

## Advances in Design Decision Support Tools for Early-stage Energy-Efficient Architectural Design: A Review

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**Abstract :** The main driving force for increasing movement towards the design of High-Performance Buildings (HPB) are building codes and rating systems that address the various components of the building and their impact on the environment and energy conservation through various methods like prescriptive methods or simulation-based approaches. The methods and tools developed to meet these needs, which are often based on building performance simulation tools (BPST), have limitations in terms of compatibility with the integrated design process (IDP) and HPB design, as well as use by architects in the early stages of design (when the most important decisions are made). To overcome these limitations in recent years, efforts have been made to develop Design Decision Support Systems, which are often based on artificial intelligence. Numerous needs and steps for designing and developing a Decision Support System (DSS), which complies with the early stages of energy-efficient architecture design -consisting of combinations of different methods in an integrated package- have been listed in the literature. While various review studies have been conducted in connection with each of these techniques (such as optimizations, sensitivity and uncertainty analysis, etc.) and their integration of them with specific targets; this article is a critical and holistic review of the researches which leads to the development of applicable systems or introduction of a comprehensive framework for developing models complies with the IDP. Information resources such as Science Direct and Google Scholar are searched using specific keywords and the results are divided into two main categories: Simulation-based DSSs and Meta-simulation-based DSSs. The strengths and limitations of different models are highlighted, two general conceptual models are introduced for each category and the degree of compliance of these models with the IDP Framework is discussed. The research shows movement towards Multi-Level of Development (MOD) models, well combined with early stages of integrated design (schematic design stage and design development stage), which are heuristic, hybrid and Meta-simulation-based, relies on Big-real Data (like Building Energy Management Systems Data or Web data). Obtaining, using and combining of these data with simulation data to create models with higher uncertainty, more dynamic and more sensitive to context and culture models, as well as models that can generate economy-energy-efficient design scenarios using local data (to be more harmonized with circular economy principles), are important research areas in this field. The results of this study are a roadmap for researchers and developers of these tools.

**Keywords :** integrated design process, design decision support system, meta-simulation based, early stage, big data, energy efficiency

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