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# Engaging building automation data visualization using Building Information Modelling and Progressive Web Application

**Extended abstract:** This paper presents a framework for efficient development an interoperable visualisation of a building digital model through an intuitive interface, for the improvement of the Building Lifecycle Management (BLM). The framework implemented as a case study, where multiple rich visualisations of buildings in Kanta-Häme region were constructed using their construction floorplans and building automation data. "Digital Twin", in the scope of building automation development, is a concept related to a physical structure's digital representative carrying real-time properties of the original copy, and thus, the implementation of such is considered to be beneficial and to gradually raise the premise's asset value in terms of operation. In the BLM process, different tasks such as ambient conditions monitoring, maintenance, occupant feedback collection etc., are necessary and would be labour intensive without proper use of digitalization and ICT. Therefore, having an effective building visualisation utilising the 'Digital Twin' principle would deliver a significant improvement on the BLM process, ensuring the effectiveness benefits achieved by automation processes. Nevertheless, to effectively deliver key insights from the collection of data as an accurate reflection of a building, a need for a systematic approach to the development of a meaningful and engaging visualisation is raised.

The aforementioned approach could be accomplished first by creating a digital model from the Building Information Modelling (BIM) process. BIM offers a global view and an integrative collaboration of a construction project, both in pre- and post-occupancy period. In other words, BIM is a multi-disciplinary combination of various shareholders, e.g. architecture, engineering, construction and operation (AECO). Three-dimensional (3D) models of occupied buildings usually require their latest two-dimensional (2D) drawings, i.e. from renovation or modernisation, from architectural to structural, from its surroundings to its interior organization, etc. However, in many cases those documents are not all available, and, as more information is given, the more detailed the model can be. For constructing a minimal BIM model, at least the

floorplan, elevation, and cross-section drawings are needed, following which the model can be utilised for different purposes. For example, BIM applications in simulation and visualisation have been proven to be versatile in the era of digitalisation - where fragmentation in information collection is minimised and multi-purposed optimisation enables the improvement building performances.

After a successful BIM process, the building model and its data can then be utilised for constructing a user interface as a "Progressive Web Application" (PWA). The term refers to a fast, reliable, and engaging web application (app). In other words, this app is expected to function and perform reliably across multiple devices to provide an enhanced user experience for better engagement/ re-engagement, without being affected by poor network conditions. For this reason, web-based applications' competence level has increased in recent years against their native, desktop counterparts. At a consumer level, the JavaScript React framework was chosen for the development process for its built-in flexibility. The interface application was then developed; the building data was filtered and organised in a user-oriented manner. It is worth noticing, that without the help of the Internet of Things (IoT) technology, this web-based application approach would have become much more challenging and even impossible. Modern IoT sensors and communication protocols development has allowed more reliable and accurate measurements in variant fields, resulting in the enhancement of building metric collection. In addition, the usage of protocol combination such as OPC-DA, OPC-UA and MQTT provides a standard to ensure a seamless connection between the web and various arbitrary devices from different providers.

The case study involved the visualisations of two buildings in Hämeenlinna city, one of which already had an extensive model and the other only had floorplan drawings. Different indoor conditions were measured and collected from the building automation system and additionally installed sensors. In the preliminary stages,

essential building data such as temperature, humidity level, CO<sub>2</sub> level, etc. were collected. By constructing engaging interfaces, building-related data was successfully displayed, while constant feedback from buildings' occupants and operators were gathered to improve the application further. Future developments include enhancement of the user interface to ensure a natural user experience (UX) and deep automation of the process to systematically generate the PWA from data model and building architecture collection.

**Keywords:** Progressive Web Application, Building Information Modelling, Building Lifecycle Management, Simulation, Visualisation.

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