Research Article

Proposed Framework for Optimizing Building Information Modelling (BIM) Usability in Energy Efficient Office Buildings

Bala Baba,.*1 and Safiya Othman2

12Department of Architecture, School of Environmental Studies, Modibbo Adama University of Technology, Yola, Adamawa, Nigeria.

Corresponding Author: arcbala2002@gmail.com

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Abstract

This study is a proposes framework of optimizing building information modeling (BIM) usability in energy efficient office buildings; A high-performance building requires comprehensive whole-building energy analyses to optimize energy consumption. It shows energy efficiency of a building is the extent to which the energy consumption per square metre of floor area of the building measures up to established energy consumption benchmarks for that particular type of building under defined climatic conditions and also shows how BIM can be used to effectively manage the energy consumption within an office building.

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1. Introduction

Energy consumption has gained much attention recently. In the Architecture, Engineering, Construction and Facilities Management (AEC/FM) field, energy efficient building design is becoming more critical,
especially as it relates to energy retrofit projects. In the process of energy efficient building design, decision-making in the very early stages might significantly influence the energy consumption (Pollock et al., 2009). The decision-making process should be built upon a channel, which connects the computational representation of a building's energy elements and the corresponding economic considerations (Jones et al., 2010). Energy modeling is such a channel providing designers with an outlook of potential energy consumption of varieties of designs prior to constructing the building (Fleming et al., 2012).
During the building design lifecycle, Energy Efficient Building (EEB) design depends on the collaboration project participants using a variety of simulation tools to make decisions for the optimized building solutions. Currently, different simulation tools running in different "energy simulation views" (Bazjanac, 2008) determine the varieties of data sets and data formats (Bazjanac & Kiviniemi, 2007). It is necessary to gather all simulation views into an integrated whole-building simulation methodology with the intent of exchanging data seamlessly (Guglielmetti et al., 2011).

Application of BIM to most aspects of building design and operation has been explored in depth since its emergence as an umbrella term for the processing of data describing a building. Not least of which in building performance design, simulation and optimisation, where publication trends show an exponential growth in recent years on the topic of BIM and building performance. In an industry still attempting to close the recognised performance-gap between predicted and measured building performance, methods of assisting in this process are encouraged, and where BIM is conveniently present as a platform on which to develop these. Yalcinkaya and Singh identified performance assessment and simulation as a target of BIM.
application, with energy management a growing trend within those areas. In contrast, its application to building performance management during operation is limited in favour of process optimisation, information querying and retrieval. Much emphasis is placed on the effective handover of information suitable for facilities management (FM) use; via model view definitions and export from design models, supported by development of open exchange formats. While useful and necessary for efficient management of building and its systems, accessibility to information does not necessarily mean that information will be utilised, nor does it guarantee effective performance management.

The AEC/FM industry shows increasing interest in adopting information technology in building designs (Bazjanac & Kiviniemi, 2007). BIM acts as a bridge between the industry and information technology (Eastman et al., 2008), which makes the entire building lifecycle more efficient and effective. BIM, an interoperable data model, can enable bi-directional data service for various simulation tools in the AEC/FM industry projects, which means the import and export of relevant data must be compatible with other tools (Bazjanac, 2007; O’Donnell et al., 2011).

Building energy performance simulation leverages computer-based building energy analysis to quantitatively validate the correctness of decisions on building design and operations (Bazjanac et al., 2011). High-performance buildings require an integrated analysis, including whole-building energy, daylighting, and airflow, among others. Traditionally, different simulation tools focus on their own domains. Typically, designers leveraging these tools use a point-to-point data exchange model (O’Donnell et al., 2011), which is often very complicated and inefficient. In order to facilitate information flow from an architectural design model to an energy model, Bazjanac and Kiviniemi (2007) developed a tool called the Geometry Simplification Tool (GST) that simplifies valid IFC geometric model and extract construction properties.

A high-performance building requires comprehensive whole-building energy analyses to optimize energy consumption. AEC/FM industry experts should leverage information technology and various simulation tools to conduct integrated analyses to assist with their decision-making in the whole building lifecycle.

Energy is what drives everything, yet we can only witness it indirectly. The way we perceive energy – by its effect on our surroundings – is the reason that we use it so carefree. Energy may be consumed where we don’t expect it, thus leading to energy waste. Until now the burden of providing us with tools to be more energy efficient was with the industry.
New developments in technologies give us new household appliances for our households that are much more energy efficient than before. But this is no longer enough. We need to address the lack of awareness with regard to energy efficiency and energy waste on the consumer side. People are usually not conscious about the amount of energy they consume. Accounting periods of energy suppliers normally include several months, therefore the understanding of individual consumption rates is very difficult. In addition, due to difficult interpretation of traditionally delivered energy data, decisions made are often incorrect or inefficient. It is because of these reasons, that a good energy visualization model is required. An important step towards this goal is to allow the user to perceive his/her use of energy in a more direct way. This means to visualize the impact of his behaviour on his energy consumption.

2. What is the energy efficiency of an office building?

The energy efficiency of a building is the extent to which the energy consumption per square metre of floor area of the building measures up to established energy consumption benchmarks for that particular type of building under defined climatic conditions.

2.1 Why is energy efficiency in an office buildings important?

Governments have a responsibility to ensure that there is secure supply of energy to ensure economic growth. In many developing countries there is normally very little margin between existing power supply and electricity demand. With increasing electricity use from existing consumers and new connections, new generation needs to be brought on line to meet increasing demand. In addition, due to changing climate patterns and the increasing risk of drought, countries that are highly dependent on electricity from hydro as their main source of electricity are losing much of their generation capacity resulting in intensive power rationing. Although renewable sources of electricity such as hydro, geothermal or wind provide electricity at a much lower cost than electricity generation from petroleum, their capital outlay is large, they are complex and take much longer to implement. Petroleum-based generation is usually brought in in the short term to meet this demand, which results in increased cost of electricity, over dependence on petroleum and subsequently vulnerability to oil price fluctuations.

Investments in energy efficiency in an office building can be compared with the cost of capital investments necessary on the supply side of the energy system to produce a similar amount of peak capacity or annual energy production. Usually, the capital costs of efficiency are lower than comparable investments in
increased supply and there are no additional operating costs of efficiency compared to substantial operating costs for supply-side options. In addition, energy efficiency investments generally have much shorter lead times than energy supply investments, a particularly important consideration in countries where the demand for energy services is growing rapidly. By setting energy efficiency targets for buildings, governments share the burden and cost of ensuring the security of energy supply with end-users. The need to increase generation capacity in developing countries is unavoidable. However governments can solve peak demand constraints by finding a balance between reducing demands and increasing supply. To increase supply, governments in developing countries often have to allocate funds to subsidize new generation capacity or subsidize the cost of petroleum-based generation. Reducing demand by setting up a low interest, easy payment energy efficiency revolving fund to incentivize consumers to implement energy efficiency measures would be a more sustainable approach and repayments could be based on energy savings. The main benefit from measures to improve energy efficiency buildings is lower energy costs but there are usually other benefits to be considered too. Energy efficiency measures are meant to reduce the amount of energy consumed while maintaining or improving the quality of services provided in the building. Among the benefits likely to arise from energy efficiency investments in an office buildings are:

- Reducing energy use for space heating and/or cooling and water heating;
- Reduced electricity use for lighting, office machinery and domestic type appliances;
- Lower maintenance requirements;
- Improved comfort;
- Enhanced property value.
- Reduced cost

In developing countries where electricity is intermittent and power rationing is frequent, there is a large demand for diesel or renewable energy-based backup/stand-by power generation from end-users. Reducing power and energy requirements in buildings reduces the capital outlay required and the running costs of these stand-by systems (SUS).

3. **Proposed Methodology for Framework**

In summary the proposed frame work can be achieved if the following workflow paths are followed.
a. A detailed Literature Review that is carefully searching and reviewing of existing literature, both academic and professional; this will comprise search, identification and retrieval of literature followed by reading, analysis and pattern recognition.

b. Expert Interrogation: identification of key experts in the field of energy efficiency will be met for, interview and discuss as it relates to the focus of this research.

c. Case Studies: Already existing project will be studied with a view to learning the challenges and benefits of BIM to energy efficient office buildings.

References


