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Study the link between the level of automation and the levels of sustainability, to manage efficiently the facilities system of a building

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Abstract:
The integration of technological advances, such as the automation of processes to the built environment are required to increase the levels of sustainability. Nowadays, the studies integrating both concepts still needing further research to take advantage of the computational advances. This research pursues to link automation and sustainability to diminish the negative impacts of the building industry; for that reason, a methodology is expected to be created for integrating both concepts, in this case, studying the facilities systems of a building during its operational stage. The results awaited include the production of 5 scientific papers studying the different phases of the research. With this, an enhancement of the sustainability levels in the built environment are expected as contributions to the science, as well as an optimized utilization of the automation strategies that can be applied to buildings.

Keywords:
Digital Twin, BIM, Automation, Sustainability, Facilities Systems.

1 Introduction

The combination of automated systems in the built environment present deficiencies, especially in the transference of data for real-time simulations between the physical and the digital models (Yoon 2022). Also, representing the Facilities System in a BIM environment is difficult since there is not a common data environment, avoiding a correct management (Soliman et al. 2022; Marzouk and Zaher 2020). Likewise, there is a lack of BIM applications for estimating the service life of the facilities systems in a building during its operational stage (Jing et al. 2019; Yan et al. 2020). Lastly, managing digital and physical assets demands a high capacity to handle data for a proper synthesis; however, there is a lack of intelligent control algorithms; difficulties to integrate devices using IoT with logistics; deficiencies in correct programming; absence of common standards and governability; and insufficient correct solutions (Zhang et al. 2021; Shikhli et al. 2022).

It has been identified that several automated solutions do not lead to sustainable practices, it could be caused by the fact that the concepts of automation, creation of digital twins, BIM modelling, creation of smart algorithms using artificial intelligence, virtual reality and so on, show a lot of troubles since they still on development. Then, this research question is: to what extent the automation strategies in facilities systems of a building lead to sustainable solutions for the decision-making process during its operational stage? Considering this, the objective stated for this research is to study the link between the intelligence of smart devices by using algorithms and optimization formulas, with the level of automation presented in different devices, to obtain high levels of sustainability when managing the facilities systems of a building during its operational stage.

This research is necessary since there is a need to increase the levels of sustainability worldwide; the construction industry is one of the most contaminant industries in the world, and the buildings are responsible for the emission of greenhouse gases and the consumption of resources. The facilities systems are one of the less studied building systems in terms of automation and intelligent management and control; if studied, an optimized management would bring difference in the operational and maintenance regime, preventing the systems to fail by detecting problems, and increasing its service life. The advances in technology and the crescent popularity of automation sets a scenario where it is possible to think that automated solutions can be implemented in the construction industry to improve the current reality.

2 Research Methodology

To accomplish this research, the first step is to execute a literature review to understand the matter; then, a proposal of methodology is expected to stablish a relationship between automation and sustainability concepts; and finally, a validation process to determine the correctness of the methodology proposed.

2.1 Literature Review

In the first phase, several articles would be evaluated to obtain the most valuable knowledge about sustainability, automation, digital twin, facilities management, and BIM environment, and to understand how they are related, as accomplished by (Feng and Wan 2022; Cho and Choi 2020). Then, it would be necessary to organize the information to develop the integration between the abovementioned matters.

2.2 Proposal of Methodology

With the information already organized, the next step is to create a methodology, which would validate the integration between sustainability, automation, digital twin, facilities management, and BIM environment.

2.3 Validation Process

The validation process would be obtained by applying the proposed methodology in a real building, focusing on the water and energy systems; also, the development of its digital twin, which will be necessary to execute the studies of measuring the levels of sustainability and automation. In this case, a proper process of digitalization would be accomplished to model the facilities system of the existent building. It is expected the utilization of drones, cameras, scanners, thermometers, sound meters, and so on. It will be employed the software REVIT as the environment to develop the digital twin.

A common platform of integration within the BIM environment will be utilized to achieve an accurate communication between the physical and the digital models. With the “current model” properly modelled, the next step is to determine the sustainability and automation levels. The automation level will be obtained by identifying how many automated solutions exist for managing the facilities systems in the building; and the sustainability level is going to be determined by the following the methodology of Life Cycle Sustainability Assessment, applied to the facilities systems.

It is expected to rectify the management process of the current model by applying artificial intelligence algorithms to improve the performance of the facilities systems. The automation and intelligence growths when more smart solutions are included in the process of management.

Finally, it is necessary to observe again the levels of automation, intelligence and sustainability accomplished, this time in the “new model”; it would be necessary to compare the results with the levels in the previous model, to prove if it is possible to obtain real facilities systems

presenting higher automation and sustainability levels, greater than the earlier ones. To understand graphically the methodology expected to be applied in this research, a flowchart was constructed and shown in Figure 1.

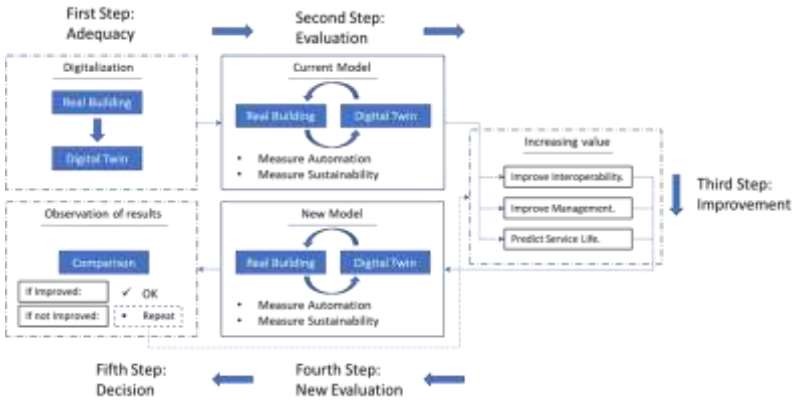

Figure 1: Expected methodology of the research.

3 Expected Results

First and second steps in the Figure 1, are part of the "Evaluation" stage. It is expected that this stage finishes in February 2024, and would lead to the production of two papers: the first one is a systematic literature review; the second one, to propose the methodology of interoperability. The third step is part of the "improvement" stage. It is expected to finish in August 2024, and that they yield two more papers: one to improve the performance of the facilities system by using artificial intelligence; and the other attending the prediction of the service life of the facilities system of the building. Finally, the fourth and fifth steps are part of the "Results" stage. In here, the obtention of the outcomes from the abovementioned measurements, expected to end by December 2024 would lead to the execution of one more paper comparing and analysing the results.

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