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The Integration of Buildings' Energy Simulation Tools (ESTs) with Intelligent Decision Support Systems (IDSS)

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BSc in Building Engineering – Ain Shams University

A Thesis Presented in Partial Fulfillment of the Requirements for
Master of Science Degree in Architectural Engineering

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Statement

This thesis is submitted as partial fulfillment of M.Sc. degree in Architectural engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or qualification at any other scientific entity.

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Abstract

The use of Building Energy Simulation Tools (BESTs) is becoming widely common among building engineers and architects as the need for sustainable buildings keeps growing. The amount of challenges within the energy optimization process is also increasing as (BESTs) are developing to become more detailed. Major challenges such as uncertainty and sensitivity within the energy simulation process and the multivariate property within the energy optimization process are being widely discussed nowadays.

The power of today's computational methods within the field of Artificial Intelligence (AI), and today's proven application of AI branches, such as: expert systems, machine learning, and deep learning; this power, in fusion with the well-established science of Decision Support Systems (DSS), forms Intelligent Decision Support Systems (IDSS); which is expected by the researcher to provide BESTs with the needed intelligence and expertise to be able to solve the existing building's energy simulation challenges, and smoothing the BES process as well.

The multi-disciplinary parametric property of the optimization process, and the occurring variation in constraints along the design and construction phases do also require an energy simulation tool that is capable of co-oping like an expert with this change in different parameters all along the building process timeline; this tool must exist as an aiding tool to the building engineer from the moment the energy model is built, all through the construction phase, and until building operation, this tool must be also capable of producing justifications, and provide certainty and sensitivity assistance to the engineer, for providing more rigid energy related decisions during the model's lifecycle.

Therefore, the thesis aims to study the possible integration between the Buildings' Energy Simulation Tools (BESTs) with the Intelligent Decision Support Systems (IDSS), as an attempt to reach a theoretical framework of a buildable IDSS-aided BEST; BEST-IDSS.

Acronyms and Abbreviations

<i>AHU</i>	Air Handling Unit
<i>AI</i>	Artificial Intelligence
<i>BAS</i>	Building's Automation System
<i>BCx</i>	Building Commissioning
<i>BDL</i>	Building Design Language
<i>BES</i>	Building Energy Simulation
<i>BEST</i>	Building Energy Simulation Tool
<i>BIM</i>	Building Information Modelling
<i>BMS</i>	Building Management System
<i>BPD</i>	Building Performance Database
<i>BPS</i>	Building Performance Simulation
<i>CAD</i>	Computer Aided Design
<i>CF</i>	Certainty Factor
<i>CHP</i>	Combined Heat and Power
<i>COP</i>	Coefficient of Performance
<i>Cx</i>	Commissioning
<i>DAI</i>	Distributed Artificial Intelligence
<i>DALI</i>	Digital Accessible Lighting Interface
<i>DM</i>	Decision Making
<i>DOE</i>	Department Of Energy
<i>DP</i>	Differential Pressure
<i>DSS</i>	Decision Support System
<i>EER</i>	Energy Efficiency Ratio
<i>EM</i>	External Memory
<i>EPA</i>	Environmental Protection Agency
<i>EST</i>	Energy Simulation Tool
<i>ETMY</i>	Egyptian Typical Meteorological Year
<i>IBPSA</i>	International Building Performance Simulation Association
<i>IDSS</i>	Intelligent Decision Support System
<i>IoE</i>	Internet of Everything

<i>IoT</i>	Internet of Things
<i>IPMVP</i>	International Performance Measurement & Verification Protocol
<i>IPS</i>	Information Processing System
<i>IWEC</i>	International Weather for Energy Calculations
<i>LAN</i>	Local Area Network
<i>LEED</i>	Leadership in Energy and Environmental Design
<i>LON</i>	Local Operating Network
<i>LPD</i>	Lighting Power Density
<i>LTM</i>	Long Term Memory
<i>M&V</i>	Measurement and Verification
<i>M2M</i>	Machine to Machine
<i>MCTS</i>	Monte Carlo Tree Search
<i>MEP</i>	Mechanical, Electrical, and Plumbing
<i>MIS</i>	Management Information System
<i>NREL</i>	National Renewable Energy Laboratory
<i>O&M</i>	Operation and Maintenance
<i>OLAP</i>	Online Analytical Processing
<i>OPR</i>	Owner Project Requirements
<i>SAGE</i>	Semi-Automatic Ground Environment
<i>SHGC</i>	Solar Heat Gain Coefficient
<i>STM</i>	Short Term Memory
<i>TAB</i>	Testing, Adjusting, and Balancing
<i>TR</i>	Ton Refrigerant
U-value	Measure of thermal transmittance
<i>UI</i>	User Interface
<i>VFD</i>	Variable Frequency Drive
<i>VT</i>	Visible Transmittance

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Introduction

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- Problem Statement
- Research Hypothesis
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- Scope and Limitations