Evaluation of Energy Consumption by using Building Information Modelling (BIM)

Siti Aisyah Kamarudin, Fathoni Usman, Rasyikin Roslan, Hew Weng San

Abstract: ***The use of Building Information Modelling (BIM) has been widely practised. In this paper, the method of Terrestrial Laser Scanning (TLS) and 3D modelling is done before analyse using BIM. This study aims to analyse the energy consumption of PMU building by using BIM in order to have a better designed project as well as to lower risk and better predictability of outcomes. It discusses studies integrated with the design method, on the use of Building Information Modeling (BIM) to build performance simulations. As for the outcome, cooling load and energy consumption analysis are presented in this study.***

Keywords: BIM, consumption, efficiency, energy, REVIT

I. INTRODUCTION

There are techniques for measuring, analyzing and documenting the design of the green construction. It relies on a number of disjointed procedures to build different systems for the discrete demands. [1]. However, a building nowadays can be easily constructed in digital way with the application of Building Information Modelling (BIM). It enables rapid application of modifications in the 3D model when needed during the interdisciplinary coordination process [2].

BIM is always linked to design and pre-construction, which benefits every stage of the project process as well as the completion of construction. BIM makes it possible to manufacture operations for all reasons before they are physically created, taking a significant amount of wasteful elements and problems that arise during the design process. According to [3], BIM also offers the chance to realize countless advantages throughout a building facility's stages of project design, construction, and post-occupancy.

The vitality portion of the structure execution assessment transforms into a pattern to fulfil construction sustainability due to the expansion of an environmental change [4]. In order to fulfil the prospect of viable constructions, a few developments in terms of vitality, water, soil and material safety, together with ecological stacking and the features of indoor and open air circumstances are needed. [5].

A building's energy simulation is helpful in analyzing the movement of energy in, out, and through the rooms and volumes in a building model.

Revised Manuscript Received on September 22, 2019.

Siti Aisyah Kamarudin, College of Graduate Studies, Universiti Tenaga Nasional, Malaysia

Fathoni Usman, Institute of Energy Infrastructure, Universiti Tenaga Nasional, Malaysia

Rasyikin Roslan, Institute of Energy Infrastructure, Universiti Tenaga Nasional, Malaysia

Hew Weng San, Grid Department, Tenaga Nasional Berhad (TNB)

This will benefit designers to create better assessment, cost-effective choices that can enhance building efficiency and decrease the environmental impact of buildings. Energy analysis for an entire construction takes into consideration the anticipated power use (fuel and electricity) depending on the geometry, construction type, climate, envelope characteristics, and active systems such as HVAC & Lighting. [6]

The aims of this study is to analyse energy consumption of PMU building using the function of BIM in order to have a better designed project.

II. RESEARCH METHODS

This part explained methods used in this study. In this part, 3D model of PMU buildings and method analysis using BIM are presented.

Methods involved in this research are detailed scanning by using Terrestrial Laser Scanning (TLS) and 3D model of *Pencawang Masuk Utama* (PMU) buildings using Autodesk Revit 2018 and Autodesk Green Building Studio as shown in Fig. 1, Fig. 2 and Fig. 3. This research involve three (3) PMU buildings which are PMU Kuantan North (3°48'41.1"N 103°16'24.9"E), PMU Seberang Jaya (5°23'52.6"N 100°24'03.1"E) and PMU Brickfield (3°08'04.3"N 101°41'35.6"E).

Terrestrial Laser Scanning (TLS)

TLS in this study is done in order to get a detailed 3D view of the existing building. It measures the dimension of the entire building by conducting an overall terrestrial scanning. 3D laser scanning has ended up being a skillful and clearly time-consuming, cross-industry productive strategy.

3D scanning capabilities are still under inquiry in all sectors, for instance, the data obtained from the filtered point cloud data is being attempted to provide a phase for programmed BIM model generation. [7].

Fig. 1 Scanning of PMU Kuantan using TLS

Fig. 2 Scanning of PMU Seberang Jaya using TLS

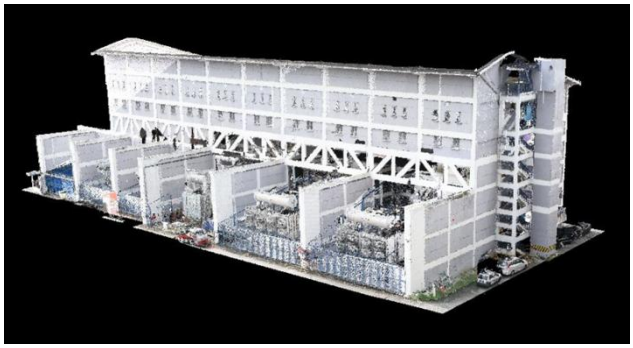

Fig. 3 Scanning of PMU Brickfield using TLS

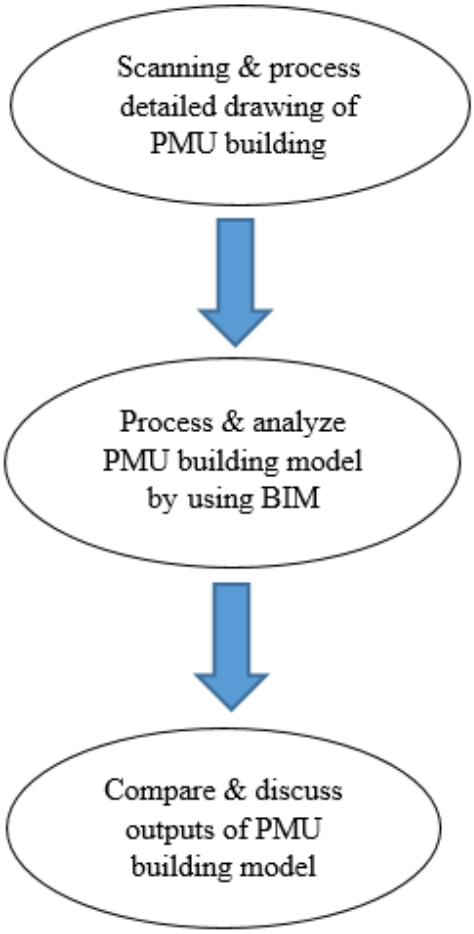

Fig. 4 A process flow diagram of research method

An actual dimension of the building can be acquired from TLS and redraw as completed 3D model by using BIM. 3D models are used to improve visualisation of the project, communication of design intent and multidisciplinary collaboration. A complete info of building properties can gives output with additional extension by using Autodesk Insight. A research flow process is shown in Fig. 4.

A method of gathering precise study information using a terrestrial laser scanner coupled with a complete station and establishing a BIM model as the basis for a digital leadership model [8].

3D Modelling of PMU building

A 3D modelling of PMU building was develop in Autodesk Revit 2018 software before been analysed in Autodesk Green Building Studio (GBS). A developed 3D models using its existing properties materials were shown in Fig. 5, Fig. 6 and Fig. 7.

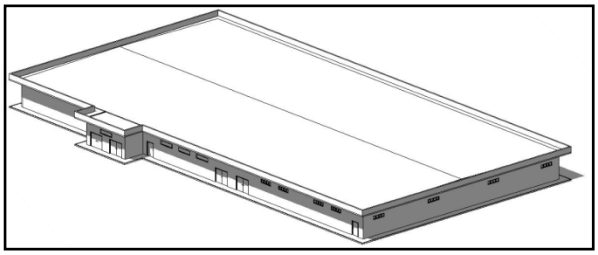

Fig. 5 3D Model of PMU Kuantan

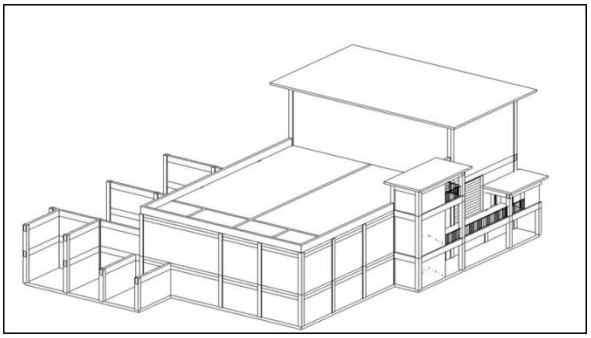

Fig. 6 3D Model of PMU Seberang Jaya

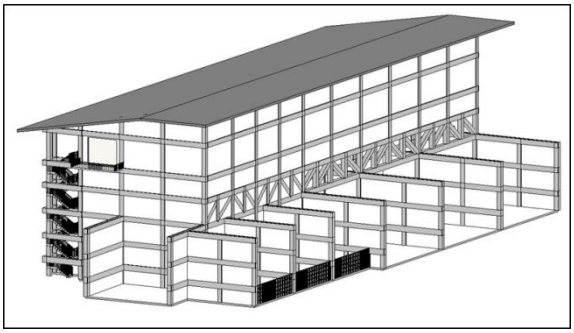

Fig. 7 3D Model of PMU Brickfield

III. RESULT & DISCUSSION

A role of Green Building Studio (GBS) is to operate simulations of construction performance to optimize power effectiveness as well as to work towards carbon neutrality previously in the design phase. This idea helps to extend ability before designing high performance buildings [6].

By using Autodesk Revit 2018, the evaluation of power usage can conduct power simulation for conceptual forms and comprehensive architectural designs produced in the software. The output of cooling load and energy consumption are presented in this part.

Cooling Loads

Fig. 8, Fig. 9 and Fig. 10 presents the cooling loads of PMU Kuantan North, PMU Seberang Jaya and PMU Brickfield.

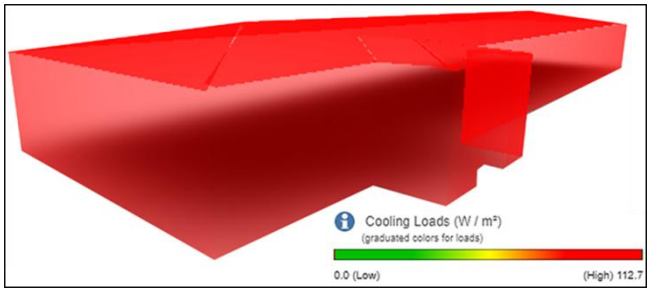

Fig. 8 Cooling loads for PMU Kuantan North.,

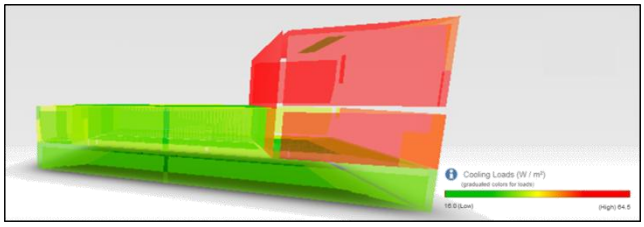

Fig. 9 Cooling loads for PMU Seberang Jaya

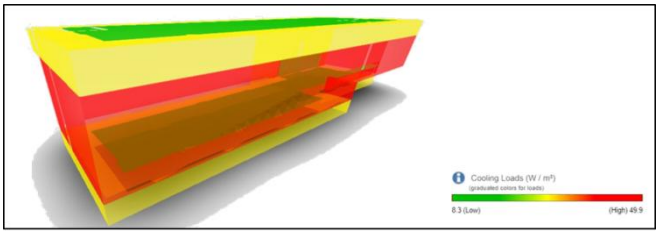

Fig. 10 Cooling loads for PMU Brickfield.

As for PMU Kuantan North, it is observed that the interior temperature is high for human comfort temperature of all over the building. This is due to the building materials that made up of cement. After on-site observation, it can be noticed that the PMU Kuantan North is fully covered with window and door closed due to the flood prevention. The indoor temperature becoming higher and in order to reduce the inside heat temperature, an in-stored air conditioner need to be switched on for 24 hours. Thus, it resulted to a higher energy efficiency usage. Unlike PMU Seberang Jaya and PMU Brickfield, a as a Gas Insulated Switchgear (GIS) type building the main gas machineries is located at certain level which may contribute to the least usage of electrical energy consumption of overall building.

Energy Consumption

According to [9], the energy consumption of the housing industry is an significant component of the complete demand for electricity. Buildings as designed today, due to excessive power usage, lead to severe environmental issues [10]. Consumers are mostly not alert about the effective use of energy.

Total energy consumption from building analysis and a summarized total energy is represented in Figure 2.7 until Figure2.10 by visualizing energy consumptions performance and statistical chart based on the area.

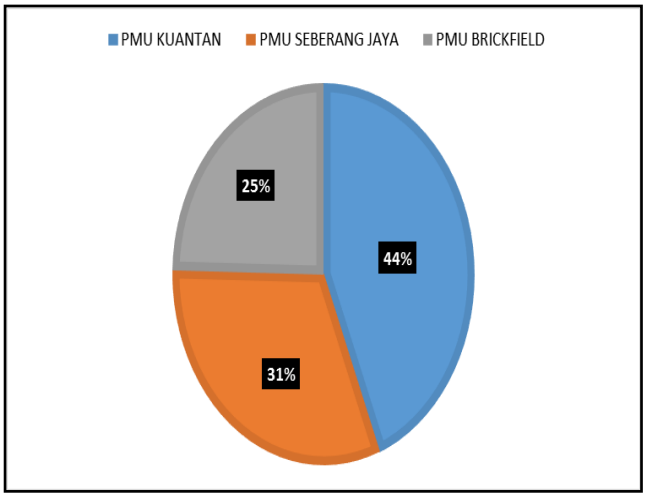

Fig. 11 Annual Energy Use

Fig. 11 shows the annual energy use. PMU Kuantan North has the higher percentage of energy use with the value 826 MJ/m^2/year followed by PMU Seberang Jaya 590 MJ/m2/year and PMU Brickfield 463 MJ/m2/year. This is due to the electricity usage that may increases during the hotter months of the year, if the building uses air conditioning.

Fig. 12 shows the annual peak demand. PMU Brickfield contribute the most percentage of demand with 109.7 kW. This is because of the building is located at the urban area where more demand is needed. While Fig 13. presents the annual energy fuel use by the building. It shows that PMU Seberang Jaya has the least usage of the fuel energy compared to PMU Kuantan and PMU Brickfield.

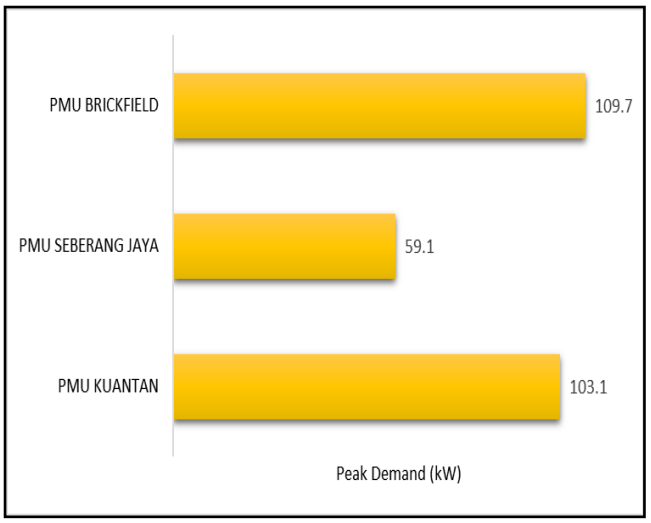

Fig. 12 Annual Peak Demand

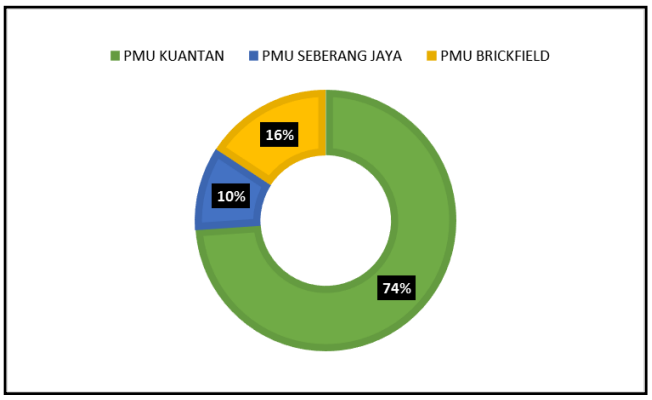

Fig. 13 Annual Energy (Fuel)

With the use of BIM technology as well as the green building services helps to be done easily in Revit energy analysis. Energy analysis report generated in Revit along with green building studio or insight 360 gives the more accurate and graphical representation [6].

IV. CONCLUSIONS

In this research, the output of energy analysis consist of energy use, peak demand and fuel energy use which gives clear idea for designers to analyse building orientation, energy requirement parameters are presented. The use of BIM may improve the project value through enhanced information flows, better project control and reduced conflicts.

This will give future researchers the concept of improving the process by using this example as a practical guide to knowing the usefulness of TLS and BIM for other current structures [7].

ACKNOWLEDGMENT

The authors would like to thank UNITEN R & D Sdn. Bhd. for the financial support through Project Grant No. U-TS-RD-18-12 TNB R&D Fund (Seeding) and for the opportunity to publish this paper. Also, to all colleagues who provided technical advice and support.

REFERENCES

1. Y. Lim and F. Shahsavari, “Building Information Modelling for Building Energy Efficiency Evaluation,” no. April, 2016.
2. I. Czmoch and A. Pękala, “Traditional design versus BIM based design,” Procedia Eng., vol. 91, no. TFoCE, pp. 210–215, 2014.
3. S. Azhar and R. U. Farooqui, “BIM-based Sustainability Analysis : An Evaluation of Building Performance BIM-based Sustainability Analysis : An Evaluation of Building Performance Analysis Software,” no. August 2014, 2009.
4. L. Che, Z. Gao, and D. Chen, “Using building information modeling for measuring the efficiency of building energy performance,” Proc. Int. Conf. Comput. Civ. Build. Eng., pp. 165–170, 2010.
5. D. Chwieduk, “Towards sustainable-energy buildings,” vol. 76, pp. 211–217, 2003.
6. A. Jangalve, V. Kamble, S. Gawandi, and N. Ramani, “Energy Analysis of Residential Building Using BIM,” pp. 15–19.
7. M. Raza, “BIM for Existing Buildings: A Study of Terrestrial Laser Scanning and Conventional Measurement Technique,” pp. 1–110, 2017.
8. T. Mill, A. Alt, and R. Liias, “Combined 3D Building Surveying Techniques – Terrestrial Laser Scanning (Tls) and Total Station Surveying for Bim Data Management Purposes,” J. Civ. Eng. Manag., vol. 19, no. Supplement_1, pp. S23–S32, 2013.
9. K. A. Rahman, A. M. Leman, M. Faris Mubin, M. Z. M. Yusof, A. Hariri, and M. N. M. Salleh, “Energy Consumption Analysis Based on Energy Efficiency Approach: A Case of Suburban Area,” MATEC Web Conf., vol. 87, 2016.
10. A. Venkataraman and R. K. M, “Whole Building Energy Analysis using BIM.,” Research Gate. (https://www.researchgate.net/publication/281965883)., no. January 2013, 2015.