# Chapter 4
# Semiotic Evaluation of Product Ontologies

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## ABSTRACT

*Product-related information can be integrated with the help of a product ontology, which can provide consensual definitions of concepts and inter-relationships relevant in a product domain of interest. A product ontology is either given by a third party or results from ontology engineering. In both cases, the problem is how to assess its quality, and then select the "right" ontology. This chapter: (1) proposes a metrics suite for product ontology evaluation based on semiotic theory, and (2) demonstrates the feasibility and usefulness of the metrics suite using a supply chain model. The contribution of this research is the comprehensive metrics suite that takes into account the various quality dimensions of product ontology.*

## INTRODUCTION

Product-related information is of paramount importance in many inter-organizational applications, since it concerns goods and services being procured, manufactured and sold to customers. Due to the involvement of multiple organizations, there is a need for integrating product-related information, e.g., by standardization or mediation. In the past years, *product ontology* has attracted both industry and academia because of its potential contribution to solving integration problems. Major fields of application are e-commerce (Shim & Shim, 2006), product engineering (Yoo & Kim, 2002), and product life-cycle management (Matsokis & Kiritsis, 2010). A product ontology provides, at least to some extent, consensual definitions of concepts and inter-relationships between these concepts in a product domain of interest. Most product ontologies define a hierarchy of product classes and respective properties for describing product instances. Such ontologies may support

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finding and comparing products being offered by multiple suppliers and described in distributed data sources, or allow for benchmarking the procurement activities of organizational units (Doring et al., 2006). Ontology users are required to annotate their product instance data accordingly.

Product ontologies have already emerged in diverse industries and for various tasks. However, assessing the quality and suitability of a given product ontology, i.e., to what degree it actually meets user requirements, remains a critical question for potential ontology adopters. This question is the focus of *ontology evaluation*, which aims at providing metrics reflecting the ontology's quality and suitability. There is great difficulty in determining what elements of quality to evaluate. In other words, what factors should be considered in evaluating product ontology quality? Current research yields a number of approaches, metrics, and tools for automatically evaluating ontologies; for an overview, see (Vrandecic, 2009). However, most of this research originates from the Semantic Web arena, and therefore relies mainly on the expressiveness of ontology languages such as DAML (DARPA Agent Markup Language) and OWL (Ontology Web Language); hence their scope is constrained by these languages and does not take the specific setting of product ontology into account.

Very often, an ontology is regarded as an artifact used by a community as a common vocabulary without considering the organizational properties of the respective community and thus the interrelations within the community (Zhdanova et al., 2007). For example, a community that often uses product ontologies is made of entities belonging to a supply chain. A supply chain is a system of entities participating in producing, transforming, and distributing goods and services from supply to demand. A single product ontology is thus used within supply chains and determining its quality and suitability has to consider the supply chain characteristics, e.g., by distinguishing different roles such as manufacturer and distributor. A major trend affecting supply chains is individualization, caused by customers demanding individualized products, which are tailored to their specific needs (e.g., custom-made products) (Coates, 1995) (Kirn, 2008). For instance, enabling customers to order custom-made shoes via an e-commerce application does not only concern the e-commerce firm but also the stakeholders in the respective supply chain (e.g., manufacturer and its suppliers). Here, a product ontology may help provide a common terminology and means of describing products along the entire supply chain.

In the context of supply chain and individualization, a product ontology should emphasize the importance of quality metrics that allow the assessment of product complexity in terms of richness of product description and product structure, and how the final product is composed of individual parts. Current evaluation metrics do not take these factors into account: Domain-independent metrics are not able to exploit the domain characteristics (e.g., Yao et al., 2005), whereas domain-specific evaluation metrics regard products as single and atomic items without considering existing interrelations that arise due to supply chain structures and customer requirements (e.g., Hepp et al., 2007). To overcome this limitation, we address product ontology evaluation on a broader scale by taking a semiotic perspective. Semiotics studies the properties of signs; for our purposes, it can provide a theoretical basis for distinguishing generic categories of quality. We define evaluation metrics based on Stamper's et al. (2000) semiotic framework and adopt the domain-independent semiotic metrics suite proposed by Burton-Jones' et al. (2005).

The objectives of this research are to: (1) develop a semiotic set of metrics that allow for assessing the quality of product ontologies, and (2) apply the metrics to two commonly available product ontologies to demonstrate the feasibility and usefulness of the metrics suite. The contribution of this research is the comprehensive metrics suite that takes into account the various quality