Architects And Energy Simulations Tool

Iman Paryudi

Abstract: Today, there are many energy simulation tools in the market. However, existing energy simulation tools are not architect friendly. There are at least three shortcomings of the existing energy simulation tools that impede architects from using them: excessive data input requirement, non intuitive user interface, and too complex. An energy simulation tool will be used regularly by architects if it accommodates their preferences such as: simple, easy to use, provide alternative designs, no excessive data input, accuracy is not important. This paper presents the results of literature study on relationship between architects and energy simulation tools.

Index Terms: Energy Efficient Building, Energy Simulation Tool, Architect.

1 INTRODUCTION

Knowing that fossil energy is not renewable, it becomes our concern to save energy as much as possible. In this modern age, energy is not only consumed by humans for their private needs like cooking but also for energizing homes or buildings. With the increase of the human population, the quantity and size of buildings also increase. Buildings have now become one of the biggest fuel consumers. In the US, 48% of the total energy is consumed by buildings [1]. Similar amount of energy consumption by buildings happens in Europe, that is 40% of the total energy [2]. Meanwhile in the UAE, buildings consume 70% of its energy [3]. Based on these developments, a lot of countries have issued initiatives or directives on low-energy buildings. In general, the directives require building developers to build low-energy buildings. In order to support these directives, the energy performance of the building must be calculated before its construction. Only buildings whose energy performance complies with the regulations are allowed to be built. To achieve this objective, energy simulation tools are used. Currently, there are many such tools available in the market. In the US, there were more than 389 tools in 2010 [4]. This paper will present our paper reviews about the relationship between architects and energy simulation tool, i.e. the shortcomings of existing energy simulation tools, the weaknesses of architects when using the existing energy simulation tools, energy simulation tools preferred by architects.

2 SHORTCOMINGS OF EXISTING ENERGY SIMULATION TOOLS

With an increased awareness of energy-efficient buildings, there is also an increase in the number of energy simulation tools available, either free or commercial. In 2010, the number of tools listed on the U.S. Department of Energy (DOE) Building Energy Software Tools Directory (BESTD) website reached more than 389 [4][5]. This means that there is a 200\% increase in such tools compared to 1997 [6]. Paradis [7] classifies these tools into four generic types: Screening tools, Architectural design tools, Load calculation and HVAC sizing tools, and Economic assessment tools. These tools are used in different stage of the projects and whether the projects are refurbishments or new constructions. There are two methods used by the existing energy-simulation tools [7]: the complex method and the simplified method. The complex method needs detailed data input to produce a precise result. Meanwhile, the simplified method does not require much data input and is used to “minimize run time”, because the calculation is simple. Lam, Huang, and Zhai [8] state that the simplified method is usually used to “address the specific requirements of the early design phase”. The above calculation methods are called by Schlueter and Thesseling [9] as the statistic calculation model and the physical calculation model. The statistic calculation model uses a simple method to calculate a building’s energy performance. Meanwhile, the physical calculation model uses a precise and complex method to calculate the energy consumption of a building. According to them, the advantage of the simple statistical model is that it needs only a few pieces of information in order to carry out the calculation. Another advantage of the statistical model is computation speed. Since it only uses a simple calculation, the statistical calculation model can provide calculation results in seconds. This is, of course, much faster than the physical calculation model which takes minutes or hours to finish the calculation. However, although the output of the statistical calculation model is not very precise, it can still be used to judge the energy performance of a building. One should understand that although an energy-simulation tool uses detailed and complex calculations, it is not guaranteed that the calculation result can predict the actual building’s energy performance precisely [7]. This is because the calculation precision is dependent on the accuracy of the input data. If any of the input data is uncertain, the energy performance calculation will not be accurate. An example of uncertain data is that of occupant usage [10] [11]. We cannot determine this occupant usage of buildings exactly, hence it must be assumed. The actual usage of the building cannot be calculated precisely if a static occupancy usage is assumed. This assumptions—that are usually used by existing energy simulation tools—cause an inaccurate energy performance calculation [16]. Knowing this fact, Lam, Wong, Henry [12] state that using complicated simulation tools are not essential, since these do not provide better decision-making support. For architects, simple energy simulation tools give more advantages than the complicated ones [5]. This is confirmed by the survey result of Lam, Wong, and Henry [12], where most companies participating in the survey said that they did not use complex energy simulation tools. The existing energy simulation tools require their users to input a lot of data before carrying out the simulation. This “excessive data input requirement” is one of the limitations of the existing energy-simulation tools [13]. The problem with excessive data input requirements is that such data may not be available in the early stages of design [14]. The statement above is supported by Lam, Wong, and Henry [12], where their survey result shows that 69\% of the respondents said that “extensive data input” required to run the simulation is the main shortcoming of the tool. Existing energy simulation tools are to be used by experts only. In order to input the required data correctly and to run the simulations and interpret the results, expert knowledge is needed. The problem is that architects are novices in the field of simulation. Since they are novices, inputting a lot of unfamiliar data through an unfriendly user interface is a big challenge for them [9]. This “non-intuitive and impractical user interface” is another limitation of the existing simulation tools [13]. In order for architects to run simulation easily, the tool designer must make sure that the user interface of the tool must be simple and user-friendly [9] [8] [15].

3 WEAKNESSES AND PREFERENCES OF ARCHITECTS

Based on studies, the existing energy simulation tools are not architect friendly and not suitable to be used by architects during the early phases to design energy efficient building [17]. The tools are not architect friendly because they are too complex for the architects [18] besides the tools are not compatible with architects’ working methods and needs [19]. This fact causes the limited use of energy simulation tools by architects during early design stage [5]. Not to mention is another fact that architects are novices in the energy simulation field, therefore they lack simulation know-how [20]. This weakness impedes architects from using existing energy simulation tools regularly. Because of that, most architects prefer simple energy simulation tools. These tools must offer features that allow them to design quickly. They must also provide alternative designs to enable architects to explore all possible scenarios. In the design stage, architects care little for the accuracy of the simulation results. Instead, they are more concerned with understanding the effects of design changes on building performance [5]. There are a number of criteria for ‘Architect Friendly’ energy simulation tools [19]: Usability and Information Management (UIM) of interface

- Integration of Intelligent Design Knowledge-Base (IIKB)
- Interoperability of Building Modelling (IBM)
- Accuracy of the tool and its ability to simulate complex and detailed building components (AASDC).

The UIM of the interface is used to support users finishing their task through communicative feedback by expressing information using good presentation techniques. There are two subcategories under UIM, i.e. usability and information management. Attia et al. [19] elaborate that the term “usability” means that the user interface has a good design that enables easy data input, simple navigation and flexible control, and that has an informative simulation result display. This design will in turn make the user interface easily accessible to users. Information management means that the user interface has the ability to use default values and templates. This feature will help in avoiding excessive data input requirements [21]. The IIKB consists of two parts: knowledge base (KB) and intelligence. The KB is mainly used in decision-making processes and in giving advice regarding the influence of the design decisions [22]. Intelligence is used to find answers to design questions that enable the users to optimize design solutions, evaluate complex design strategies, and consider any possible scenarios. IBM is related to building data exchange among all parties participating in a project. Finally, AADC is related to the validity and quality of the simulation models [6].

4 SUMMARY

Existing energy simulation tools are not used by architects regularly because they have shortcomings such as: excessive data input requirement, non intuitive user interface, and too complex. Meanwhile architects are novices in the field of energy simulation hence they prefer tools that are simple, easy to use, provide alternative designs, and no excessive data input requirement. For architects accuracy is not important.

ACKNOWLEDGEMENT

I would like to thank the Directorate General of Higher Education, Ministry of Education and Culture, Republic of Indonesia for the scholarship awarded to him.

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