# The Evaluation of the Performance of the Old Lecture Building Using Overall Thermal Transfer Value

Widya Fransiska F. Anwar[1], Isnaini[2]

[1] Department of Architecture, Faculty of Engineering, Universitas Sriwijaya.
[2] Indonesian Institute of Architects Chapter South Sumatra.

Email korespondensi: widyafransiska@ft.unsri.ac.id

Submitted: 10-07-2025 Reviewed: 15-07-2025 Revised: 08-08-2025 Accepted: 20-08-2025

**ABSTRACT.** The old lecture building is one of the campus assets that is still used for lectures. Generally, buildings like this are built with different climate conditions than today. The lecture process requires conducive and comfortable conditions for students and teachers. It is necessary to conduct an evaluation of building performance to assess the building's ability to create comfort for its users. The problem in this study is how the performance of a lecture building that was built more than 50 years ago, whether it can still provide the same comfort as when this building was newly built. This study aims to determine whether the old lecture building is able to create comfort that is in accordance with current lecture activities. To achieve this goal, this study measures the performance of the Lecture Building “I” using the Overall Thermal Transfer Value (OTTV) parameter. This study method is quantitative in the form of calculating the building envelope of Lecture Building “I”, which is the old lecture building of the Faculty of Engineering, Sriwijaya University. The results show that the OTTV value of building I is 38.22 watts/m$^2$. This study concludes that the Lecture Building ”I” has not been able to create comfort for its users. The effect of this is the waste of electrical energy used in air conditioning. The study suggests replacing the opening material with one that reduces heat transmittance to the interior of the building.

**Keywords:** OTTV, evaluation, building performance, energy efficiency, lecture building

***ABSTRAK.*** *Gedung kuliah lama merupakan salah satu aset kampus yang masih digunakan untuk perkuliahan. Umumnya gedung seperti ini dibangun dengan kondisi iklim yang berbeda dengan saat ini. Proses perkuliahan memerlukan kondisi yang kondusif dan nyaman bagi mahasiswa dan pengajar. Untuk itu perlu dilakukan pengukuran evaluasi performa bangunan gedung untuk menilai kemampuan gedung menciptakan kenyamanan bagi penggunanya. Permasalahan pada penelitian ini adalah bagaimana performa bangunan kuliah yang dibangun lebih dari 50 tahun yang lalu, apakah masih dapat memberikan kenyamanan yang sama dengan saat bangunan ini baru dibangun dengan perubahan kondisi cuaca. Penelitian ini bertujuan untuk mengetahui kemampuan gedung perkuliahan lama menciptakan kenyamanan yang sesuai dengan kegiatan perkuliahan saat ini. Untuk mencapai tujuan tersebut, penelitian ini mengukur performa bangunan gedung I dengan menggunakan parameter Overall Thermal Transfer Value (OTTV). Metode kajian adalah kuantitatif berupa perhitungan dari selubung bangunan Gedung Kuliah I yang merupakan bangunan perkuliahan lama Fakultas Teknik Universitas Sriwijaya. Hasil pengukuran menunjukkan bahwa nilai OTTV Gedung Kuliah I adalah 38,42 watt/m$^2$. Penelitian ini menyimpulkan bahwa kenyamanan yang diwujudkan pada bangunan gedung kuliah I memerlukan energi yang lebih dari standar SNI tentang konservasi energi maksimal 35 watt/m$^2$. Efek dari hal ini adalah pemborosan energi listrik yang digunakan pada pengkondisian udara. Penelitian menyarankan untuk mengganti material bangunan pada bukaan dengan yang mengurangi transmitansi panas ke ruang dalam bangunan.*

***Kata kunci:*** *OTTV, evaluasi, performa gedung, efisiensi energi, gedung kuliah*

## INTRODUCTION

The lecture process requires conducive conditions. The quality of the lecture room affects student’s motivation to be able to focus more on the lecture notes given in class. Lecture buildings are campus assets whose existence is intended for a long period of time. Many campuses have lecture buildings that are more than 50 years old. In order to make the knowledge delivery run well, it is necessary to evaluate the performance of the old lecture building on campus in providing optimal comfort for lecture activities. Students need to have sufficient thermal and visual comfort as part of the educational service (Widyakusuma and Zainoeddin, 2022). The evaluation of the old lecture building's performance is carried out to assess how the building creates efficiency, comfort, and sustainability. This evaluation is intended to ensure that the lecture building meets the needs of a good academic atmosphere.

In evaluating building performance, the things that are considered are air quality, energy efficiency, thermal comfort, visual comfort, and user satisfaction. Therefore, the influence of weather is very important in creating the expected building performance. The problem arises with the old lecture building, which was built more than 50 years ago. The weather conditions have changed. Can the old lecture building provide the same comfort as when it was first built in current natural conditions? Building age is one of the determining factors that provide indoor quality of the classroom (Broadway, L.A., 2025). For this reason, this study uses the Lecture Building "I" as a case study. It is an old lecture building of the Faculty of Engineering, Universitas Sriwijaya, which is located at the Bukit Besar Campus.

This study aims to evaluate the old lecture building in creating comfort that is in accordance with lecture activities in the current context. To achieve this goal, this study measures the performance of Lecture Building "I" using the Overall Thermal Transfer Value (OTTV) parameter.

**LECTURE BUILDING AND OTTV**

Most of the old lecture building was built with less consideration of energy efficiency. 50 years ago, the temperature was relatively low and the urban green area was larger than it is in the current condition. Therefore, the performance of an old lecture building requires special attention considering the age of the building and the climate conditions around the building, which are no longer the same as when the building was built (Wibowo, Yudiarma, and Fitriyanto, 2024). In old buildings, the potential for energy savings can be achieved by evaluating the building envelope and calculating OTTV (Octafiansyah, Marwati, and Wasnadi, 2024; Gigante, A. et.al., 2024; Efiariza, et al, 2025). The building envelope is important to control heat transfer into the building (Efiariza et al., 2025; El-Darwish and Gomaa, 2017). OTTV is important to understand how to optimise energy use. Elements that have an influence on OTTV are the area of the opening and the material of the opening (Oktariano and Feriadi, 2021).

Most of the old lecture building was built with less consideration of energy efficiency. 50 years ago, the temperature was relatively low and the urban green area was larger than it is in the current condition. Therefore, the performance of an old lecture building requires special attention considering the age of the building and the climate conditions around the building, which are no longer the same as when the building was built (Wibowo et al., 2024). Meanwhile, approximately 40% of the total energy is reportedly consumed in the building sector (Akram et al., 2022). For old buildings, the potential for energy savings can be achieved by evaluating the building envelope and calculating OTTV. Elements that have an influence on OTTV are the area of the opening and the material of the opening (Oktariano and Feriadi, 2021).

Overall Thermal Transfer Value (OTTV) is a number to indicate the heat gain due to solar radiation that passes a square meter of the building envelope area (Satwiko, 2009). The value of OTTV is a design criterion for the walls and glass of the exterior of a conditioned building (Indonesian National Standard (SNI) Number 6389-2020). OTTV symbolises building performance because it shows the thermal performance and affects building energy consumption. Building performance and OTTV values are interrelated because they show energy efficiency and the sustainability of building design.

From the architectural design perspective, OTTV is related to the building envelope (Mas' um et al., 2024). The building envelope shows the geometry of the building, which will significantly affect energy consumption. A'yun (2023) mentions that buildings with different shapes and sizes show different levels of energy performance. OTTV measures heat gain through the building envelope, directly affecting energy efficiency and performance. By using the OTTV, architects and designers can optimise building components and air conditioning systems to improve energy conservation (Siaw and Chang, 1996). OTTV directly affects energy needs for heating and cooling the building. A compact and efficient design can minimise energy loss, thereby improving the overall performance of the building. Harmati et al. (2016) state that optimising the window-to-wall ratio and glass usage parameters can significantly improve energy performance. This shows the importance of OTTV in design decisions (Harmati et al., 2016; Hidayat dan Bachri, 2025).

According to SNI 6389-2020, OTTV is the total thermal transfer value of the outer wall, which has a certain orientation or direction (Watt/m$^2$). A building has an energy efficiency when the OTTV (Overall Thermal Transfer Value) and RTTV (Roof Thermal Transfer Value) values do not exceed 35 Watt/m$^2$. The smaller the OTTV value, the smaller the energy transfer into the building (Oktariano and Feriadi, 2021). The OTTV concept includes three basic heat transfers through the outer building envelope, namely, heat conduction through walls and heat conduction through glass. And solar radiation through windows (Hidayat, 2022). These three things are the values that determine the OTTV calculation value with the following formula:

$$OTTV = (Qw + Qg + Qsol)/Ai \qquad (1)$$

Qw = heat conduction through solid walls
Qg = heat conduction through windows
Qsol = solar heat radiation
Ai = total area of windows and solid walls

The building envelope energy conservation criteria include the ratio of window glass to walls or Window to Wall Ratio (WWR), type, thickness of the outer wall, colour of the outer wall, protection, glass conductance, roof and wall insulation, roof and wall absorption, facing direction, and others (SNI 6389-2020). The area exposed to the entry of heat into the room, which causes heat transfer, is called the fenestration area. WWR is the ratio of the area of the fenestration system to the gross area outside the wall. The WWR value determines the heat conduction value calculated in the OTTV calculation. The OTTV formula is derived as follows.

$$OTTV = \alpha\ [(U_w \times (1-WWR) \times TD_{Ek}] + (U_f \times WWR \times \Delta T) + (SC \times WWR \times SF) \qquad (2)$$

OTTV = Total thermal transfer value on the outer wall that has a certain direction or orientation (W/m$^2$)
α = Absorbance of solar radiation
Uw = Thermal transmittance of opaque walls
WWR = Comparison of the window area with the total area of the outer wall at the specified orientation
TDEk = Equivalent temperature difference
SF = Solar radiation factor
SC = Shading coefficient of the fenestration system
Uf = Thermal transmittance of fenestration
ΔT = Difference in temperature between the outside and inside of the design

**METHOD**

This study uses the Lecture Building “I”, Faculty of Engineering, Sriwijaya University, as the object of research. This building has two floors and two functions. The first floor functions as a lecture area and consists of several lecture rooms. The second floor is used as an administrative area for the faculty, which consists of an office and a hall to accommodate campus activities with a larger capacity. This building was erected 50 years ago. This building's front side faces the campus ring road to the east, so the back side is to the west of the building. The right and left sides of the building envelopes are brick walls and glass windows. Initially, this building was not designed to use an Air Conditioner, but in its development, the room in the building was conditioned using a split air conditioner. The room’s layout faces the corridor of the building. There are two foyer areas, on the west and east sides of the corridor. The foyer area is unconditioned. Figure 1 shows an illustration of the research object.

The OTTV calculation method begins with collecting data. The required data includes building envelope data, conditioned areas, and materials. Building envelope data is obtained by measuring the area of exterior walls and the size of openings in the walls. The area of exterior walls is measured using a manual meter and a digital meter. The measurement of opening area includes the length and width of windows. Conditioned area data includes floor plan areas that are not air-conditioned. The material data is obtained from the visual observation. After all data is obtained, the OTTV can be calculated. The OTTV calculation method follows the Indonesian National Standard (SNI).

As mentioned before, the calculation follows the SNI 6389-2020 standard. The OTTV calculation procedure includes (1) determining the conditioned building envelope area and its WWR value, (2) determining the solar absorbance value, (3) determining the thermal transmittance value, (5) determining the shading coefficient, (6) determining the radiation factor and equivalent temperature difference, (7) calculating partial OTTV, (8) calculating total OTTV and (9) checking the obtained OTTV value with the specified standard.

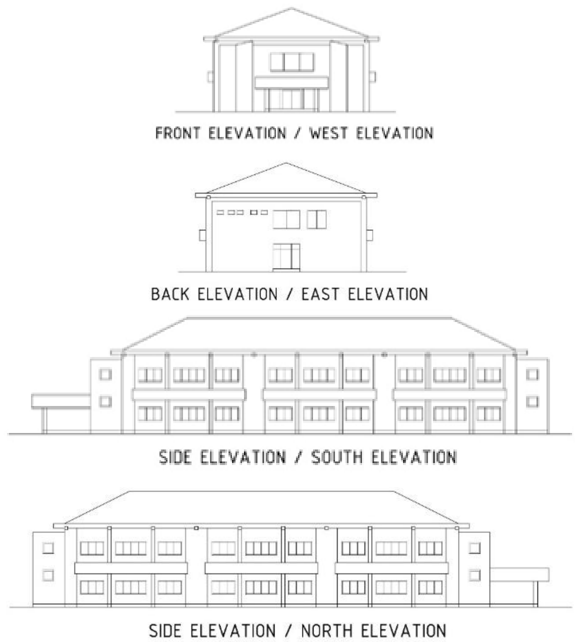



**Figure 1**. 4 Facades of the Research Object
Source: Author, 2024

In calculating the OTTV, some steps were taken in this study. First of all, it is necessary to identify the wind direction on the plan. This is to find out which direction of the building envelope receives the maximum exposure to solar heat. Secondly, the study identified the room that needs to be air-conditioned on the plan. The study also elaborated on the area of the openings on the building envelope, which includes the dimensions of the openings, the dimensions between floors, and is identified per side of the building. Because OTTV directly affects the energy needs for heating and cooling the building, the calculated area is the air-conditioned side of the building envelope. In this Lecture Building "I", the air conditioning is on the north and south sides. Lastly, data on the technical specifications of building materials is sought, including the types of transparent and non-transparent walls installed in the building. Specifically, for transparent materials included in the calculation, the dominant material is glass. Meanwhile, minor materials such as frames and glass lists are ignored in this calculation.

## RESULT AND DISCUSSION

The Lecture Building "I" has a main facade facing east. The building extends to the west and the east, and the west and east axes become a central corridor connecting the spaces on the north and south sides (Figure 2).

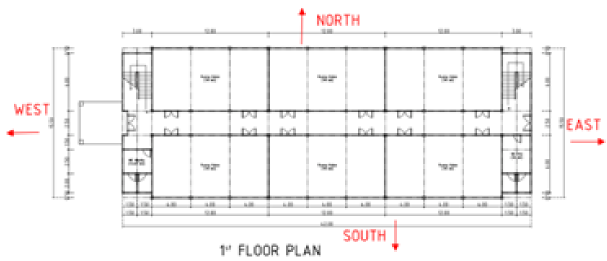
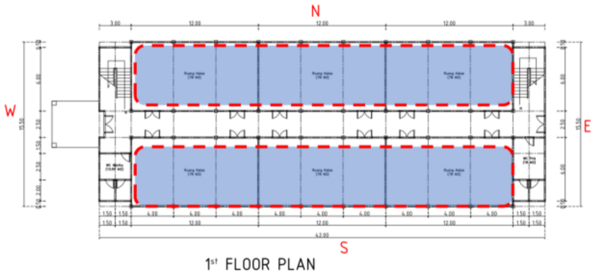
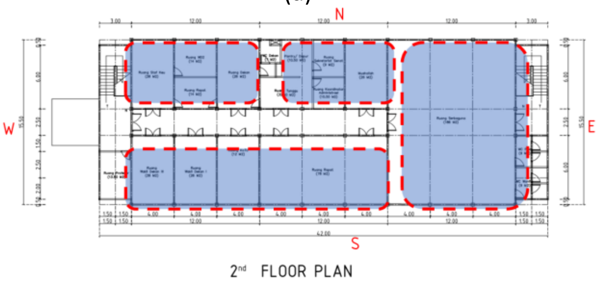



**Figure 2.** Identification of the Building's Wind Direction
Source: Author, 2024

There are two rooms or areas that are not conditioned, namely the foyer area on the east and west sides of the building. This area is the stair area that connects the first and second floors. Furthermore, all the rooms in this building are rooms that are conditioned for ventilation (Figure 3).



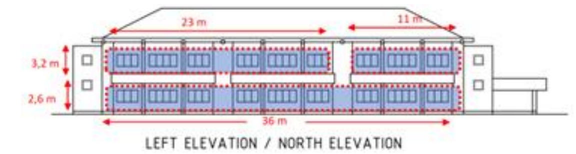

(a)



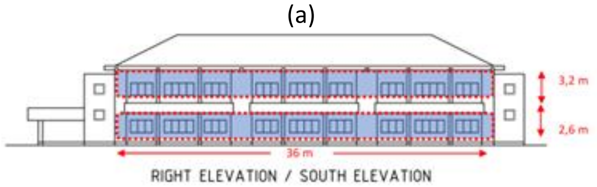

(b)

**Figure 3.** Identification of Conditioned Spaces on the Floor Plan, (a) 1st Floor and (b) Second Floor
Source: Analysis, 2024

Regarding the building envelope, conditioned spaces are also identified on the building elevation. Based on the identification on the floor plan, the conditioned spaces are visible on the north and south elevations. The east and west elevations are not conditioned. Identification of elevations is done by giving boundaries to the elevation and measuring its dimensions. The illustration in Figure 4 is as follows.



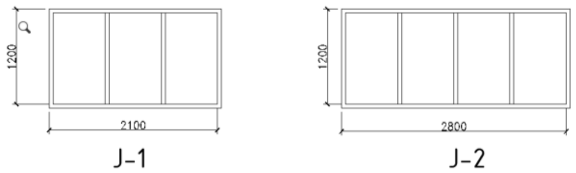

(a)



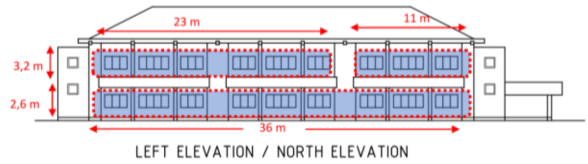

(b)

**Figure 4**. Identification of Conditioned Space in the Elevation Image, (a) North Side View (Right) and (b) South Side View (Left)
Source: Analysis, 2024

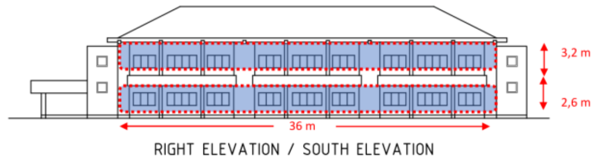
Next, the area of the opening is calculated, including the dimensions of the opening, dimensions between floors, and identification of each side of the building whose space is conditioned (Figure 5). After calculating the area, the technical specifications of the materials of building I are identified. The windows have clear glass without shades. The type of material on the walls is plastered brick, and the table appears immediately after being referred to in the text.




(a)




(b)




(C)

**Figure 5.** Identification of Opening Dimensions: (a) Window Dimensions; (b) Dimensions of Openings on the North View; (c) Dimensions of Openings on the South View

After identifying the openings and materials, the OTTV calculation can be done. By entering the equation value in the formula, the OTTV calculation results are obtained for the south facade and north facade. For the south facade, the OTTV value is 37.39. The north facade has an OTTV value of 39.05. From these two values, the overall OTTV is calculated using the following formula:

$$OTTV = ((A0_1 \times OTTV\ 1)+(A0_2 \times OTTV\ 2)+\cdots+(A0_i \times OTTV\ i))/(A0_1+A0_2+\cdots+A0_i) \quad (3)$$

The overall OTTV calculation result is calculated using this formula. The results of the calculation are shown in the following table 1:

**Tabel 1**. Overall OTTV Calculation

| Number | Elevation | OTTV (watt/$m^2$) | Fasade Area ($m^2$) | OTTV X Fasade Area |
|---|---|---|---|---|
| 1 | North | 39,48 | 202,40 | 7991,75 |
| 2 | East | 0 | - | 0 |
| 3 | South | 37,39 | 208,80 | 7806,69 |
| 4 | West | 0 | - | 0 |
| | | | 411,20 | 15798,45 |
| | | | OTTV | 38,42 |

Source: Analysis, 2025

From the results of the overall OTTV calculation in Table 1, it can be seen that the value obtained is 38.42 watts/$m^2$.

**CONCLUSION**

This study aims to determine whether the lecture building, in terms of creating comfort that is in accordance with current lecture activities, is included in the category of energy-efficient buildings. From the OTTV calculation carried out on the building envelope in the conditioned room, the overall OTTV value is 38.42 watts/$m^2$. An energy-efficient building is one that has a maximum OTTV value of 35 watts/$m^2$. This means that with the existing conditions, this lecture building is only able to create comfort with inefficient energy use. This building must use air conditioning to create comfort. With an OTTV value that exceeds the energy-saving standard, it is reflected that the use of electrical energy for air conditioning in this building is inefficient. This causes the building to not meet the rules of energy-efficient buildings. What can be done is to replace the opening material that has a thermal transmittance value that can produce an optimal OTTV calculation value and is not more than 35 watts/$m^2$. One of the suggestions is to replace the type of glass that is replaced with glass that can reduce the heat entering the room.

**REFERENCE**

Akram, M. W., Mohd Zublie, M. F., Hasanuzzaman, M., & Rahim, N. A. (2022). Global Prospects, Advanced Technologies and Policies of Energy-Saving and Sustainable Building Systems: A Review. *Sustainability*, *14*(3), 1316. https://doi.org/10.3390/su14031316

A'yun, Q. (2023) Identifikasi Pengaruh Bentuk Desain Bangunan terhadap Intensitas Konsumsi Energi Melalui Metode Simulasi Komputasional Sefaira, *Nature,* Vol.10.(10). hlm 130-143. https://doi.org/10.24252/nature.v10i2a2

Broadway, L.A., et.al. (2025). Building age is a determining factor of indoor CO2 levels in a university setting. *Indoor Environments*, 2 (2),100100, https://doi.org/10.1016/j.indenv.2025.100100

Chou, S.K., Chang, W.L. (1996). A Generalized Methodology for Determining the Total Heat Gain Through Building Envelopes. *International Journal of Energy Research*. Vol.20 (10) hlm. 887-901. https://doi.org/10.1002/(SICI)1099-114X(199610)20:10<887::AID-ER202>3.0.CO;2-T

Efiariza, R. R., Hikmah, N., Damanik, N. H. C., & Ayutia, G. T. (2025). Studi Nilai Transfer Panas Keseluruhan Pada Selubung Bangunan Pusat Kegiatan Mahasiswa. *Jurnal Ilmiah Poli Rekayasa*, *20*(2), 60-66. http://dx.doi.org/10.30630/jipr.20.2.395

El-Darwish,I and Gomaa,M. (2017). Retrofitting Strategy for Building Envelopes to Achieve Energy Efficiency, *Alexandria Engineering Journal*, 56 (4). 579-589 https://doi.org/10.1016/j.aej.2017.05.011

Gigante, A. et.al. (2024). Indoor quality-oriented approach for the performance evaluation of building retrofit with façade transformation: Case study of student dormitory in Mediterranean climate. *Energy and Buildings*. 312, 114227 https://doi.org/10.1016/j.enbuild.2024.114227

Harmati, N.L., Folic, R.J., Magyar, Z., Drazic, J.J., Kurtovic-Folic, N. (2016). Building Envelope Influence on The Annual Energy Performance in Office Buildings. *Thermal Science.* Vol.20 (2) hlm 679-693. https://doi.org/10.2298/TSCI141111109H

Hidayat, MS. (2022) Studi Overall Thermal Transfer Value (OTTV) di Gedung Kampus Universitas.*Metrik–Serial Teknologi dan Sains*. Vol.3(2). hlm 1-7. https://doi.org/10.51616/teksi.v3i2.344

Hidayat, M. S., & Bachri, A. (2025). Studi Window-to-Wall Ratio dan Pengaruhnya terhadap Temperatur Udara dalam Ruang Kelas untuk Mencapai Bangunan Hemat Energi. *Jurnal Lingkungan Binaan Indonesia*, *14*(2), 108-115. https://doi.org/10.32315/jlbi.v14i2.475

Mas' um, I. N., Amalia, R. R., & Musda, G. H. (2024). Analisis OTTV (Overall Thermal Transfer Value) sebagai Pendekatan Arsitektur Hemat Energi pada Selubung Bangunan Museum Kota Makassar. *Jurnal Ilmu Pengetahuan Dan Teknologi (Iptek)*, *8*(2), 7-11. https://doi.org/10.31543/jii.v8i2.341

Octafiansyah, H. A., Marwati, A., & Wasnadi, H. F. (2024). Analisis Fasad Bangunan Itb Ahmad Dahlan Karawaci Dengan Perhitungan Overall Thermal Transfer Value (OTTV). *RUSTIC: Jurnal Arsitektur*, *4*(1), 49-71. https://doi.org/10.32546/rustic.v4i1.2360

Octarino, C. N., & Feriadi, H. (2021). Evaluasi Kinerja Selubung Bangunan Gedung Agape Universitas Kristen Duta Wacana Yogyakarta. *Langkau Betang: Jurnal Arsitektur*, *8*(2), 86-97. https://doi.org/10.26418/lantang.v8i2.45436

Wibowo, T., Yudiarma, Y., & Fitriyanto, A. (2024). Analisis Nilai Termal Selubung Bangunan (OTTV) Pada Bangunan Gedung Direktorat Politeknik Negeri Pontianak sebagai Indikator Penilaian Kinerja Bangunan Gedung Hijau menggunakan Building Compliance Form V3. 0. *Vokasi: Jurnal Publikasi Ilmiah*, *19*(1), 34-54. https://ejurnal.polnep.ac.id/index.php/vokasi/article/view/783/516

Widyakusuma, A., & Zainoeddin, A. (2022). Redesign Optimization of Campus Building Envelope With a Green Architecture Approach (Case Study: Borobudur University Jakarta). *TRAVE*, *26*(1), 20-27. Retrieved from https://ejournal.istn.ac.id/index.php/TRAVE/article/view/1195