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Implementation of Building Information Modelling to Monitor, Assess, and Control the Indoor Environmental Quality of Higher Education Buildings

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Abstract : The landscape of Higher Education (HE) institutions, especially following the CVID-19 pandemic, necessitates advanced approaches to manage Indoor Environmental Quality (IEQ) which is crucial for the comfort, health, and productivity of students and staff. This study investigates the application of Building Information Modelling (BIM) as a multifaceted tool for monitoring, assessing, and controlling IEQ in HE buildings aiming to bridge the gap between traditional management practices and the innovative capabilities of BIM. Central to the study is a comprehensive literature review, which lays the foundation by examining current knowledge and technological advancements in both IEQ and BIM. This review sets the stage for a deeper investigation into the practical application of BIM in IEQ management. The methodology consists of Post-Occupancy Evaluation (POE) which encompasses physical monitoring, questionnaire surveys, and interviews under the umbrella of case studies. The physical data collection focuses on vital IEQ parameters such as temperature, humidity, CO2 levels etc, conducted by using different equipment including dataloggers to ensure accurate data. Complementing this, questionnaire surveys gather perceptions and satisfaction levels from students, providing valuable insights into the subjective aspects of IEQ. The interview component, targeting facilities management teams, offers an in-depth perspective on IEQ management challenges and strategies. The research delves deeper into the development of a conceptual BIM-based framework, informed by the insight findings from case studies and empirical data. This framework is designed to demonstrate the critical functions necessary for effective IEQ monitoring, assessment, control and automation with real time data handling capabilities. This BIM-based framework leads to the developing and testing a BIM-based prototype tool. This prototype leverages on software such as Autodesk Revit with its visual programming tool i.e., Dynamo and an Arduino-based sensor network thereby allowing for real-time flow of IEQ data for monitoring, control and even automation. By harnessing the capabilities of BIM technology, the study presents a forward-thinking approach that aligns with current sustainability and wellness goals, particularly vital in the post-COVID-19 era. The integration of BIM in IEQ management promises not only to enhance the health, comfort, and energy efficiency of educational environments but also to transform them into more conducive spaces for teaching and learning. Furthermore, this research could influence the future of HE buildings by prompting universities and government bodies to revaluate and improve teaching and learning environments. It demonstrates how the synergy between IEQ and BIM can empower stakeholders to monitor IEQ conditions more effectively and make informed decisions in real-time. Moreover, the developed framework has broader applications as well; it can serve as a tool for other sustainability assessments, like energy analysis in HE buildings, leveraging measured data synchronized with the BIM model. In conclusion, this study bridges the gap between theoretical research and real-world application by practicalizing how advanced technologies like BIM can be effectively integrated to enhance environmental quality in educational institutions. It portrays the potential of integrating advanced technologies like BIM in the pursuit of improved environmental conditions in educational institutions.

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