Integration Of Virtual Reality (VR) And Building Information Modeling (BIM) Technology In Simulating The Concept Of Green Building Drawing Studio Room, Faculty Of Engineering, Universitas Negeri Medan

Harry Wibowo[1], Ahmad Zulfikar[2] , Denny Meisandy Hutauruk[3]

harry_ft@unimed.ac.id [1], ahmadzulfikar@unimed.ac.id [2],denny_ft@unimed.ac.id[3]

Department of Architecture, Faculty of Engineering, Universitas Negeri Medan, Indonesia, 20221 [1,2], Department of Civil Engineering, Faculty of Engineering, Universitas Negeri Medan, Indonesia, 20221[3]

Abstract. The application of virtual reality (VR) technology in building design can provide users with a fun and interactive experience to explore the concept of building design. Besides that, building information building (BIM) can provide accurate and integrated 3D data about aspects of facilities, such as architecture, structure, mechanical, electrical, and plumbing. This research will evaluate how the integration of VR and BIM can be used in simulating the Green Building concept under the constraints of natural lighting and natural airing of image studio space by existing standards. This research will analyze how VR can improve user interaction with building concepts and how BIM can provide accurate and integrated data for natural lighting and natural ventilation analysis. Overall, this research will provide insight into how the integration of VR and BIM can be used to improve the quality of Green Building concept simulations in image studio spaces and provide solutions to create environmentally friendly buildings.

Keywords: VR (Virtual Reality), BIM (Building Information Modeling), Green Building

1 Introduction

The development of information technology is growing rapidly every year in various fields. One of them is BIM (Building Information Model) and VR (Virtual Reality) technology that can be applied to the field of architecture [5]. These technologies have a huge impact, resulting in better presentation and planning quality. The use of Virtual Reality (VR) technology can provide new experiences for students about "space" in designing a building [9]. In the construction field, this technology can ensure construction safety and rationally carry out engineering planning, avoid misuse of materials in construction, ensure the rationality of construction techniques, improve construction quality comprehensively, and

ICIESC 2023, October 24, Medan, Indonesia

DOI 10.4108/eai.24-10-2023.2342335

realize the continuous development of construction techniques [10]. In addition, the use of BIM (building information modeling) technology, which is a combination of digitizing building models and information, basically includes all building project information, including geometric and non- geometric information of material properties, volumes, and other information is also very useful for architectural planning efficiency, especially during design revisions [11]

In line with the development of information technology, today, the direction of building architectural planning leads to the concept of green building (Latifah et al., n.d.). Green buildings meet building requirements and have measurable performance in saving energy, water, and other resources by applying green building principles to their functions and classifications at each implementation stage [1]. Green buildings today have become the foundation of an ideal sustainable building. Green buildings have provided tangible benefits through design, can reduce carbon emissions, reduce energy, reduce waste, save water, prioritize safer materials, and reduce pollution [4]. Policies on implementing green buildings as part of sustainability planning in campus areas have also been widely applied in various universities. This is part of efforts to conserve energy in the campus environment [7].

In 2016, Medan State University was ranked 20th out of all campuses in Indonesia with a score of 3774.96 and became the only university in North Sumatra included in the UI Green Metric (unimed.ac.id/2016/12/30/unimed-raih-peringkat-20-kampus-hijau). UI GreenMetric World University Ranking is a ranking of green campuses and environmental sustainability initiated by the University of Indonesia in 2010. Through 39 indicators in 6 criteria, UI GreenMetric World University Rankings carefully determines the ranking based on the university's environmental commitments and initiatives. However, in 2022, Medan State University dropped to rank 59 out of 101 existing national universities and rank 768 internationally.

From these facts, a study was formulated on applying the green building concept with a virtual reality approach and building integration modeling in the campus environment, with a case study being a lecture room, namely the drawing studio of the Faculty of Engineering, Medan State University. The limitation of the research is one image studio room with a size of 10x12m with green building criteria focusing on aspects of the application of natural lighting of the room to minimize the use of electrical energy in the morning-afternoon. This research discussed the design of the drawing studio space in a new building to be built in the Department of Building Engineering Education, Faculty of Engineering. This image studio is used by 3 study programs, including architecture study programs, building engineering education, and civil engineering. From the schedule of using the drawing studio space, the frequency of using the image studio is very high, just like the studio must be able to accommodate and support the needs of students optimally in terms of physical facilities so that the process and learning outcomes of designing them are achieved positively, especially accumulatively for the long term. The existence of an image studio is considered successful if it is effective and on target by considering the needs of students as its intense users, one of which is the need for lighting conditioning, which is important to support the goals of the image studio, in terms of student vision performance to be able to draw without difficulty [10]. Therefore, students' preference for studio lighting must be considered in building image studio lighting design criteria.

2 Research Methods

2.1 Place and Time of Research

The research place is in the Lecture Building of the Faculty of Engineering, Medan State University, with the object of research in the Image Studio room. The activity begins by observing existing conditions through measurements of both natural and artificial lighting during lecture hours of the Building Drawing Course as a consideration in determining the lighting design criteria to be produced.

Fig. 1. Existing Conditions of the Drawing Studio Room of the Faculty of Engineering.

2.2 Research Materials and Tools

The materials needed are existing drawings of the studio room, technical specifications of lighting standards for the drawing room, and research objects obtained from direct observation and resource persons. The tools used in this study are laser / digital meter lux meter. More details can be seen in the table below

Table 1. Research Materials and Tools

No	Tool Name & Specifications	Function
1	Digital measurmentor (Leica Disto D1)	This tool serves to measure the dimentions of the room in the form of length, width and height of space and openings.
2	Lux Meter	This tool serves to measure the lighting in the room
3	Camera Digital	This tool serves to document activities
4	headset virtual reality (VR) (Oculus Quest 2)	This tool serves to provide a simulation of virtual space

2.3 Research Design

The research method uses a qualitative approach with an Experimental Research approach. This research consists of the stages of data collection, processing, presentation, and analysis. The study consisted of four steps, as shown in Figure 1. The first step is determining the image studio room's design criteria that meet natural and artificial lighting standards using GBCI and SNI parameters. The second step is creating a BIM model, which includes geometry, material, and space information using Autodesk Revit 2019 software. The third step is to test the model using Dialux software to determine the needs of natural and artificial enumeration. Lastly, it combines natural lighting simulation and user experience in a virtual environment using Enscape software with the help of Oculus Quest 2 VR tools.

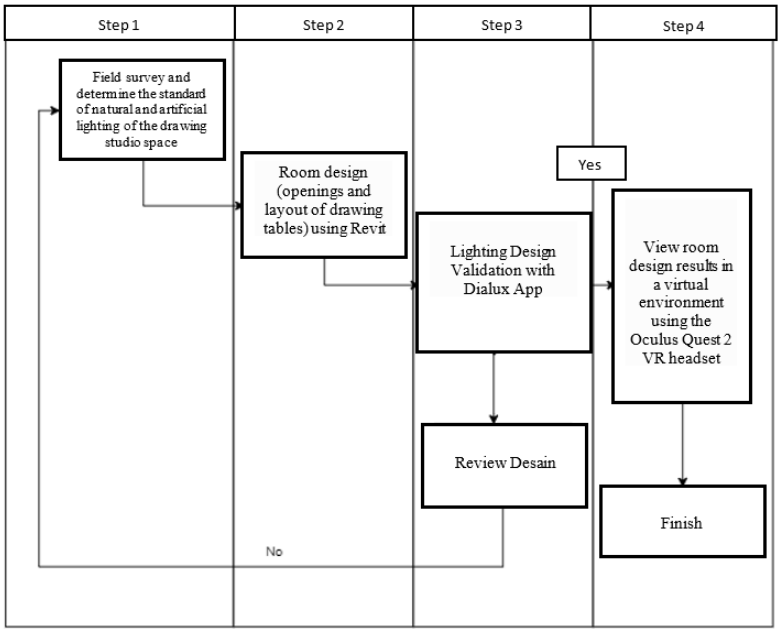

Fig. 2. Green Building Analysis Framework Image Studio Space Design using BIM and VR

3 Research Methods

According to Green Building Council Indonesia, energy-saving efforts in the EEC (Energy Efficiency and Conservation) interior space category include five criteria as follows [30] :

1. Energy Conservation Campaign
2. MVAC Control
3. Lighting Power Density and Control
4. Energy Monitoring and Control
5. Electrical Equipment and Appliances

Natural lighting uses light from natural lighting objects such as the sun, moon, and stars as a light for space. Sunlight used as interior lighting is often referred to as daylight. Natural light

is generally distributed into the room through side lighting, top lighting, or a combination of both [8]. A good distribution of natural light in a space is directly related to the architectural configuration of the building, the orientation of the building, and the depth and volume of the space.

According to SNI No. 03-2396-2001 concerning Natural Lighting System Design Procedures [12], the level of natural lighting, especially in image studio rooms, is 750 lux, or exactly 3x the lighting for ordinary study rooms. More details can be seen in the following table.

Table 2. Minimum recommended Lighting Level

No	Room Functions	Lighting Level (lux)	Information
1	Classroom	250	
2	Library	300	
3	Laboratory	500	
4	Drawing Room	750	Added Local Artificial Lighting if needed
5	Canteen	500	

4 Results And Discussion

Lighting recording is carried out at the start of lectures, namely at 08.00 WIB, and at the end of using the Image Studio room at 16.45 WIB, using the Lux meter tool. From the results of field data collection on natural and artificial lighting in 1 day, the following results were obtained:

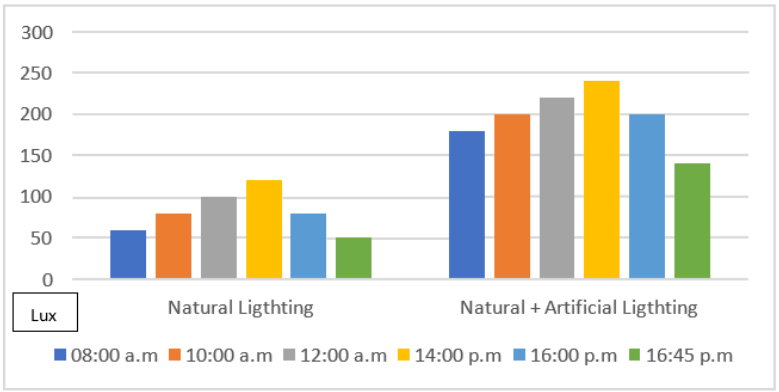

Fig. 3. Data on the amount of natural and artificial lighting (lux) in FT Unimed Image Studio

From the results of field data, it was concluded that the drawing studio room of the Faculty of Engineering in Building 8 was not standard for drawing activities. So, it is necessary to make a good room design by following the rules of green buildings through modeling with the BIM method. The BIM software used in this study is Autodesk Revit 2019.

4.1 Design Recommendations

The design of the Faculty of Engineering, State University of Medan's drawing studio space maximizes natural enumeration from both sides of the building with a total opening area of 70% of the building wall area. The room size is by the standard room requirements for 30 students, which is 120m2. The position of the Drawing Table is placed parallel to the natural lighting source, namely the window, to maximize lighting during the drawing process. To increase the intensity of light in the afternoon, additional artificial lighting is needed in the form of 15-watt tube-type LED lamps (Save Engergi) as many as 16 points. Here is a model of an image studio room simulated using the BIM Revit method.

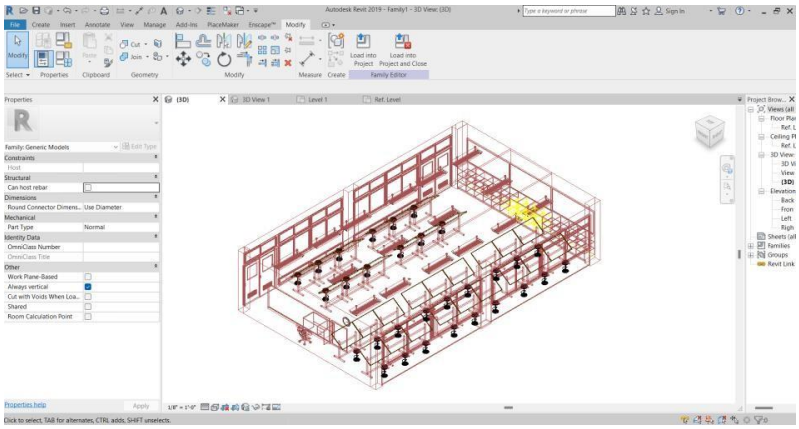

Fig. 4. Modeling Drawing Room with Autodesk Revit (BIM) Eksterior

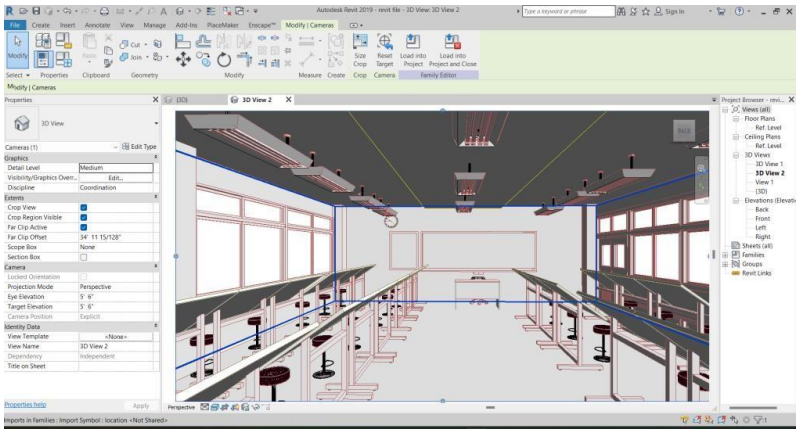

Fig. 5. Modeling Drawing Room with Autodesk Revit (BIM) Interior

After successfully making a room simulation complete with room furniture and room windows. Furthermore, standard validation testing of natural lighting of the image studio room (min.750 lux) was carried out using Dialux software. This software presents lighting simulation options in a building or room. Room data from Autodesk Revit software can be directly exported to Dialux by making it an IPC

extension. After finishing opening and running the Dialux program using the previous model, it will appear on the screen as shown below.

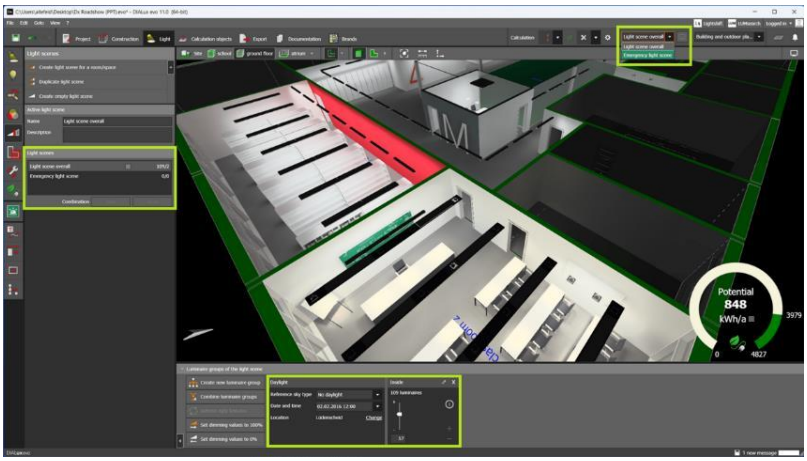

Fig. 6. Validate lighting values with the Dialux app

From the results of the simulation of the concept of the image studio room, the amount of natural enumeration produced from the studio room that has been designed is 848 lux; this is by the SNI and Green Building criteria standards.

Next is to integrate the studio room model in BIM format into virtual visuals to obtain direct user interaction with the design to be built. To realize this, use the Enscape plugin on the Autodesk Revit application and using hardware in virtual reality tools, namely Oculus Quest 2. With this tool, users can experience virtually the natural enumeration conditions and artificial lighting in the drawing studio room.

Fig. 7. Final design visualization using VR technology

5 Conclusion

This research proposes a visualization integration framework that combines BIM and VR, which is used to visualize lighting information, both natural and artificial, that has been validated by green building criteria through the Dialux application in a Virtual environment in a case study of the drawing studio room of the Faculty of Engineering, State University of Medan. In addition, these prototypes can visualize the actual building design, inner spaces, openings, and existing lighting and provide effective design feedback. BIM and VR can be integrated to achieve room lighting design. Combining VR and BIM technology provides users, such as architectural owners and designers, a more realistic and natural lighting environment experience.

In future research, we will build a more refined modular BIM, combined with the simulation results of several other aspects related to green buildings in the campus environment, including aspects of air/wind, water utilization, and building materials in the Virtual Reality (VR) environment. By expanding the application of virtual reality technology in architectural design, the interaction of BIM simulation and other programs can be realized, and design efficiency can be improved.

References

[1] Yudelson, J : The Green Building Revolution.Island Press.Washington (2010)

[2] Chandra, T., Amin, A. R. Z., Alami, S. P., Buatan, D., Chandra, T., Rachmad, A., & Amin, Z. (n.d.). Simulasi Pencahayaan Alami Dan Buatan Dengan Ecotect Radiance Pada Studio Gambar Kasus Studi: Studio Gambar Sekolah Tinggi Teknik Musi Palembang (2013)

[3] Greenship, Green Building Council Indonesia Untuk Bangunan Baru Versi 1.2 Ringkasan Kriteria Dan Tolok Ukur (2013)

[4] Ragheb, A., El-Shimy, H., & Ragheb, G.. Green Architecture: A Concept of Sustainability. Procedia - Social and Behavioral Sciences, 216, 778–787. https://doi.org/10.1016/j.sbspro.2015.12.075 Washington (2016)

[5] Hermund, A., Lars, ;, Klint, S., Ture, ;, & Bundgaard, S. (n.d.). Architecture, Design and Conservation Danish Portal for Artistic and Scientific Research Aarhus School of Architecture // Design School Kolding // Royal Danish Academy BIM with VR for architectural simulations BIM with VR for architectural simulations Building Information Models in Virtual Reality as an architectural and urban designtool. (2018)

[6] Latifah, N. L., Erwin, D., Rahadian, Y., Arsitektur, J., Sipil, T., & Perencanaan, D. (n.d.). Strategi Green Building untuk Optimalisasi Penghematan Energi Operasional Bangunan terkait Rancangan Ventilasi dan Pengkondisian Udara pada Gedung Kantor Pengelola Bendungan Sei Gong-Batam. (2018)

[7] Khoshbakht, M., Gou, Z., & Dupre, K. Campus green buildings: Policy implications for the implementing, monitoring and evaluation of campus green building initiatives. IOP Conference Series: Earth and Environmental Science, 294(1). https://doi.org/10.1088/1755-1315/294/1/012004. (2019).

[8] Wijaya, F. (n.d.). Seminar Nasional Infrastruktur Berkelanjutan Era Revolusi Industri 4.0 Teknik Sipil dan Perencanaan Sistem Pencahayaan Dan Penghawaan Hemat Energi Pada Gedung Q Universitas Kristen Petra. (2019).

[9] Syafril, R. S., Redo Hervando, A., & Jovan, A. (n.d.). (2019) Penerapan Sederhana Virtual Reality dalam Presentasi Arsitektur (Red Savitra Syafril, Ahmad Redo Hervando. (2019).
[10] Chen, Y. Application Research of BIM + VR Technology in Real Green Building Engineering. Learning & Education, 10(3), 198. https://doi.org/10.18282/l-e.v10i3.2450 (2021).
[11] Rizki, M. A., Hermawan, H., & Wahyuni, A. (2023). EVALUASI GREEN CAMPUS BERBASIS
BIM (Vol. 12, Issue 2). http://u.lipi.go.id/1320332466
[12] SNI No 03-2396-2001, Tata Cara Perancangan Sistem Pencahayaan Alami Pada Bangunan Gedung