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Assessment of Retrofitted Buildings' Energy Efficiency using Nano-Based Materials via Life Cycle Cost Analysis

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In

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ABSTRACT

Buildings are major energy consumers worldwide. The Egyptian building stock is about 12 million buildings and many of these buildings are inefficient in terms of energy use. In order to considerably reduce the negative effects of buildings on the environment and economy, it is crucial to focus on making energy-efficient upgrades to the current building stock. An important strategy for reducing energy use and carbon emissions in existing structures is building energy retrofitting. It could be less expensive than constructing a new facility. Energy conservation retrofits should be started since buildings use a lot of energy and because existing structures make up the majority of the built environment. An energy retrofit is a physical or operational change made to a building, its energy usage, or the energy-use habits of its occupants to transform it into a facility that uses less energy. Additional long-term advantages of energy retrofitting might include cheaper maintenance costs, less air pollution, enhanced human health, and better thermal comfort.

The fact that there are so many combinations of suitable energy efficiency measures that may be taken into consideration makes choosing the best retrofit plan one of the most difficult elements of building energy retrofitting. Although there are various systems to retrofit a building, determining the optimum strategy of retrofitting measures for a specific building is often challenging. Furthermore, most energy retrofit decisions are restricted to economic categories rather than environmental and social issues. Accordingly, the aim of this research is to offer decision-makers a platform for the evaluation and selection process of energy efficiency measures in buildings by taking into consideration the representative metrics that integrates sustainable Triple Bottom Line (TBL) criteria (i.e. economic, environmental, and social benefits).

This aim will be met by achieving the following objectives; identify and quantify the sustainable benefits of building energy retrofit by means of an exhaustive investigation of the existing literature; determine how the decision-making process for energy retrofitting is affected by the building life cycle; develop a systematic approach to select among different sustainable decision criteria for insulating materials; combine different environmental analysis tools to create a hybrid approach for analysis of energy efficiency measures; develop and demonstrate a multi-tiered framework to select the optimum combination of energy efficiency measures that maximizes sustainable benefits and; validate the effectiveness, feasibility and accuracy of the proposed framework by mean of case study. The developed framework established in this study may be used to various types of buildings to assist decision-makers in selecting the best energy retrofit approach that not only optimizes monetary advantages but also maximizes environmental and social benefits.

Keywords: Energy Efficiency Measures, Energy Retrofitting, Multi-Objective Optimization, U-Value, Simulation, Environmental System Analysis Tools, Nano-materials.