Applied Energy 114 (2014) 475–484

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Simulation and evaluation of Building Information Modeling in a real pilot site

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HIGHLIGHTS

- The article opens the door to a new body of knowledge.
- BIM results optimization using human flows.
- Application and results of a BIM software tool.
- Pilot site that encompass the entire spectrum of uses.
- Energy savings with minimal budget.

ARTICLE INFO

Article history:
Received 20 May 2013
Received in revised form 16 September 2013
Accepted 17 September 2013

Keywords:
Architecture
Building Information Model
Energy efficiency
Human flow
Simulation
Software

ABSTRACT

The current methods of building energy simulation that designers and engineers (D&E) use in order to find the energy performance of a building do not take into account the real behavior of the people who will use the building. The main aim of this paper is to show how by merely including the real behavior of people in building simulations there may be differences of up to 30%, through the study of a real pilot site simulation with existing software. These data confirm the possibilities of energy and money saving that energy simulation programs bring about when they include schedules of true use of the building (BIM).

Contents

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http://dx.doi.org/10.1016/j.apenergy.2013.09.047

1. Introduction

Building simulation is a common practice in the industry. It has undergone a substantial growth both in the academic world and the building industry since its emergence three decades ago. Research in this field of building simulation is also abundant.

Moreover, much research effort within EU funded projects [1] as well as international research action has been devoted to resolving the shortcomings of available building simulations and automation programs and respective Building Information Modeling (BIM) approaches. Recent relevant EU projects such as HESMOS [2] or PEBBLE [3] address these issues and try to make major breakthroughs in Building Information Modeling, though they deal only to certain extend with the occupant factor. They aim at monitoring and modeling occupant responses that are based on individual preferences (comfort of the personnel) under specific environmental conditions [4–8]. A system for building simulation that produces data about the activity behavior of occupants as members of an enterprise structure and framework can significantly improve the relevance and performance of building simulation tools. This is relevant for engineering spheres, such as building physics, as well as for architects who can analyze and evaluate the performance of a building design [9–11].

The particular issue presented in this article is a part of a project whose objective is to increase the contemporary architectural frame by incorporating business and occupancy related information, thus providing a holistic approach to the design and evaluation of the energy performance of construction products at an early stage and prior to their completion as shown in Fig. 1 [12–15].

The project aims to develop and validate a holistic energy performance evaluation framework that incorporates architectural metadata (BIM), critical business processes (BPM) and consequent occupant behavior patterns, enterprise assets and their respective operations as well as overall environmental conditions.

The project structure, with occupancy behavior (presence and movement) as a central point of reference, will align energy consumption points to all interrelated enterprise aspects (business processes, enterprise assets and utility state and operations) as detailed in the project simulation platform, Fig. 2.

The project framework and tools will be thoroughly evaluated in terms of modeling, simulation and energy performance with predictive precision, energy gains as well as end-user acceptance, within two different pilot cases, carried out at a hospital and a Multipurpose Office/Commercial Building, more specifically the *Clínica Universidad de Navarra* in Spain and the *Estádio Cidade de Coimbra* in Portugal respectively.

In order to execute this study in the framework of the project, one of the pilot sites, the *Clínica Universidad de Navarra*, has been modeled and analyzed. It is a mixed-use building type that makes it very suitable for this study and allows the extrapolation of the results to a wide range of building types. The *Clínica* is a large medical center located in Pamplona, in the north of Spain, with recognized prestige in the scientific community.

2. Methods

2.1. General approach

Architects, designers and engineers (D&E) need tools that will assist them in creating better and more sustainable construction projects. More specifically, during early design phases the focus on energy efficiency should be on designing the most efficient system, taking into consideration the many possible variables (health and comfort performance, building costs, whole life costs, etc.) and also including one of the most important factors, that of occupant behavior. However, D&E lack the tools that will assist them in the complete evaluation of the energy performance of alternative design and making decisions to produce better and more sustainable construction products.

Building simulation has now been established as an integral part of the design process and many simulation tools are available in commercial use and are considered common practice by engineers. Building performance simulation programs must play an important role in the early design process [16–20].

As far as contemporary research or available technological solutions are concerned, there are no modeling and simulation tools which take into account the real effect of occupants and respective occupant patterns. The available modeling methods and systems do not deal with activities performed by occupants or with the

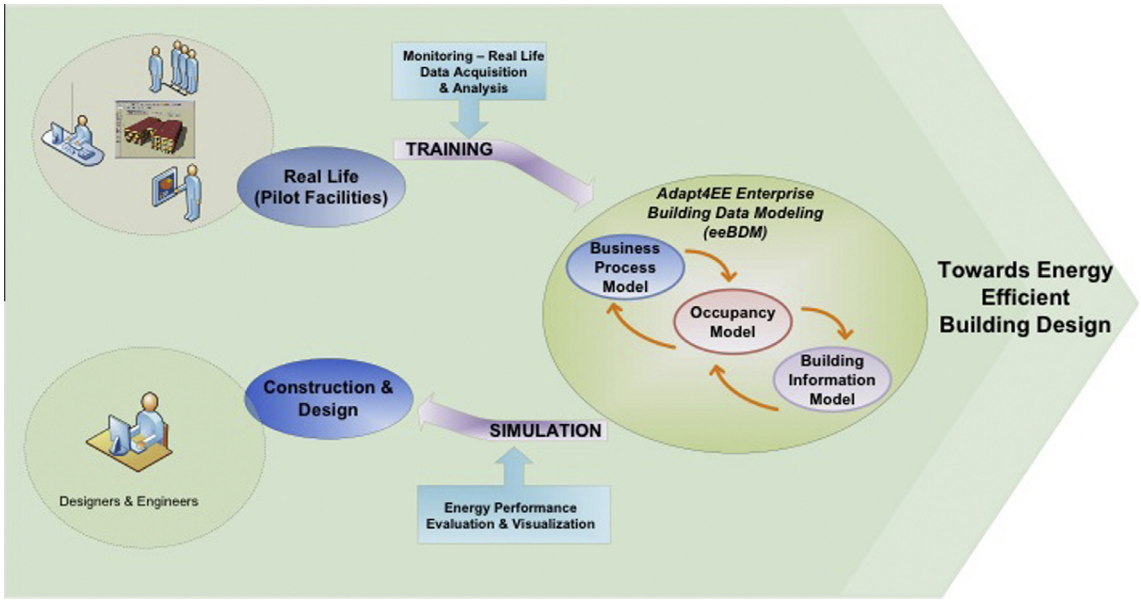

Fig. 1. Graphical abstract (Source: Adapt4EE Project).