Paper 1 title - Information modelling for urban building energy simulation—A taxonomic review

Paper 1 pdf link - https://www.sciencedirect.com/science/article/pii/S0360132321009422

1.Summary

The paper in question focuses on Urban Building Energy Modelling (UBEM), employing a taxonomy-based analysis to understand different facets of UBEM. It explores data models, simulation tools, results visualization, validation methods, and reproducibility of research studies in the UBEM domain. The research identifies CityGML as a commonly used input data format but notes a mismatch with the prevalent simulation environment, EnergyPlus. It highlights the challenge of reproducibility in many studies due to unavailability of input data and insufficient description of simulation workflows. Additionally, the paper emphasizes the need for open data sets, benchmark validation sets, and standardized approaches to enhance UBEM research.

2. Motivation / Purpose

The motivation and purpose of the paper on Urban Building Energy Modelling (UBEM) lie in comprehensively understanding and categorizing the diverse aspects of UBEM. The primary goals include:

Taxonomy Development: To create a structured taxonomy or classification system that organizes various elements of UBEM research, such as data models, simulation tools, validation methods, and result visualization. This taxonomy serves as a framework for analysis.

Understanding Research Landscape: To explore the landscape of UBEM research, including the prevalent data formats, simulation tools used, and methods employed for validation and result presentation.

Identifying Challenges and Gaps: To identify challenges, discrepancies, and limitations within UBEM research, such as mismatches between commonly used data formats and simulation tools, issues with reproducibility, and the need for standardized validation datasets.

Proposing Future Directions: To suggest future directions for UBEM research, emphasizing the need for standardized data formats, open data sets, benchmark validation sets, and clearer descriptions of methodologies to improve reproducibility and collaboration in the field.

In summary, the paper aims to provide a structured understanding of UBEM research, pinpoint challenges, and propose pathways for enhancing the field's transparency, reproducibility, and collaboration.

3. Contribution

The paper's key contributions are:

Taxonomy Development: It introduces a comprehensive taxonomy for Urban Building Energy Modelling (UBEM), categorizing diverse elements like data models, simulation tools, validation methods, and result visualization.

Research Landscape Exploration: It maps the prevalent data formats, simulation tools, validation approaches, and result presentation methods used in UBEM research.

Identification of Challenges: It highlights discrepancies between commonly used data formats and simulation tools, issues with reproducibility, and the need for standardized validation datasets in UBEM research.

Future Research Directions: It proposes avenues for improvement, emphasizing the necessity for standardized data formats, open datasets, benchmark validation sets, and clearer methodologies to enhance reproducibility and collaboration in UBEM.

4. Methodology

The methodology involves:

Keyword Identification: Expert workshops defined keywords for classification and literature search in Scopus and Google Scholar databases.

Taxonomy Development: Constructed a taxonomy categorizing UBEM aspects like input data, simulation tools, validation, and reproducibility.

Literature Review: Identified and reviewed 72 relevant papers, analyzing their usage of data models, simulation tools, validation methods, and result visualization.

Analysis and Synthesis: Evaluated the prevalence of data formats, simulation tools, validation techniques, and reproducibility issues, summarizing trends and gaps in UBEM research.

5. Conclusion

The paper concludes by emphasizing critical findings in Urban Building Energy Modelling (UBEM). It underscores the challenges in reproducibility due to unshared data, incomplete methodology descriptions, and the lack of open-source tools. Highlighting the dominance of EnergyPlus despite limitations in handling common input formats like CityGML, the study recommends future research to bridge this gap. The need for standardized validation datasets,

transparent data enrichment, and increased support for open data and software in UBEM is emphasized. Additionally, the paper advocates for a shift towards comprehensive reporting standards to enhance reproducibility and collaboration within the field.

2.Limitations

2.1 Limitation1 - Keyword Selection Bias: The reliance on a predefined set of keywords might have limited the scope of included studies, potentially excluding relevant research that didn't match the specified keywords.

2.2 Limitation2 - Reproducibility Challenges: While highlighting the issue of reproducibility, the paper itself faces limitations in providing clear pathways or frameworks to address the reproducibility challenges it identifies, offering more of a diagnosis than a comprehensive solution.

2.2 Synthesis: The paper explores Urban Building Energy Modelling (UBEM) through a structured taxonomy approach. It aims to categorize and understand various facets of UBEM, including data models, simulation tools, results, and reproducibility. This study seeks to streamline the analysis of UBEM literature by implementing a systematic methodology. The synthesis of the paper encapsulates the following:

Structured Taxonomy: The paper presents a comprehensive taxonomy framework, classifying UBEM research based on input data, simulation tools, simulation results, and validation techniques. This taxonomy serves as a structured lens to analyze and categorize diverse research within the UBEM domain.

Identified Trends: Through systematic categorization, the study identifies prevalent trends in UBEM research. It highlights the dominance of CityGML as an input data model, EnergyPlus as a prominent simulation tool, and the focus on heating energy demand in simulation results.

Reproducibility Concerns: The paper emphasizes the critical issue of reproducibility within UBEM studies, highlighting that a majority of reviewed publications lack the necessary details or openness for result reproducibility, hindering scientific advancement and collaboration.

Contributions and Future Pathways: The study contributes by offering insights into UBEM practices, identifying gaps in reproducibility and validation, and highlighting the need for open data and standardized validation sets. It paves the way for future research to address these limitations, promote data transparency, and enhance the robustness of UBEM studies.

Overall, this synthesis encapsulates the paper's systematic approach to categorize and understand UBEM research, emphasizing the need for enhanced reproducibility, standardized datasets, and transparent methodologies to advance the field effectively.