Towards Holistic Traceability Solution: From Systematic Literature Review to Proposed Traceability Model

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ABSTRACT

The purpose of traceability is to ensure persistent alignment of product knowledge between stakeholders, artifacts, and traceability objects. On the other hand, process knowledge is equally important to ensure a systematic software development process with accurate specification and verifiable quality attributes. Previous studies lacks in presenting a consolidated view from product and process knowledge perspectives. This study has taken a systematic literature review approach to evaluate sixty one previously published papers on traceability in leading journals and conferences. Based on the findings, the authors propose to extend the definition of an existing traceability meta-model to combine both product and process knowledge perspectives. The scope of this paper is to define the extension of the traceability meta-model without violating any of its statements. This study aims to contribute by taking steps towards defining a holistic model of traceability that will provide practical guidelines to IT practitioners in general and to process engineers in particular.

Keywords: Management Systems, Meta-Models, Requirement, Software Configuration, Traceability, Traceability Framework, Traceability Models

PROBLEM AND MOTIVATION

Traceability is considered as an important quality attribute both for plan-driven and agile software development environments (Espinoza & Garbajosa, 2011). The key purpose of traceability is to ensure persistent alignment of product knowledge between stakeholders, artifacts, and various traceability objects (Balasubramaniam Ramesh & Jarke, 2001). Also, process knowledge is equally important and refers to knowledge about the process followed in the development of the project artifacts (Mohan, Xu, Cao, & Ramesh, 2008). To be useful in the industrial setting such knowledge should be organized in the form of holistic traceability meta-model (Balasubramaniam Ramesh & Jarke, 2001; Spanoudakis & Zisman, 2005).

With radical advancements in the field of software engineering and information systems,
the paradigm also got shifted for various dynamics. The example of such dynamics includes software development methodologies, computing environments, and software improvement standards. With rising demand, complexity and sophistication of these dynamics, traceability is now considered equally important even by small and medium organizations (Durrani, Richardson, & Lenarcic, 2013).

With such dynamics, it is simply not feasible to follow the strict traceability approaches as were used in the past. In order to realize the full benefit of traceability and making it valuable and flexible, an adaptable traceability approach is required. Such a suggestion was also made by Dömges and Pohl (1998) to have a lean traceability approach in place based on developers’ innate knowledge of the system, and using existing artifacts.

According to Spanoudakis and Zisman (2005), no matter how sophisticated and modern a given traceability solution is, it cannot be called as effective unless it is tailored according to the needs of specific projects and organizations. At present there is a lack of methodological support for identifying these needs and using them to inform traceability adoption and deployment strategies (Spanoudakis & Zisman, 2005). Also lack of tools and environment capabilities to support all sort of artifacts and traceability relations is identified as one of the main reasons for its limited use in industrial settings (Spanoudakis & Zisman, 2005). Past studies have raised the need to establish such traceability solutions by incorporating management process. (Bendix, Magnusson, & Pendleton, 2012; Bendix & Pendleton, 2012; Capilla, Dueñas, & Krikhaar, 2012; Lanubile, Ebert, Prikladnicki, & Vizcaíno, 2010; Balasubramaniam Ramesh & Jarke, 2001)

Motivated by the need to establish holistic traceability model covering both product and process knowledge perspectives, this research opted to extend the definition of the traceability meta-model as developed by Balasubramaniam Ramesh and Jarke (2001).

**RESEARCH METHOD**

Systematic reviews have been gaining significant amount of attention from information systems and software engineering researchers (Dybå & Dingsøyr, 2008; B. Kitchenham et al., 2009; Pedreira, Piattini, Luaces, & Brisaboa, 2007). The main reason for its adoption is its improvement of quality of the resources covered in the subject of interest in comparison with its less formal counterparts (Magdaleno, Werner, & Araujo, 2012).

According to (Brereton, Kitchenham, Budgen, Turner, & Khalil, 2007; Magdaleno et al., 2012), a systematic literature review is a type of secondary study with its basis in previously published research. The aim of this research methodology is to gather, evaluate, and analyze all the available literature relevant to a particular research question, topic area, or phenomenon of interest (B. A. Kitchenham & Charters, 2007). Systematic literature review follows a strict, well-defined sequence of methodological steps to yield high scientific value and reliable results (Magdaleno et al., 2012).

As stated by Brereton et al. (2007), performing a systematic review involves several discrete activities, and can be grouped in three phases as, 1) plan review, 2) conduct review, and 3) document review. In phase 1, the researcher identifies the objectives, research questions, and develops the protocol for the study. During phase 2, execution is performed by searching the defined publication resources, and the evaluation of the studies identified according to the protocol in phase 1. The relevant data is extracted from the selected papers and synthesized (Magdaleno et al., 2012). Phase 3 reports the results of the review. The 3-phase systematic review process can be further subdivided into overall 10-state review process and is described in detail in Brereton et al. (2007).

For the purpose of this paper, next two sections will only provide the summary of the first two phases and it will be reported in detail in another publication. For phase three, we described the results and identified the gap in the current literature on traceability.
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