**ABSTRACT**

During recent years, green building information modeling technology is gaining substantial attention in the sustainable engineering sector since traditional design methods are time-consuming and inefficient processes. Designing low-energy architecture to minimize carbon emissions requires thoughtful articulation of green building design alternatives. Reducing excess material waste, construction improvement, and promotion of urban sustainability are three main advantages of Building Energy Simulation Optimization technology development, directly intersects with the residential building sector, which currently utilizes approximately 21% of total operational energy in the United States. A sustainability analysis highlighting the benefits of a common building information modeling method was utilized to assess the impact of lighting efficiency, glazing, and window-wall ratio on thermal energy efficiency. Autodesk Revit and Green Building Studio software, interoperable tools developed to aid in building performance analysis, displayed results showing that lighting efficiency improvement decreases annual energy demand, directly lowering annual energy costs and carbon emissions significantly. Epistemic uncertainty and sensitivity analyses utilize a detailed building model to define and propagate input parameterization uncertainties. Multi-step epistemic analyses coupled with hybrid metaheuristic optimization are proposed to identify critical design parameters during the early stages of sustainable building design. A proposed hybrid metaheuristic technique utilizes deep learning algorithmic techniques to minimize energy utilization and maximize occupant comfort.High-performance building elements are optimized by employing a Multi-Objective Evolutionary Algorithm, coupled with an IHPBE Artificial Neural Network structure and Direct Search approach to modify the behaviors of conventional evolutionary algorithms, consequently improving optimization convergence performance, and increased accuracy.