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A domain ontology for construction concepts in urban infrastructure products

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ABSTRACT

Domain ontologies are the cornerstone of informatics systems. Like their philosophical counterparts, they aim at providing a shared representation (language) for the concepts within a domain of knowledge. Ontologies are related more to knowledge representation rather than reasoning. Consequently, they normally can be complemented by artificial intelligence tools to enhance their decision support capabilities. This paper presents an ontology that is an abstract (yet extendable) philosophical (yet practical) conceptualization of the essence of knowledge that relates to construction aspects of infrastructure products. A product is the outcome of any work process and includes physical products, decisions, abstract knowledge and knowledge items generated based on all of these. A set of related constraints, mechanism, actors and process are identified along with these products. Product attributes and modalities are also presented to help describe the behavior of these products and support the generation of types or classes of these products.

1. Introduction: the dawn of e-city

The realization of e-city (cities that exploit information technology) is a necessary component for green-city. In other words, we cannot build 21st century cities without coherent business-savvy and human-oriented informatics solutions. One of the key domains where information technology can support e-city is the management of civil infrastructure systems in a sustainable way. Sustainability is a multi-disciplinary domain (encapsulating engineering, environmental, economic and social sciences). It relies on knowledge and human wisdom as much as it relies on data and information. Moreover, given that the concepts of sustainability are relatively new, it is impossible to allocate all required "human" expertise in one place, hence sustainability analysis is by default "networked". In fact, the desire for sustainable development along with globalization and the emergence of knowledge economies are reshaping infrastructure as a global e-industry. Soon, virtual enterprises and "knowledge products" (in the form of web services) will flourish as valuable commodities in a new e-market for civil infrastructure.

This triggers discussions (and concerns) about the suitability of our knowledge management systems in the urban infrastructure domain to the demands of the globalized knowledge economy. Case after case, the massive and complex nature of rebuilding our urban environment is magnifying the inefficiencies in the current approaches: focus on short term costs (in contrast to life cycle costing); lack of coordination and sporadic project developments (in contrast to coherent integrated development); limited community engagement; inadequate tools for quantifying sustainability-related costs; and lack of mechanisms to harness, use and share knowledge.

Knowledge can be seen as spanning three spheres: software (means for static capture of knowledge), work processes (reflection of best practices and value generation), and human judgment (the wisdom/intelligence of human experts). It is sad to notice that except for the software facet, knowledge management practices in the infrastructure domain have lagged almost every other industrial sector. Extensive work has been dedicated to achieve interoperability in the software sphere. For example, XML and data exchange standards (such as industry foundation classes-IFC) have been introduced to address data interoperability problems in the domain. However, there is very limited application of business process management (BPM).

More alarming, communication protocols in the industry are normally based on verbal or paper-based techniques. While, the advancement of social networking and is emphasizing the role of human communication alongside computer-based systems, current information systems in the domain focus on data handling and utilize database-driven applications. Such systems are static in nature and cannot support the varying subjective nature of a decision situation [1]. Moreover, information is spread amongst several organizations. Even though a good part of such information is represented in GIS-based systems, they usually lack interoperability.

It is argued that what we need at this stage is the development of a fundamental model that facilitates (philosophical and linguistically) representation of infrastructure knowledge (not just data or

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