A framework for ontology-based design assessment for human behaviour during fire evacuation

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Abstract. The current procedures in assessing fire performance designs are costly and inefficient, as they require the preparation and analysis of several scenario models, which may change at every design iteration. To address this, this paper presents a way to leverage BIM model data using OWL ontology tools to integrate, automate and provide feedback to the design decision-making process. The paper introduces methodologies from research which are relevant to the presented concept, then expands on a problem identification section, arguing why crowd simulation analysis might also benefit the ontology-based approach. The core emphasis of the paper is the framework required to achieve the process where ontology rules, reasoning and inference are leveraged from existing IFC models, with minimal user input. The framework consists of several components which are described independently, based on a system currently under development. A use case presents the practical flow of the process and some of its requirements and limitations.

1. Introduction

With the gradual increase of interoperable tools and the proliferation of the IFC format, BIM centric design and management has led to the use of BIM and IFC as a means to assess code-compliance in performance-based design (Eastman et al. 2009). However, most of the tools and methods are less suitable in performance-based design situations, where the regulation process needs to include modelling assumptions such as data input and their sources, as well as the analysis results. Conventionally, these factors are usually at the discretion of the designer, based on personal and professional judgement and knowledge. In this sense, we aim to explore how more advanced information formats which support basic semantic reasoning can fill this gap, by adopting ontologies as tools to integrate information, automate the processes and provide adequate feedback. Several studies have already adopted similar methodologies when considering either rules checking or other building performance design criteria, which will be presented and discussed, along with the reasons we believe ontologies can leverage BIM information.

This paper aims to identify how semantic web applications can be used to integrate and automate the performance based design for safe fire evacuation. Based on this, the methodology we adopted looks to: a) identify the problem with fire escape design analysis and rules checking and b) propose a framework which describes the process of using semantic linked data and reasoning for performance based design of human behaviour analysis. A short use case example is presented at the end.

2. Related work

Pauwels et al. 2011 is one of the pilot studies investigating the capabilities of semantic web rule checking, applied to acoustic building design. They state that limitations in the IFC schema expressivity of concepts are overcome by an ontology approach. Another pilot study on using ontology tools is Scherer and Schapke 2011, which describes a framework for using ontologies