Available online at www.sciencedirect.com
SCIENCE DIRECT®
Data & Knowledge Engineering 55 (2005) 243–276
DATA & KNOWLEDGE ENGINEERING
www.elsevier.com/locate/datak

Theoretical and practical issues in evaluating the quality of conceptual models: current state and future directions

Daniel L. Moody *

Department of Computer Science, University of Iceland, Reykjavik, Iceland
Gerstner Laboratory, Czech Technical University, Prague 13000, Czech Republic

Received 14 December 2004; accepted 14 December 2004
Available online 12 January 2005

Abstract

An international standard has now been established for evaluating the quality of software products. However there is no equivalent standard for evaluating the quality of conceptual models. While a range of quality frameworks have been proposed in the literature, none of these have been widely accepted in practice and none has emerged as a potential standard. As a result, conceptual models continue to be evaluated in practice in an *ad hoc* way, based on common sense, subjective opinions and experience. For conceptual modelling to progress from an "art" to an engineering discipline, quality standards need to be defined, agreed and applied in practice. This paper conducts a review of research in conceptual model quality and identifies the major theoretical and practical issues which need to be addressed. We consider how conceptual model quality frameworks can be structured, how they can be developed, how they can be empirically validated and how to achieve acceptance in practice. We argue that the current proliferation of quality frameworks is counterproductive to the progress of the field, and that researchers and practitioners should work together to establish a common standard (or standards) for conceptual model quality. Finally, we describe some initial efforts towards developing a common standard for data model quality, which may provide a model for future standardisation efforts.

* Current address: Department of Computer Science, University of Iceland, Reykjavik, Iceland, 107.
E-mail addresses: dm@hi.is, dmoody@labe.felk.cvut.cz

0169-023X/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.datak.2004.12.005

Keywords: Conceptual model; Software quality; Measurement; Requirements analysis; Quality management; Standardisation; Technology transfer; Empirical validation

1. Introduction

1.1. Conceptual modelling

Conceptual modelling is the process of formally documenting a problem domain for the purpose of understanding and communication among stakeholders [118]. Conceptual models are central to IS analysis and design, and are used to define user requirements and as a basis for developing information systems to meet these requirements [131]. More generally, they may be used to support the development, acquisition, adaptation, standardisation and integration of information systems [82]. Conceptual modelling may be used to define user requirements at several different levels:

- Application level: an application-level model defines requirements for a specific information system and provides the basis for developing or acquiring a system to meet those requirements [6].
- Enterprise level: an enterprise model defines information requirements for a whole organisation and provides the basis for enterprise-wide management of data or business processes [117].
- Industry level: a reference model defines information requirements for an entire industry and provides the basis for industry-wide standardisation and development of generic software solutions [2,39].

Conceptual modelling naturally belongs as a subdiscipline of *requirements engineering* (as conceptual models are used to define user requirements) and *software engineering* (as conceptual models are used to develop, acquire or modify information systems). Some might argue that conceptual models are not necessarily used to develop systems and should be evaluated as representations of the "real world" [131]. This paper takes the *critical-realist* view that conceptual modelling is a design discipline and that conceptual models are design artifacts used to actively *construct* the world rather than simply describe it [59,120]. In practice, almost all conceptual models are used directly or indirectly to develop, acquire or modify information systems.

1.2. Why conceptual model quality is important

The traditional focus of software quality has been on evaluating the final product [9,126]. However empirical studies show that more than half the errors which occur during systems development are requirements errors [1] [37,73,85]. Requirements errors are also the most common cause of failure in systems development projects [37,121,122]. The cost of errors increases expo-

[1] A requirements error is defined as where the requirements specification does not match actual user requirements. A design or implementation error is defined as where the design or implementation does not match the requirements specification [73].