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Integrating BIM and Social Networking Technologies using Semantic Web

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Introduction

Over the past few years, several studies have been focused on solving the interoperability and information sharing issues in AEC-FM industries. Building Information Modeling (BIM) has made a great impact on AEC-FM by providing a shared virtual model of the project that includes 3D and non-geometry information. However, BIM technologies are still under research and development. For example, performing a search in Google scholar for the exact phrase "Building Information Modeling" reveals that at least 5060 papers are published in this area since 2016 to the date of writing this paper. One of the major research challenges in the area of BIM is the interoperability issues between several domains because of different software packages and database management systems. Data are stored in heterogeneous data formats which make it difficult to merge and integrate data from different domains.

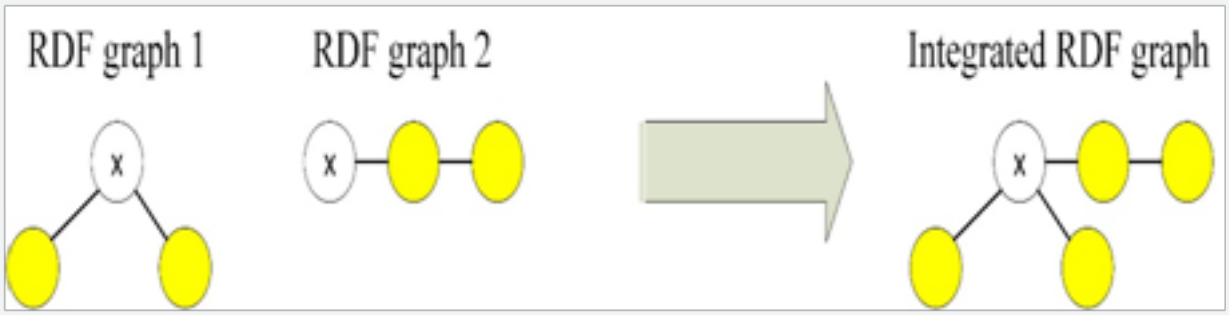

Figure 1: Integrating RDF graphs of data.

Semantic Web technology Semantic Web [1] is designed to solve the interoperability issue and allow information integration between several domains. Semantic Web uses RDF triples to store data which means that data are stored in graph data structure where nodes are instances of data that are pointing to other nodes. In the Semantic Web, each instance data has a globally unique identifier referred to as a Uniform Resource Identifier (URI). When a data with a unique URI is repeated in different locations and different graphs of data, computers can easily merge graphs of data. Figure 1 shows this visually. In Figure 1, circles are instances of data that are connected to each other with lines. x is an instance data with the same URI repeated in two different graphs of data.

A number of studies have used RDF data integration capabilities in AEC-FM projects [2-9]. However, one of the major challenges still remaining is that project participants need to find each other, interact and collaborate with each other to make the information integration possible. They need to ask for information and ask for clarification from each other. In a construction project, a large number of individuals are involved (sometimes a few thousands). These individuals work for different organizations at different locations and at different times. Therefore, it is very difficult for them to find, contact and/or have meetings with each other for every single task. An earlier study Niknam & Karshenas [7] suggested the use of virtual social networking in AEC projects. They presented a social networking website that is connected to a semantic knowledge base in the backend. The semantic knowledge base uses RDF data structure and allows project participants add their knowledge to the knowledge base in a way that can be merged with other project participants' knowledge of the project. They define the

main characteristics of a construction project social networking website as:

1. Open participation
2. Fast virtual group formation
3. Semantically-defined information
4. Storage and retrieval mechanism for fast access to information
5. Information privacy

At the time that Niknam & Karshenas [7] was published, there was not enough publications explaining how to convert BIM data to a semantic format. Later, Niknam and Karshenas presented approaches to convert BIM [8], cost estimating and material supplier [3,9], energy analysis [6] and scheduling [4] data to RDF/OWL format. Now that the methodologies to convert different domain data to RDF/OWL are defined, we have extended the knowledge base scope to include all those data. The social networking website in this study is connected to the new knowledge base with BIM, cost estimating, material supplier, scheduling, and energy analysis data ontologies (data schemas).

This makes it possible for project participants to add their knowledge to the knowledge base in different domains and solve project problems together as a team. If one wants to request for information or ask for clarification, they can use virtual social interactions. Project participants can easily form virtual group conversations to discuss different project issues. If one wants to mentions a specific data (e.g. a BIM element) in their conversation, they can mention its URI. When other users click on the URI, system displays all relevant data about that URI (e.g. element dimensions, material properties, supplier, scheduling, and cost estimating data). Therefore, everyone has access to the same data when discussing it. Virtual group conversations can happen in real time or if one is busy, they can contribute at their preferred time.

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