible, usable and useful method, which reduces the limitations of current SCAMPI method and defines how to apply process mining techniques in SCAMPI-based process assessments
Method: Research method comprises nine steps that were performed in a manner that raised questions in the first four steps were answered by the last four steps of the research design.
Results: The method "Process Mining Extension to SCAMPI" was designed, developed, applied in two cases and submitted for review by experts who judged it viable, usable, and useful.
Conclusions: As per this research, process mining techniques are suitable to be applied in software process assessments since they are aligned with the purposes of data collection and analysis tasks. In addition to that, the resulting method was judged by experts as something that reduces identified limitations of one of the most used process assessment method.

Keywords: Process mining; Software process assessment; SCAMPI; Data collection and analysis; Process Mining Extension to SCAMPI.

1. Introduction

The software development process is widely recognized as a key factor that contributes to the quality of software. To systematize software development processes, reference models are considered, since they provide a set of universally accepted best practices used as a reference for the creation of such processes. Differences between the actually performed processes and the documented processes have already been recognized by the research community [1]. In this context, the challenge is to determine how much a software process, as performed, is in accordance with the reference model. This can be done through software process assessments. Rout et al. [2] referred to process assessment as the disciplined examination of the process used by an organization in relation to a set of criteria to determine the ability of these processes to run within quality, cost and schedule goals. One of the best-known process assessment methods is the Standard CMMI Appraisal Method for Process Improvement (SCAMPI) v1.3b [3]. It is used to identify strengths, weaknesses and ratings related to the Capability Maturity Model Integration (CMMI) reference models [4].

Despite the fact that SCAMPI method is mature and, along with a CMMI model, it has been used to assess thousands of organizations worldwide [5]. Chen et al. [6], Northcutt and Paulk [7] and Margarido et al. [8] mention that process software assessments have drawbacks that typically make its execution time and resource consuming, especially in large organizations. As noted by to Chen et al. [6], process assessments are generally manual, which usually makes a simple evaluation an inefficient process; external appraisers are frequently not allowed to directly access the information due to security and privacy concerns (i.e. restriction of authority) and assessments are based on subjective evaluation, causing bias results and usually require experienced appraisers to understand specific software processes and to prepare relevant questions for interviews.

Although there are some initiatives to create "lightweight" process assessment (and improvement) methods such as Adept [9], iFLAP [10], METvalCOMPETISOFT [11] and the ones (e.g [12]) based on ISO/IEC TR 29110, studies such as Rout et al. [2] point out that the costliest activity of an appraisal is evidence collection, representing 47% of total effort. Moreover, this fact is aggravated since in an appraisal, typically only a small sample (typically less than 25% of all process instances, as per one of the author's practical experience) of the process execution is considered. It is corroborated by Northcutt and Paulk [7] who stated that process assessments typically deal with populations "*in the tens and similarly small sample sizes*". In addition, data collection and analysis techniques that consider the recent capabilities in information technology, such as data, text and process mining are not employed. The idea of process mining is to discover, monitor and improve real processes by extracting knowledge from event logs that are readily available in modern information systems [13]. Process