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AN ONTOLOGY TO ENABLE SEMANTIC BIM-BASED DATA QUALITY ASSURANCE AND QUALITY CONTROL

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Abstract: Quality assurance (QA) and quality control (QC) are two central and concurrent processes for data quality management. Together, they enable construction project participants to ensure high quality output by meeting client requirements and complying with a range of building regulations. QA is a proactive process used iteratively from the beginning of the project, while QC is reactive to be triggered to verify the product quality regarding the delivery requirements. When implemented in a BIM strategy, QA-QC aim at ensuring the quality of BIM data throughout the entire lifecycle of a construction project (Leygonie, et al. 2022).

Over the last fifty years, several research works, methodologies and tools have been developed to optimise QA-QC processes and automate their execution, thus avoiding manual, time consuming, and error-prone implementation which can result in financial losses and project failure (Doukari et al. 2022). Most of these approaches have relatively succeeded, in different domain applications, to satisfy a set of desired compliance checking characteristics and enable syntactic data quality checks, such as data (objects, relations, attributes and values) completeness, structure and naming verifications. However, to the best of our knowledge, there is no comprehensive framework for data quality validation which proposes efficient semantic QA-QC processes that should automatically enable semantic compliance checking, such as data relevance, and ensure the overall accuracy of the project data. Conventional practice still consists in involving human experts while conducting semantic QA-QC processes. Moreover, there is little research that addresses how QA-QC can best be coupled and used with Artificial intelligence (AI) technologies to optimise and develop more effective strategies for better project data management (Sacks et al. 2019).

A combination of BIM and AI could exploit the massive and increasing amount of data and knowledge (e.g., project feedback, domain expertise) that are increasingly obtainable. A prerequisite for doing so is the development of a dedicated ontology that would enable the formalisation of domain knowledge, including associated concepts, relations, and constraints that are specific to QA-QC processes (Amorocho and Hartmann 2021). This knowledge is acquired directly or indirectly from domain experts in different expertise areas. Furthermore, ontologies enable process automation and tools development as they provide a machine-readable representation of knowledge.

This project proposes the development of a QA-QC ontology to support BIM-based projects and ensure both syntactic and semantic high quality BIM data. Also, it aims at demonstrating the ontology application by developing a knowledge-based system for application within the context of a new construction which is

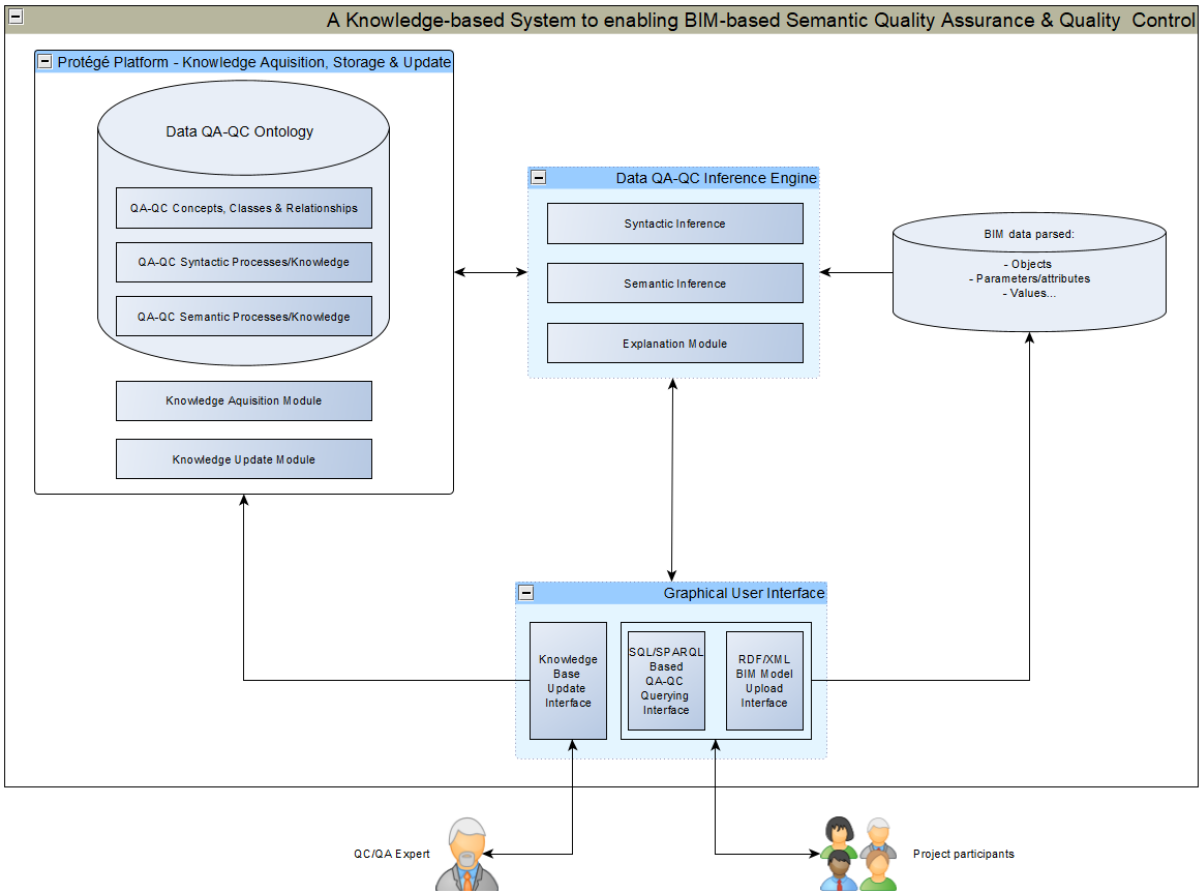

Figure 1- QA-QC Knowledge-based System Architecture

the 'ETS Pavilion F' project in Montreal. Knowledge-based systems are known to be 'intelligent' due to their inherent ability to mimic the human decision process while reasoning and using domain specific knowledge (Doukari and Greenwood 2020). The digital tool proposed (Figure 1) will provide support to project participants lacking QA-QC knowledge, and so substitutes for human experts. In addition, this system will be equipped with learning capabilities so that its knowledge can be updated and extended continuously.

Keywords: QA & QC, ontology; artificial intelligence; knowledge-based system; Protégé platform; automated compliance checking; ETS pavilion F project; BIM One

References

Amorocho, Jerson Alexis Pinzon, and Timo Hartmann. 2021. 'Reno-Inst: An Ontology to Support Renovation Projects Planning and Renovation Products Installation'. Advanced Engineering Informatics 50 (October): 101415. https://doi.org/10.1016/j.aei.2021.101415.

Doukari, Omar, and David Greenwood. 2020. 'Automatic Generation of Building Information Models from Digitized Plans'. Automation in Construction 113 (May): 103129. https://doi.org/10.1016/j.autcon.2020.103129.

Doukari, Omar, David Greenwood, Kay Rogage, and Mohamad Kassem. 2022. 'Object-Centred Automated Compliance Checking: A Novel, Bottom-up Approach'. Journal of Information Technology in Construction (ITcon) 27 (17): 335–62. https://doi.org/10.36680/j.itcon.2022.017.

Leygonie, Romain, Ali Motamedi, and Ivanka Iordanova. 2022. 'Development of Quality Improvement Procedures and Tools for Facility Management BIM'. Developments in the Built Environment 11 (September): 100075. https://doi.org/10.1016/j.dibe.2022.100075.

Sacks, R., Tanya Bloch, Meir Katz, and R. Yosef. 2019. ‘Automating Design Review with Artificial Intelligence and BIM: State of the Art and Research Framework’. Computing in Civil Engineering 2019. https://doi.org/10.1061/9780784482421.045.