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The Effect of the Implementation of Secondary Skin on the Decline in OTTV Value. Case Study: Outmall AEON Mall Jakarta Garden City

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ABSTRACT

The planning of the application of Secondary Skin on the façade of the Aeon Mall Jakarta Garden City Outmall was carried out with a quantitative method approach, which involved simulation using a 3D model of Building Performance Simulation (BPS) and shadow animation using AndrewMarsh-Dynamic Overshadowing. This study focuses on OTTV measurement and evaluation of the effect of Secondary Skin application on a building's thermal comfort and energy efficiency. The current consideration shows that the façade area of the building is oriented towards the south and is uncomfortable for activities, one of which is caused by excessive heat due to direct exposure to sunlight. This makes the area not ideal for visitors who want to do activities or sit outdoors due to the temperature that is too hot. With the application of secondary skin, previously hot areas can become more comfortable and shady, thus supporting the comfort of visitors or residents around the façade of the building. This study shows that the application of Secondary Skin is essential in lowering OTTV (Overall Thermal Transfer Value), increasing thermal comfort, and creating better energy efficiency. Using BPS simulation and shadow animation, data was obtained that the Secondary Skin design reduced exposure to direct sunlight, thus making the hallway area more comfortable, especially at critical hours such as during the day when the sun was in a high position. Therefore, applying Secondary Skin to the Aeon Mall Jakarta Garden City Outmall can create a more comfortable, sustainable, and energy-efficient building.

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1. INTRODUCTION

BMKG Extreme Weather and Climate Practitioner Siswanto explained that, in general, Jakarta's climate has changed significantly in line with the city's growth due to rising global and regional temperatures that have increased sharply by 1.6 degrees Celsius in the last 130 years (Humas BRIN 2024). This issue is related to global warming, according to the Environment Agency, this phenomenon occurs due to the accumulation of greenhouse gases that change the composition of the Earth's atmosphere. This increase in temperature can lead to extreme climate change, melting polar ice, and disrupting ecosystem systems worldwide. The Intergovernmental Panel on Climate Change (IPCC), in its report, concluded that most of the increase in global average temperature since the mid-20th century is most likely due to human activities, which are mainly through the burning of fossil fuels (such as coal, oil, and gas) and increased concentrations of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrogen oxides (N_2O) in the atmosphere. Other human activities, such as deforestation, also contribute to the increase in these greenhouse gases (Admin DLH 2019).

Global warming has become an urgent environmental issue, with an impact that can be felt worldwide through energy efficiency. Energy consumption does not become wasteful and requires energy to be appropriate. The estuary is to reduce greenhouse gases and avoid global warming. Joe Millward-Hopskin, Environment at Leeds University, says that almost 50% of the modeling must be implemented to provide a decent standard of living but still save energy by 2050 (Kahn 2019). Applying the concept to buildings is an effort in energy efficiency, whereas the idea of sustainable design is used, especially on the façade of the building. Facades designed with energy efficiency can reduce energy consumption for heating and cooling (Fadhlan, Susetyarto, and Rosnarti 2024).

Aeon Mall is one of the shopping malls located on Jakarta Garden City Boulevard, Cakung, East Jakarta, Indonesia. Aeon Mall is one of the supports for daily needs for the existing organizational area, education center, and business district. The planning of the use of Secondary Skin in the Aeon Mall Jakarta Garden City Outmall area reduces the load of incoming solar heat. It increases thermal comfort in the room, thereby supporting the activities of visitors looking for entertainment or just walking. This study aims to determine the effect of the application of secondary skin on the decrease in the Overall Thermal Transfer Value (OTTV) value. The requirement measured by OTTV is 35W/m2. This requirement applies to buildings that meet the qualifications of energy-efficient buildings that aim to reduce external loads in air conditioning (Saifulhaq et al. 2023). Is the secondary skin design in the outmall area enough to protect its comfort, but can it also reduce energy in the Aeon Mall Jakarta Garden City Outmall building? The results of this research can be used to design more efficient buildings in terms of energy use and make them more comfortable and environmentally friendly.

1.1. Shopping Malls

A shopping center is a commercial building erected in a location that has been planned and developed based on the unit's location, size, type of store, and shopping area. Shopping malls provide parking spaces to load vehicle capacity, calculated by comparing visitor visits (Fahrul and Alimuddin 2018).

According to the Great Dictionary of Indonesian, a mall is a type of shopping center with architectural characteristics in the form of a closed building with a centrally regulated temperature to create comfort for its visitors (KBBI n.d.). Malls are usually designed with regular circulation lines, which connect the several shops facing each other. This allows visitors to stroll around and interact with the several shops inside easily. This concept creates

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a more organized atmosphere and will enable visitors to enjoy a comfortable shopping experience without being distracted by outside factors such as the weather (Rianto 2017). An example of a mall that follows modern mall design standards is Aeon Mall. The mall has a comfortable design, with complete visitor facilities, such as a large parking area, regular pedestrian walkways, and good temperature regulation inside the building, making it an ideal place to shop, socialize, or even relax (Ensiklopedia Dunia n.d.).

Figure 1. Outmall Aeon Mall, Jakarta Garden City
(Source: Rossy, 2024)

1.2. Secondary Skin

Secondary skin or double skin façade is a design element on the façade of a building in the form of an additional layer installed on the outermost side of the building. Its functions are very diverse, especially for improving the aesthetics and performance of buildings against several external factors, such as climatic conditions and sun exposure**.** Using secondary skin, buildings can be more responsive to the environment, reduce cooling loads, and create a more comfortable atmosphere (Poiraziz 2006).

Secondary skins can trap rainwater entering the building, provide security, reduce heat propagation, and limit privacy areas on the façade of the building. Some secondary skins are box windows, corridor windows, and multistory windows (Ricardo 2022).

According to research conducted by Razqyan et al., which refers to information from the Belgian Building Research Institute, the distance between the secondary skin and the main building surface generally ranges from 0.2 meters to 2 meters**.** This distance depends on the purpose of the functionality and aesthetic design of the building. In addition, the more variety of ornamental art applied to the secondary skin, the more complex and attractive the visual appearance of the building. The addition of ornaments and decorative elements can provide a richer aesthetic effect, as well as enhance the character and visual identity of the building. This variety of ornaments can be patterns, textures, or shapes carved or installed on the surface of the secondary skin (Islahuddin, Fahrizal, and Olivia 2022).

1.3. OTTV

OTTV (Overall Thermal Transfer Value) originated from the first energy conservation standard of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), which was later revised to ANSI/ASHRAE/IES Standard 90A-1980, which was based on the refrigeration criteria. OTTV. OTTV is a measure of the average heat transfer rate from the outside area to the inside of the building through the envelope of the building (walls and roof), where the higher the OTTV, the greater the heat gain will continue (Muhammad 2015). The OTTV requirements specified in the building envelope of the energy conservation standard apply to air-conditioned (or mechanically cooled) buildings. It aims to achieve an adequately insulated building envelope design to reduce external heat gain and the air cooling load (Octarino and Feriadi 2021).

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To determine the improvement of energy efficiency in Indonesia by limiting OTTV, it is explained that the overall thermal displacement for the glass and the outer wall of the building must not exceed the thermal displacement value, which does not exceed 35 W/m2 (Hasanah, Safyan Yahya, and Saputra 2023). Steps in calculating OTTV:

Specifying the Wall Type (W) and its variables (Uw, TDek, and)

b. Determining the Area of each Wall Type (W), Fenestration Area (F), and WWR

c. Determining SC Glass, U Glass, and SC Effective

d. Calculate the OTTV of each orientation

e. Calculate overall OTTV

According to the Indonesian National Standard (SNI) regarding "Envelope Energy Conservation in Buildings," which is a revision of SNI 03-6389-2011, the overall thermal displacement value for each area of the exterior wall of a building with a particular orientation will be calculated through an equation. (Hidayat 2022)

2. RESEARCH METHODS

This study uses a quantitative approach by calculating the OTTV value in the Outmall Aeon Mall Jakarta Garden City building. The analysis was carried out on the outmall part of the building by analyzing the number and dimensions of openings and the type of building material used in the façade finishing techniques. The Building Performance Simulation (BPS) of the 3D model and shadow animation used Andrewmarsh-dynamic overshadowing to determine the influence of light when using secondary skin on the design of the building. Dynamic shadow simulation and OTTV calculations to identify the influence of secondary skin design on building design, for energy performance and comfort of Aeon Mall users.

The author follows the following steps to collect the data needed for the research. The overview and steps can be seen in the following Flowchart.

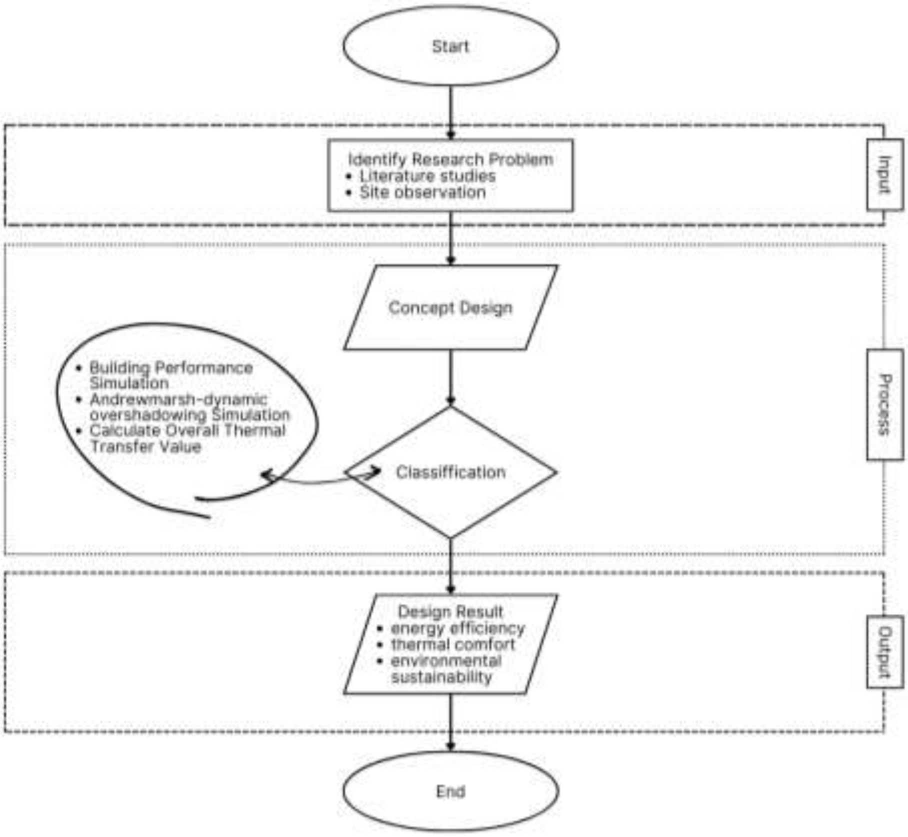

Figure 2. Flowchart, research methods and stages
(Source: Rossy, 2025)

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3. RESULTS AND DISCUSSION

3.1 Existing Data

The case study in this study is the Aeon Mall Jakarta Garden City Outmall Building, located in the independent city of Jakarta Garden City Boulevard No.1, RT.8/RW.6, Cakung Tim., Kec. Cakung, East Jakarta City, Special Capital Region of Jakarta 13910. This revitalization plan is located in the Outmall area of Aeon Mall, where the current condition is no activity. One reason is that the air in this area feels quite hot, making it uncomfortable to do activities or sit around.

Geographically, Jakarta has a tropical climate, with an average annual temperature of 27 C with a humidity of 80-90%, while this building is located at the coordinates 6°10'23" S – 106°57'04.6 E. Tropical climate has a relatively high temperature (reaching 35˚C). It can be found up to 15 degrees north latitude and south latitude from the equator (meteoblue n.d.). Therefore, it is necessary to optimize the façade on the south-oriented Aeon Mall Jakarta Garden City Outmall which vertical fins will cover as a secondary skin to reduce heat transmission entering the Outmall building.

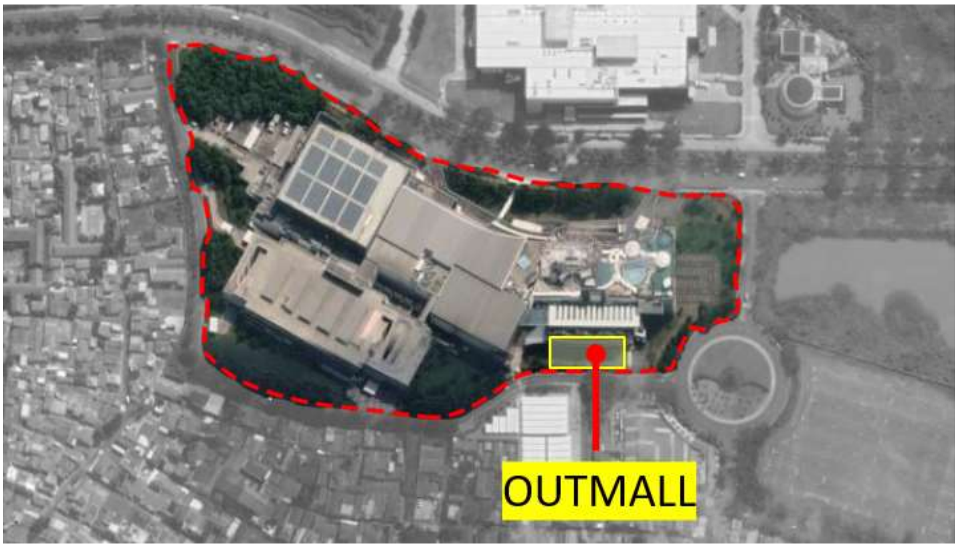

Figure 3. Area Outmall Google Earth
(Source: Rossy, 2024)

3.2 Concept Design

The façade design of the Aeon Mall Jakarta Garden City Outmall Building uses a parametric design, which allows the façade elements to be adjusted to specific parameters such as size, shape, and orientation to be responsive to the surrounding environmental conditions. This approach uses computer-based design technology (CAD) and parametric algorithms, which allow for more dynamic façade design and integration with environmental factors, such as sunlight, wind, or direction of view, and provide better aesthetics and functionality (Hibatullah and Aqli 2024)

Parametric designs can utilize data about the direction and intensity of sunlight at certain times to minimize overheating through façade elements such as shading devices or grilles that can regulate light flow. The design can also be adjusted to improve natural ventilation, with the orientation of the façade elements directing airflow through the building and reducing the need for mechanical cooling (Trieddiantoro Putro et al. 2019).

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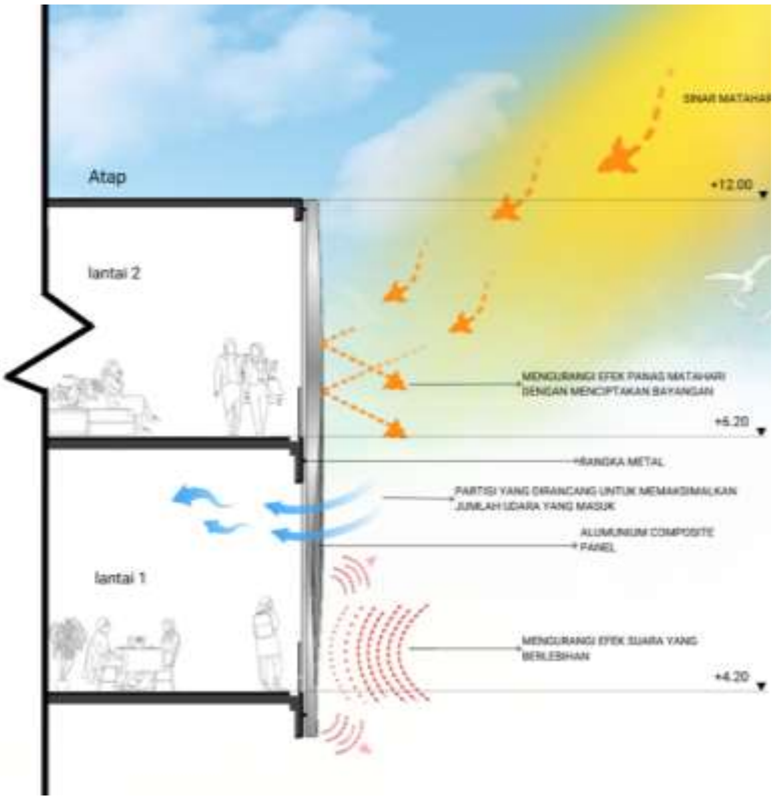

Figure 4. Outmall Concept Design
(Source: Rossy, 2024)

It can be seen in Figure 4. Using the parametric design not only serves as a protective shield of the building but also contributes to energy efficiency and occupant comfort and provides high aesthetic value, creating a dynamic and environmentally responsive façade. Elements on the secondary skin can be set to be oriented according to the sun's position throughout the day, reducing heat by creating shadows and improving the comfort of the building's occupants. Materials such as aluminum composite panels (ACP) or other innovative materials that are lightweight and durable can be used to manufacture secondary skins, providing an aesthetic solution while improving structural efficiency.

Figure 5. Outmall Render Perspective
(Source: Rossy, 2024)

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3.3 AndrewMarsh-Dynamic Overshadowing Simulation

In the Andrew Marsh-Dynamic Overshadowing simulation seen in Figure 6, sunlight appears to enter and hit the hallway area and the mall façade directly. This causes visual glare that interferes with the comfort of residents or visitors, especially when direct sunlight hits windows or other building surfaces. The glare produced by the reflection of this overbright light can cause some visual disturbances, such as eye strain, headaches, or difficulty concentrating, especially for those in or around the building.

This problem becomes more pronounced without secondary skin, especially in cities like Jakarta, which have a tropical climate with very hot temperatures during the day. Without this additional protection, the building's occupants can feel uncomfortable due to the high temperature that enters the room. This can interfere with indoor activities, be it for work**,** rest, or other activities, because of excessive heat, making indoor conditions less than ideal.

Secondary skin can effectively solve this problem by filtering incoming sunlight, reducing glare, and maintaining a comfortable indoor temperature. With an additional protective layer, residents and visitors can better enjoy the atmosphere inside and around the building without being disturbed by direct sunlight or excessive temperature (Novianto 2018).

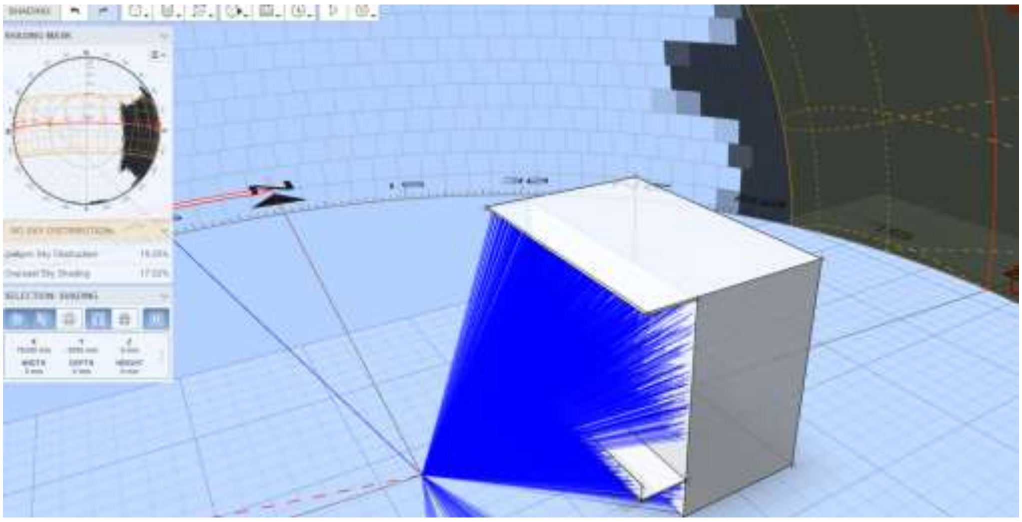

Figure 6. The Perspective of Aeon Mall JGC Outmall without Secondary Skin
(Source: Rossy, 2024)

As seen in Figure 7. which shows the area of the Outmall façade**,** the use of a properly installed secondary skin significantly impacts user comfort. In this design, sunlight can only faintly penetrate the building, thanks to a layer of secondary skin that acts as a light filter. This reduces exposure to direct sunlight, which can cause the temperature inside the space to overheat and create a refreshing shadow in the exterior area of the building.

This shadow effect creates a more comfortable and shady atmosphere, thus providing a pleasant experience for visitors who want to pass between mall buildings or just sit around enjoying the mall's atmosphere. The shadows created also help reduce the effects of overheating during the day, especially in hot or tropical climates, increasing user comfort by keeping temperatures cool and natural.

With a design like this, the secondary skin functions as an aesthetic element and a microclimate regulator that supports visitors' comfort. It creates a more comfortable space for several outdoor activities without sacrificing the natural lighting that enters the building (Rahadian et al. 2021)

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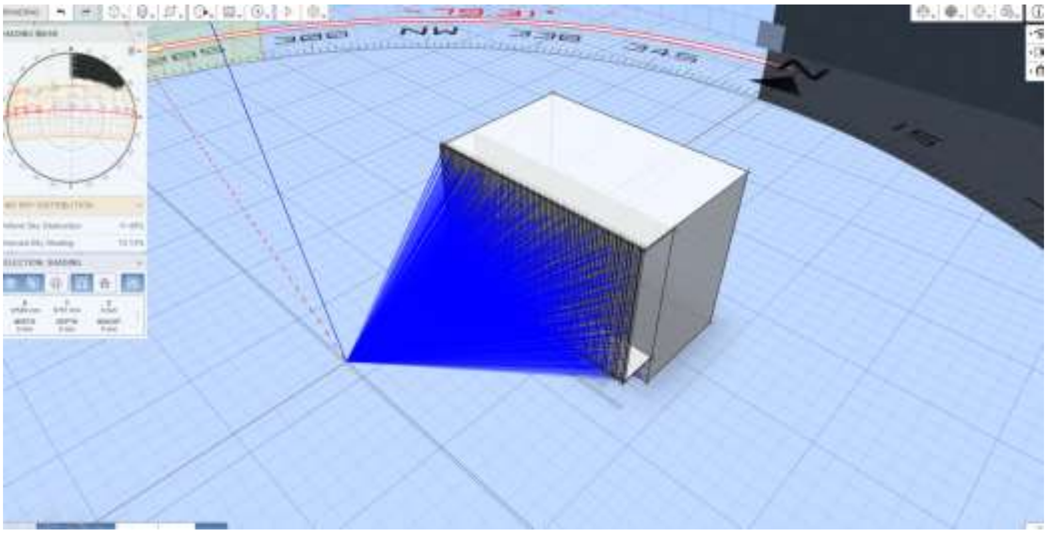

Figure 7. The perspective of Outmall Aeon Mall JGC using Secondary Skin
(Source: Rossy, 2024)

3.4 OTTV Simulation

The Aeon Mall JGC Outmall Building's orientation to the South (Front View) by adding secondary skin in the form of parametric facades is carried out using aluminum composite panel material because of its lightweight, strong, and durable nature. Based on the analysis of the results of the OTTV Calculator, in "Table 1. The results of the analysis without using the OTTV Calculator without secondary skin" on the secondary façade with a total façade area of 1,176.3 m2 OTTV obtained is 48.57 with a total WWR of 46.08% where the opening area has not met the minimum requirements. The OTTV space has also not met the requirements because it is less than the 35 Watt/m2 limit.

Over-elevated OTTV indicates that the building is susceptible to overheating coming in through the façade, leading to more significant cooling needs and increased energy consumption. A high WWR figure (46.08%) indicates that the proportion of windows to walls is also quite large, which has the potential to cause lighting and temperature control problems.

Table 1. Results of Analysis using OTTV Calculator without using Secondary Skin

Side	Conduction through walls	Conduction through openings	Radiation through openings	Total	Total area facade	OTTV Watt/m2
Utara	-	-	-	-	-	-
Timur	315,42	10,00	195,35	520,77	13,81	37,70
Selatan	3.273,08	3.000,0	36.093,02	42.366,10	868,00	48,81
Barat	311,42	12,50	282,56	606,8	13,65	44,43
	3.899,91	**3.022,50**	**36.570,93**	**43.493,34**	**895,46**	**48,57**
	Total	Total	Total	Total	Total	Total

Source: Results of personal analysis, 2024

While the results in "Table 2. The results of the analysis using the OTTV Calculator using the secondary skin" for the secondary façade with a total façade area of 1,176.3 m2 OTTV obtained is 28.37 with a total WWR of 34.08% where the opening area has met the minimum requirements, and the OTTV space has met the requirements because it is less than the limit of 35 Watt/m2. The use of Secondary Skin is very effective in reducing the OTTV value, where the thermal transfer from 48.57 watts/m2 to 28.37 watts/m2 with the ability of the material to reflect light to minimize the absorption of heat received in the hallway area. The dark

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brown paint used as a concrete parapet wall finish has a low absorption value, so it can help improve the material's thermal insulation.

The use of secondary skin has proven very effective in reducing OTTV and increasing thermal comfort in buildings. By lowering heat transfer and improving the thermal performance of the façade, the secondary skin helps meet the established energy standards while reducing the cooling load required inside the building, which is especially important in a hot climate like Jakarta.

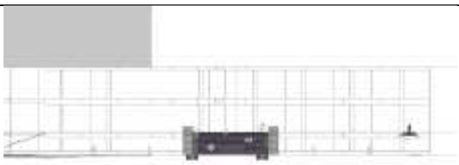
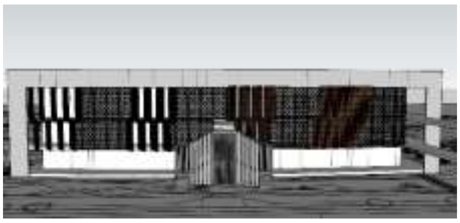
Table 2. Results of Analysis using OTTV Calculator using Secondary Skin

Side	**Conduction through walls**	**Conduction through openings**	**Radiation through openings**	**Total**	**Total area fasad**	**OTTV Watt/m2**
Utara	-	-	-	-	-	-
Timur	315,42	8,00	53,40	376,81	13,81	27,28
Selatan	11.521,22	3.200,0	9.925,58	24.646	868,00	28,39
Barat	311,42	8,00	62,16	381,58	13,65	27,95
	12.148,06 Total	**3.216,00** Total	**10.041,14** Total	**25.405,20** Total	**895,46** Total	**28,37** Total

Source: Results of personal analysis, 2024

Table 3 shows the effect of the secondary skin's shape on OTTV and its comparison with conditions without the use of secondary skin, using Stopray Vision 31T material and a fenestration design that combines vertical grid and parametric patterns. This analysis shows significant differences in the thermal performance of buildings, both with and without the use of secondary skin.

Table 3. Analysis Results using OTTV Calculator

Facade	**Glass type**	**Name Condition** **Distance**	**Degree**	**WWR**	**OTTV** (WATT/M2)
 Without Secondary Skin	6mm Stopray (#2)+12mm AS+6mm Clear Glass VISION 31T	-	-	48	48,57
 With Secondary Skin	6mm Stopray (#2)+12mm AS+6mm Clear Glass VISION 31T	5 cm	90	34	28,37
 With Secondary Skin	6mm Stopray (#2)+12mm AS+6mm Clear Glass VISION 31T	10-20 cm	20-40	41	32,44

Source: Results of personal analysis, 2024

The Stopray Vision 31T material is known to have the ability to reduce heat entering through fenestration thanks to its low-E nature (it has a reflective coating that reduces the amount of heat transmitted). However, without the addition of a secondary skin, the resulting OTTV results still show higher values and have not fully met the limit recommended by SNI (the maximum limit of OTTV is 35 W/m²). Nonetheless, fenestration designs with this material, at certain times, such as at 2:00 PM and 4:00 PM, can meet minimum lighting standards, although they still require improvements to achieve overall thermal comfort.

Using secondary skin with parametric design has been proven effective in lowering OTTV values to below 35 W/m² by SNI standards. The parametric design on the secondary skin helps regulate lighting and limit exposure to direct sunlight, reducing heat absorption and making the indoor temperature more stable and comfortable. This form of parametric secondary skin is very effective in controlling incoming light and reducing the heat received by the building, helping to meet SNI standards below 35 W/m² at certain times.

Although the secondary skin's vertical grid design also decreases OTTV, it does not fully meet SNI standards at some times, especially at 14.00 and 16.00. This suggests that while vertical grids can help reduce direct sunlight, the shape and orientation of these grids may not be optimal in filtering light at these hours, so OTTV is still higher than desired.

4. CONCLUSION

The Aeon Mall Outmall building has a vital role in the mall building itself, where this area transitions from the main building to the park and play garden area. Because the area is so open and Jakarta is so hot during the day, visitors do not pass through the hallway area. As a result, some restaurants are empty of visitors. Therefore, a secondary skin is created so that the incoming sunlight turns into a shadow that provides thermal comfort for the user.

Through Building Performance Simulation (BPS) simulation, 3D models, and shadow animation using AndrewMarsh-Dynamic Overshadowing and calculating OTTV values on the Aeon Mall Jakarta Garden City Outmall building. The use of secondary skin can be seen in significant differences over time that can affect natural lighting and temperature in buildings and surrounding areas. OTTV measures the heat load transferred into the building through walls, windows, and other elements exposed to sunlight.

This can be considered design planning after identifying the use of secondary skins in the Outmall area of Aeon Mall Jakarta Garden City. A secondary skin supports the building's function in terms of comfort, energy efficiency, and environmental sustainability.

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