

# Chapter 7

## Supporting Conceptual Model Analysis Using Semantic Standardization and Structural Pattern Matching

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### **ABSTRACT**

*Analysis of conceptual models is useful for a number of purposes, such as revealing syntactical errors, model comparison, model integration, and identification of business process improvement potentials, with both the model structure and the model contents having to be considered. In this contribution, we introduce a generic model analysis approach. Unlike existing approaches, we do not focus on a certain application problem or a specific modeling language. Instead, our approach is generic, making it applicable for any analysis purpose and any graph-based conceptual modeling language. The approach integrates pattern matching for structural analysis and linguistic standardization enabling an unambiguous analysis of the models' contents.*

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## INTRODUCTION

Conceptual models are a common way of documenting requirements and system design in projects addressing the reorganization and development of information systems (IS) (Kottemann & Konsynski 1984). As IS projects are often large-scaled, the required models are increasingly developed in a distributed way in order to increase the efficiency of modeling (vom Brocke & Thomas, 2006). In such cases, different modelers participate in the modeling process developing sub-models – potentially at different places and at a different time. Empirical studies show that such models can vary heavily concerning naming and structure (Hadar & Soffer, 2006). However, even models developed by a single person might include semantic and structural ambiguities if s/he does not follow any explicit modeling conventions (Delfmann, Herwig & Lis, 2009b). Trying to analyze such models, comparison conflicts can occur, which are commonly divided into *naming (semantic) conflicts* and *structural conflicts* (Batini & Lenzerini 1984).

In Figure 1, we present examples of a semantic and a structural conflict as well as a combination of both of them. (1a) depicts two structurally equivalent models, which include different vocabulary and phrasing. Two interpretations are possible. On the one hand, both models might depict the same real-life situation with structurally corresponding element names being semantically equivalent. The differences could result from the lack of semantic standardization. In this case, the terms “bill” and “o.k.” would be synonyms of “invoice” and “valid” correspondingly. On the other hand, the two models could depict different issues and the structurally corresponding names could represent semantically different things. The only chance to find out which situation is the case is to discuss the differing semantics with the modeler(s) involved. Thus, an automated analysis is not possible. (1b) depicts two models, which already apply standardized corporate vocabu-

lary disallowing for naming conflicts. However, although these models potentially represent the same real-life issue, they involve different but in this case synonymous modeling structures. When trying to analyze (and compare) these models, we need to take account of the relation between synonymous structural patterns, such as the two depicted here. In (1c), two models involving both semantic and structural conflicts are presented. Besides using proprietary vocabulary (e.g., “component” vs. “part”), the model on the right-hand side has a higher level of detail than the left one, although both depict the same real-life situation. To sum up, due to semantic and structural conflicts performing a consistent analysis might pose an extremely laborious task.

The analysis of conceptual models addresses different goals. For example, single conceptual models are analyzed using typical error patterns in order to check for syntactical errors or potential problems (Mendling, 2007). In the domain of Business Process Management (BPM), process models’ analysis helps identifying process improvement potentials (Vergidis, Tiwari & Majeed, 2008). For example, applying structural model patterns to process models can help revealing changes of the data medium during process execution (e.g., printing and subsequently retyping a document), redundant execution of process activities, or application potentials of software systems. In most cases, where modeling is conducted in a distributed way, subsequent integration is necessary to obtain a coherent model. To find corresponding fragments and to evaluate integration opportunities, multiple models – generally of the same modeling language – are compared with each other applying structural model pattern matching (Gori, Maggini & Sarti, 2005). Semantically equivalent (or at least similar) structures are defined as corresponding patterns, which allows for identifying related model fragments. This way, structural pattern matching provides decision support in model analysis and, in particular, integration. Model patterns have already been

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