

Transformation of Malaysian Shop Office and The Impact of Visual Comfort

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ARTICLE INFO

Article history:

Received 28 February 2023

Revised 29 March 2023

Accepted 7 September 2023

Available online 13 September 2023

E-ISSN: 2721-3463

P-ISSN: 2086-910X

How to cite:

Tan, Hui Ping., Majid, Roshida Abdul. (2023). Transformation of Malaysian Shop Office and The Impact of Visual Comfort. Jurnal Koridor, 14(2), 48-60.

ABSTRACT

This paper investigates the transformation of Malaysian shop offices over the last few decades, and the impact of visual comfort on their design and functionality. Shop offices are a prevalent building type in Malaysia, combining commercial and office spaces in the same structure. The rise of e-commerce and the need for visually appealing and functional spaces has driven the transformation in shop office design. This study examines the historical context of shop offices in Malaysia, the factors driving their transformation, and the concept of visual comfort, including its various elements. The study then analyzes the impact of visual comfort on the design and functionality of modern shop offices in Malaysia. The research findings provide insights into the importance of visual comfort in commercial space design and the factors driving the evolution of shop office design in Malaysia. Finally, the paper identifies challenges and opportunities for the continued development of visually appealing and functional shop offices in Malaysia.

Keyword: Malaysian Shop Offices, Visual Comfort, Historical Context, Lighting Configuration

ABSTRAK

Artikel ini menyelidiki transformasi kantor toko di Malaysia selama beberapa dekade terakhir, serta dampak kenyamanan visual pada desain dan fungsionalitas mereka. Kantor toko adalah jenis bangunan yang umum di Malaysia, menggabungkan ruang komersial dan kantor dalam struktur yang sama. Munculnya *e-commerce* dan kebutuhan akan ruang yang menarik secara visual dan fungsional telah mendorong transformasi dalam desain kantor toko. Penelitian ini menguji konteks sejarah kantor toko di Malaysia, faktor-faktor yang mendorong transformasi tersebut, dan konsep kenyamanan visual, termasuk elemen-elemennya yang beragam. Studi ini kemudian menganalisis dampak kenyamanan visual pada desain dan fungsionalitas kantor toko modern di Malaysia. Temuan penelitian memberikan wawasan tentang pentingnya kenyamanan visual dalam desain ruang komersial dan faktor-faktor yang mendorong evolusi desain kantor toko di Malaysia. Akhirnya, artikel ini mengidentifikasi tantangan dan peluang untuk pengembangan lebih lanjut kantor toko yang menarik secara visual dan fungsional di Malaysia.

Keyword: Kantor Toko di Malaysia, Kenyamanan Visual, Konteks Sejarah, Konfigurasi Pencahayaan



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<http://doi.org/10.26594/register.v6i1.idarticle>

1. Introduction

Over the last several decades, the commercial landscape of Malaysia has undergone significant transformation with regards to the design and functionality of shop offices, which are a common type of building in Malaysia that combines commercial and office spaces. This transformation has been driven by factors such as the rise of e-commerce and changing consumer preferences for visually appealing and functional spaces. The investigation and inquiry into the Transformation of Malaysian Shop offices hold scientific significance as it contributes to understanding the economic impact, urban development implications, cultural preservation concerns, social dynamics, and opportunities for sustainable development. Through rigorous scientific inquiry,

this research informs decision-making processes to create inclusive, vibrant, and sustainable urban spaces in Malaysia.

Buildings with good quality of visual comfort offer a heightened sense of comfort, stress relief, improved emotional well-being, heightened concentration, and enhanced patient recovery (Puren, Eddy & Abdillah, 2021). The impact of visual comfort within the Transformation of Malaysian Shop should also be raised. It provides valuable insights into the influence of visual comfort on the design, functionality of the space. The visual comfort of a building is a critical aspect of its design that can significantly affect the well-being, productivity, and overall experience of its occupants. However, limited research exists on the relationship between visual comfort and the transformation of shop offices in Malaysia. Therefore, the objective of this study is to investigate the transformation of Malaysian shop offices and the impact of visual comfort on their design and functionality.

This study begins by providing a historical overview of shop offices in Malaysia and their traditional design. It then examines the factors that have contributed to the transformation of shop office design, including the influence of e-commerce and changing consumer preferences. Subsequently, the concept of visual comfort is explored, including its various elements such as lighting, color, and spatial arrangement. Finally, the study analyzes the impact of visual comfort on the design and functionality of modern shop offices in Malaysia.

The outcomes of this research will provide valuable insights into the importance of visual comfort in the design of commercial spaces, as well as the factors that have driven the evolution of shop office design in Malaysia. Additionally, this paper will identify the challenges and opportunities that exist for the continued development of visually appealing and functional shop offices in Malaysia.

2. Literature Review

2.1 Transformation of Shop Office

The commercial landscape of Malaysia has undergone a significant transformation over the past few decades, with changes in the design and functionality of shop offices being a notable aspect of this transformation (Khoo, 2021). Shop offices are a common type of building in Malaysia that combines commercial and office spaces. Traditionally, they were designed with a focus on utilitarian functionality rather than aesthetics. However, the rise of e-commerce and changing consumer preferences have had a significant impact on the design and functionality of modern shop offices (Abdullah, M. A., Noor, R. M., & Ismail, 2021). These factors have driven a transformation in the design of shop offices in Malaysia, resulting in the creation of visually appealing and functional spaces that meet the needs of modern businesses and consumers. As a result, there is a growing need to understand the factors that have contributed to this transformation, including the impact of visual comfort on the design and functionality of modern shop offices in Malaysia.

2.2 Shop Houses Style Timeline

As a developing nation, Malaysia experiences urbanization with similar patterns to numerous other cities globally, characterized by swift and uncontrolled modernization. As a result of the requisite for novel infrastructure and constructions, numerous vernacular building styles, including the Malaysian Shophouse, are rapidly disappearing from the urban fabric. The shophouse, which was prevalent from 1840 to the 1960s, persisted as a typical architectural form for over a century, yet it is likely a typology of a previous era. The progression of shophouses from the 1790s to the 1960s is illustrated in Figures 1 and 2.



Figure 1. Different style of shophouses from 1790s to 1960s

Source: Wagner, 2017

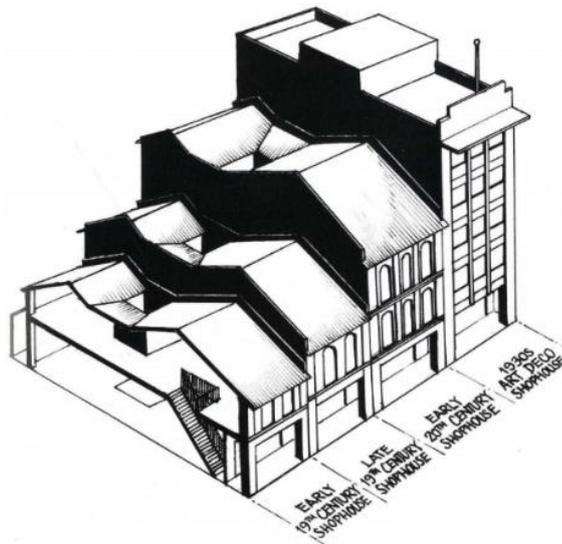


Figure 2. Timeline of shop house to shop office
Source : Sanyal, 2003

The findings presented in Figure 2 demonstrate that the courtyard design is no longer prevalent in shophouse architecture during the 1930s. Historically, courtyard shophouses suffered from inadequate planning and development, leading to issues such as poor ventilation and insufficient daylighting. Only a limited number of courtyard designs were able to meet the physical environment requirements. In modern times, the installation of air conditioning in buildings and the prioritization of quality of life have rendered the courtyard an obsolete architectural feature. Currently, shophouses are predominantly utilized for commercial purposes, whereas in the past, they also served as living quarters due to the absence of a separation between housing and commercial areas by developers. As a result, space has become a valuable commodity in shophouses, particularly for small businesses such as cafes, restaurants, and offices that require ample space to accommodate furniture and increase customer capacity. However, modern shophouses, especially those of the long and narrow variety, lack courtyards, which can negatively impact interior brightness and, by extension, visual comfort. The restricted entry points for daylighting into the shophouses, typically only at the front and rear, can result in gloomy interiors. To counteract this, artificial lighting is often implemented, leading to an increase in energy consumption, which is a notable weakness of contemporary shophouses.

2.3 History of Shop Houses in Malaysia

Shophouses are a unique building type found in Southeast Asia that serve as both a residence and a commercial business. The city of George Town was recognized as a UNESCO World Heritage site in 2008 due to its rich cultural heritage, including its unique architectural and cultural townscape along the Straits of Melaka. According to UNESCO's agreement, shophouse owners cannot demolish and rebuild them at will (S. Li, 2020). Shophouses were initially designed to be narrow and deep so that many businesses could be accommodated along a street, with the front area reserved for customers and the rear areas serving as informal spaces for family members, toilets, bathrooms, kitchens, and infrastructure. The early shophouses were narrow in width and high in height, typically around 6 to 7 meters wide and up to 60 meters long. This narrow façade was due to taxation rules imposed by the British, who taxed based on the number of windows per façade (Ahmad, 1994). Shophouses were built side by side with a common party wall made of bricks and plaster, and typically included a central courtyard rising from a sunken well or sink to the roof eaves.

2.4 Courtyard in Shop Houses

The courtyard is a unique architectural feature found in many shophouses throughout Southeast Asia. In Malaysia, the courtyard is also known as the "air-well" and is a central feature of shophouse design. The air-well is an interior courtyard space that rises from a sunken well or sink to the roof eaves, and it serves several important functions.

One of the primary functions of the courtyard is to provide natural ventilation and light to the interior spaces of the shophouse. With the courtyard located in the center of the building, air can circulate throughout the space, bringing in fresh air and expelling stale air. This is particularly important in hot and humid climates, where good ventilation is essential for the health and comfort of occupants. Additionally, the courtyard allows natural light to filter into the interior spaces, reducing the need for artificial lighting during the day and creating a bright and airy atmosphere.

In addition to its functional benefits, the courtyard also plays an important cultural and social role in shophouse design. It serves as a communal space for families to gather, relax, and socialize. In many cases, the courtyard may also contain a small garden or decorative features, such as fountains or statues, that add to the aesthetic appeal of the space. This creates a sense of harmony and balance between the built environment and nature, which is an important aspect of traditional Southeast Asian design.

While the function and design of the courtyard has evolved over time, it remains a defining feature of shophouse architecture in Malaysia and throughout Southeast Asia. As shophouses continue to adapt to modern needs and changing cultural values, the courtyard will likely continue to play a central role in their design and function, providing a unique and valuable contribution to the built environment.

2.5 Factors of Transformation From Shop House into Shop Office

The transformation of traditional Malaysian shop houses into modern shop offices is driven by several factors, which have scientific significance in understanding the changing commercial landscape and urban development patterns. These factors include:

Urban Redevelopment: Rapid urbanization and the need for efficient land use have propelled the conversion of traditional shop houses into multi-functional shop offices. This transformation allows for optimal utilization of limited urban space and adaptation to evolving business needs, which aligns with urban development and planning objectives.

Changing Business Landscape: The shift towards modern retail practices, including the rise of e-commerce and evolving consumer behaviors, has necessitated the demand for more versatile and functional spaces. Shop offices provide a flexible environment capable of accommodating various business models, combining commercial and office spaces to cater to diverse industry requirements.

Infrastructure and Modernization: Upgrades in infrastructure and technological advancements have become drivers for the transformation of shop houses into shop offices. This enables the integration of modern amenities, such as advanced electrical systems and high-speed internet connectivity, to meet the demands of contemporary businesses and enhance operational efficiency.

Regulatory Changes: Government regulations and urban planning policies have played a significant role in encouraging the conversion of traditional shop houses into modern shop offices. These policies may provide incentives or support for property owners to renovate and repurpose their buildings, aligning with urban development goals and enhancing the overall quality of commercial spaces.

Economic Considerations: The potential for higher rental yields and increased property value has incentivized property owners to undertake the transformation of shop houses into shop offices. This transition allows for better space utilization and attracts higher-paying tenants or businesses, contributing to economic growth and property market dynamics.

2.6 Transformation of Shop House into Shop Office

In recent decades, the commercial landscape of Malaysia has undergone a significant transformation in the design and functionality of shop offices. Shop offices are a common type of building in Malaysia that combines commercial and office spaces, and they have replaced the traditional shophouses in many areas. Unlike the shophouses, modern shop offices are designed to be wider, have larger floor areas, and provide more functional space for commercial and office use.

One of the significant changes in the design of modern shop offices is the absence of courtyards or air-wells. The traditional shophouses were built with an interior courtyard, also known as an air-well, located in the

center of the building. The courtyard was an essential feature of the shophouse, as it provided natural light and ventilation to the interior spaces. However, modern shop offices are designed to maximize the use of space, and courtyards take up valuable floor area.

Additionally, the absence of courtyards in modern shop offices is also due to the availability of advanced technology and artificial lighting systems. With the availability of advanced lighting systems, modern shop offices can create a comfortable and well-lit working environment without relying on natural light. This allows shop offices to be designed with a more compact and efficient layout, providing more functional space for commercial and office use.

Another factor contributing to the absence of courtyards in modern shop offices is the changing needs and preferences of consumers. Modern consumers are more interested in functional spaces that are visually appealing, and courtyards do not fit into this design aesthetic. As such, modern shop offices are designed with more modern architectural styles, focusing on maximizing the use of space, energy efficiency, and visual comfort.

The transformation of shop offices in Malaysia has brought about significant changes in the design and functionality of commercial buildings. The absence of courtyards in modern shop offices is due to the need to maximize space, advancements in lighting technology, and changing consumer preferences. However, the traditional courtyard design still holds historical and cultural significance, and efforts should be made to preserve and incorporate it into the modern shop office design.

2.7 The Impact of Visual Comfort on The Design and Functionality of Modern Shop Office in Malaysia

Occupant Well-being and Productivity: The impact of visual comfort on the design and functionality of modern shop offices in Malaysia extends to the well-being and productivity of occupants. Elements such as adequate natural and artificial lighting, as well as a harmonious color scheme, contribute to a visually pleasant environment that reduces eye strain, fatigue, and discomfort. This, in turn, positively affects the overall physical and psychological well-being of individuals, leading to increased productivity and performance.

Functional Efficiency: Visual comfort plays a crucial role in enhancing the functional efficiency of shop offices. By ensuring proper lighting conditions and well-designed spatial arrangements, visual comfort enables clear visibility, easy navigation, and efficient space utilization. This results in smoother operations, optimized workflow, and improved functionality within the shop office. The overall efficiency and operational effectiveness are thereby enhanced.

Energy Efficiency and Sustainability: In addition to its impact on occupant well-being and functional efficiency, visual comfort considerations also have implications for energy efficiency and sustainability in modern shop office design. By implementing efficient lighting systems, effectively utilizing natural daylight, and incorporating smart controls, visual comfort can be achieved while reducing energy consumption and environmental impact. This aligns with sustainable design principles, promoting an environmentally conscious approach to shop office development.

Understanding the influence of visual comfort on occupant well-being, functional efficiency, and energy sustainability is essential for designing modern shop offices in Malaysia. By considering these factors, stakeholders can create spaces that promote occupant comfort, enhance operational effectiveness, and contribute to a more sustainable built environment.

2.8 The Impact of Transformation of Shop Houses on Visual Comfort

The transformation of Malaysian shop houses in the mid-20th century involved several changes in building design and usage, which had a significant impact on visual comfort. One of the most important changes was the conversion of many shop houses from residential to commercial use, which often involved the removal of central courtyards and the construction of partition walls to create individual rooms.

This change in building design can have a negative impact on visual comfort, as it reduces the amount of natural light that can enter the building and increases the need for artificial lighting. Research has shown that exposure to natural light has significant positive effects on visual comfort, productivity, and overall health and well-being (Ko, Y. K., & Lee, 2022). In addition, a lack of natural light can lead to visual discomfort, eyestrain, headaches, and other health problems (Tabadkani et al., 2021).

The removal of courtyards also reduces ventilation and air circulation within the building, which can further decrease visual comfort. Poor indoor air quality has been linked to a range of negative health effects, including respiratory problems, allergies, and headaches (Moschandreas & Sofuoglu, 2012)

Furthermore, the construction of partition walls and closed doors can create a feeling of claustrophobia and visual discomfort, as well as reduce social interaction and sense of community within the building (Rashid, A. A., Yusoff, S., & Sipan, 2021).

While some modernized shop houses may have incorporated alternative sources of natural light or artificial lighting to counteract the negative impact on visual comfort, the removal of central courtyards and partition walls still have the potential to reduce visual comfort and negatively affect the health and well-being of occupants (Lim, W. Y., Wong, N. H., & Tan, 2021).

The transformation of Malaysian shop houses had a mixed impact on visual comfort, as it introduced some positive changes such as the incorporation of larger windows and lighter colours, but also introduced negative changes such as the removal of courtyards and the construction of partition walls. Future research can help to identify ways to mitigate the negative effects of these changes and further improve the visual comfort of modernized shop houses in Malaysia.

2.9 The Impact of Windowless Working Environment on Employees in Malaysian Shop Office

The impact of windowless working environments on employees in Malaysian shop offices can be significant, as these spaces may lack natural light and views to the outside world. Research has consistently shown that exposure to natural light and views of the outdoors can have positive effects on human health and well-being, including improved mood, increased productivity, and reduced stress (Figueiro, M. G., Nagare, R., Price, L. L., & Cunningham, 2018). In contrast, windowless working environments may lead to negative outcomes such as decreased job satisfaction, decreased productivity, and increased feelings of stress and anxiety (Cheung, H., Ip, H., & Lam, 2020). One of the main negative impacts of windowless working environments is the lack of natural light, which can have detrimental effects on human health and well-being.

Natural light is necessary for the regulation of circadian rhythms, including sleep-wake cycles, and a lack of exposure to natural light can disrupt these rhythms and lead to sleep disorders (Harrison, Y., & Horne, 2018). In addition, natural light is necessary for the production of vitamin D, which is important for bone health and immune function (Holick, 2017). A lack of natural light can also lead to decreased levels of physical activity and increased sedentary behavior, which can contribute to obesity and other health problems (Buman, M. P., Mullane, S. L., Toledo, M. J. L., Rydell, S. A., Gaesser, G. A., & Crespo, 2018). In addition to the negative impacts on physical health, windowless working environments can also have negative psychological effects.

Research has shown that exposure to natural light and views of the outdoors can improve mood, increase feelings of well-being, and reduce stress (Hanssen, M. M., van der Laken, J., de Vries, J., & Smink, 2021). In contrast, windowless working environments may lead to decreased job satisfaction and decreased productivity, as well as increased feelings of stress and anxiety (Lavy, S., & Littman-Ovadia, 2021). These negative psychological effects can be particularly detrimental in the long term, as they can lead to burnout and other mental health problems.

3. Research Method

This study adopts a comprehensive research methodology to achieve its objectives of investigating the transformation of shophouse offices in Malaysia, analyzing the impact of visual comfort on their design and functionality, and identifying challenges and opportunities for sustainable development. The research methodology consists of several key steps designed to gather relevant data and draw meaningful conclusions. To begin with, a diverse sample of typical shop office designs, encompassing variations with and without courtyards, is carefully selected to represent different design trends and characteristics. This selection ensures the study captures a comprehensive understanding of the transformation of shophouse offices over the past decades.

The research methodology utilizes Revit software for modelling and simulating the natural lighting conditions within the selected shop office designs. Factors such as the presence or absence of windows and the positioning of office spaces are taken into account during the modelling and simulation process. By simulating different times of the day, from morning to evening, the study captures variations in natural light levels and its impact on visual comfort.

The illuminance levels within the simulated shop office designs are then meticulously analysed and compared to evaluate the natural light levels, lighting quality, and overall visual comfort experienced by occupants. Special attention is given to examining the dependence on artificial lighting in windowless intermediate shop offices, recognizing the potential implications for occupant well-being and productivity.

To ensure the reliability and validity of the findings, the simulation results are cross-referenced with the existing literature in the field. This comparative analysis serves as a means of validation, providing support for the conclusions drawn from the simulation and analysis of visual comfort in shop office designs.

Through this research methodology, the study aims to provide valuable insights into the transformation of shophouse offices in Malaysia, the impact of visual comfort on their design and functionality, and the challenges and opportunities for sustainable development. By adopting a systematic approach that combines simulation, analysis, and literature review, this study strives to contribute to the existing knowledge in the field and offer practical recommendations for the design and development of modern Malaysian shop offices.

4. Discussion

This study employs simulation software to evaluate the lighting conditions of three shop offices in Johor Bahru, Malaysia. The simulation results are compared with the existing lighting conditions in these spaces to assess the potential benefits of proposed lighting improvements. The findings of the simulation study emphasize the importance of considering lighting in the design of shop offices in Malaysia. Inadequate lighting can result in poor task performance and visual discomfort for occupants, which may contribute to symptoms of Sick Building Syndrome (SBS), such as itchy, watering eyes, and eye irritation. Therefore, architects and designers should ensure that shop offices provide adequate levels of lighting and visual comfort to create spaces that are comfortable and conducive to occupant performance and satisfaction.

To simulate the interior lighting patterns of the shop offices, Revit Architecture software is used in this research. Revit Architecture is a useful tool that allows architects and designers to evaluate and optimize lighting layouts in shop offices. By conducting simulations, architects and designers can identify potential lighting issues and make adjustments to the design before construction, ensuring that shop offices provide adequate levels of lighting and visual comfort for occupants.

Table 1. Illuminance Level of Office 1

Parameter	Value
Office Type	Intermediate shop office
Total Space Size	1302.8 sqft
Type of Planning	Open space planning
Number of Space	1 Pantry 1 Open workspace 2 Toilet 1 Meeting Room
Illuminance in office (lux)	
9.00am	Maximum: 6000 lux Minimum: 14 lux
12.00pm	Maximum: 6000 lux Minimum: 29 lux
3.00pm	Maximum: 3129 lux Minimum: 4 lux
6.00pm	Maximum: 585 lux Minimum: 1 lux
Type of Lighting	Fluorescent x 14 units Incandescent x 3 units
Number of Lighting	Pantry x 1 units (fluorescent) Open workspace x 11 units (fluorescent) Toilet 1 x 1 units (Incandescent) Toilet 2 x 2 units (Incandescent) Meeting Room x 2 units (fluorescent)

Correlated Colour Temperature (CCT)	4230k (fluorescent) 2800k (Incandescent)
Ceiling Height	3500mm
Size of Window	910mm x 1210mm
Number of windows	Front x 6 Rear x 6

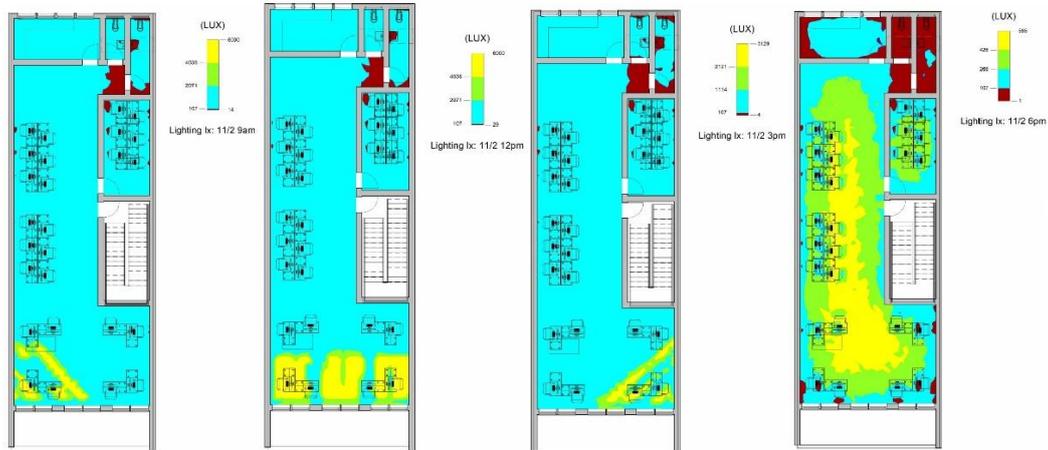


Figure 3. Simulation result of office 1

Table 1 shows the illuminance in office 1. The maximum illuminance level was found to be 6000 lux, while the minimum level was 1 lux. Glare was observed near windows at 9 a.m., 12 p.m., and 3 p.m. The area further from the windows received less than 600 lux throughout the daylight period. These findings suggest potential issues with the lighting configuration, particularly regarding brightness and illumination consistency. To improve the lighting conditions, adjustments may be necessary, such as changing the lighting units, optimizing window placement and orientation, and incorporating more natural light sources. These changes can help to create a more comfortable and effective working environment for office workers.

Table 2. Illuminance level of Office 2

Parameter	Value
Office Type	Intermediate shop office
Total Space Size	1068.3 sqft
Type of Planning	Open space planning with 2 private office
Number of Space	1 Pantry 1 Open workspace 2 Toilet 2 Private Office 1 Meeting Room
Illuminance in office (lux)	
9.00am	Maximum: 1892 lux Minimum: 0 lux
12.00pm	Maximum: 1960 lux Minimum: 0 lux
3.00pm	Maximum: 1146 lux Minimum: 0 lux
6.00pm	Maximum: 653 lux Minimum: 0 lux
Type of Lighting	Fluorescent x 16 units Incandescent x 4 units
umber of Lighting	Toilet 1 x 2 units (Incandescent) Toilet 2 x 2 units (Incandescent) Pantry x 2 units (Fluorescent) Open workspace x 6 units (Fluorescent)

	Private Office 1 x 1 units (Fluorescent) Private Office 2 x 1 units (Fluorescent) Meeting Room x 6 units (Fluorescent)
Correlated Colour Temperature (CCT)	4230k (fluorescent) 2800k (Incandescent)
Ceiling Height	3500mm
Size of Window	910mm x 1210mm
Number of windows	Front x 6 Rear x 4

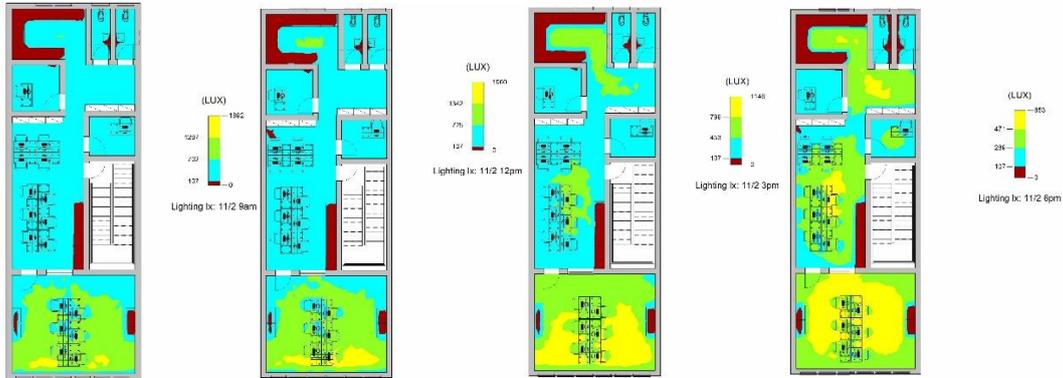


Figure 4. Simulation result of office 2

The simulation results show that shop office 2 has suboptimal lighting conditions for office workers. The maximum illuminance level is too bright in some areas, potentially causing glare and discomfort for workers. There is also a lack of sufficient illuminance in some areas of the office, potentially leading to negative effects on health and productivity. The open workspace has an illuminance level below the preferred level of 500 lux, which may cause eyestrain and other negative effects on workers. Adjustments to the lighting configuration, such as changing the number and type of lighting units and adjusting window placement and orientation, may be necessary to improve the illuminance levels and reduce glare in this office.

Table 3. Illuminance level of Office 3

Parameter	Value
Office Type	Intermediate shop office
Total Space Size	1305.1 sqft
Type of Planning	Open space planning with 2 private office
Number of Space	1 Pantry 1 Open workspace 2 Toilet 1 Private Office
Illuminance in office (lux)	
9.00am	Maximum: 933 lux Minimum: 0 lux
12.00pm	Maximum: 1186 lux Minimum: 0 lux
3.00pm	Maximum: 664 lux Minimum: 0 lux
6.00pm	Maximum: 424 lux Minimum: 0 lux
Type of Lighting	Fluorescent x 10 units Incandescent x 4 units

Number of Lighting	Toilet 1 x 2 units (Incandescent) Toilet 2 x 2 units (Incandescent) Pantry x 2 units (Fluorescent) Open workspace x 7 units (Fluorescent) Private Office x 1 units (Fluorescent)
Correlated Colour Temperature (CCT)	3450k (fluorescent) 2800k (Incandescent)
Ceiling Height	3500mm
Size of Window	910mm x 1210mm
Number of windows	Front x 4 Rear x 4

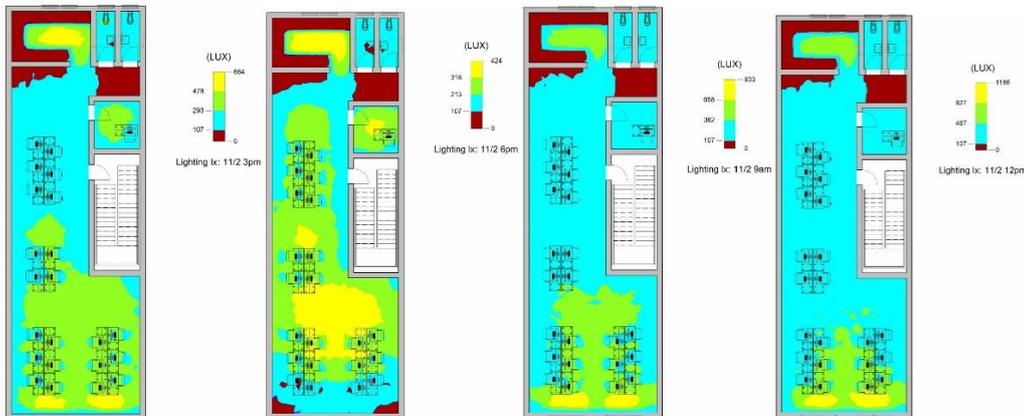


Figure 5. Simulation result of office 3

The results of the simulation for office 3 are presented in table 3 for different timings. The area near the window has glare only during 9 a.m. to 12 p.m. with an illuminance level ranging between 933 and 1186 lux. The illumination in the middle section of office 3 is moderate and within the range of 200 to 750 lux recommended by the Malaysian Department of Occupational Safety and Health for workplace illumination. To provide employees with a safe and comfortable visual working environment, it is important to design and install the lighting system based on the suggested illuminance level.

The simulation results show that the lighting in office 3 is generally appropriate for office workers. The illuminance level near the window-near desk is within the recommended range of 200 to 750 lux. Additionally, the results indicate that there is glare only between 9 a.m. and 12 p.m. at the window-near desk, which means that the lighting in this area is not excessively bright and unlikely to cause discomfort or visual fatigue for office workers.

In the middle section of office 3, the illuminance levels are moderate, with a maximum of 1186 lux and a minimum of 0 lux. This suggests that the lighting in this area is adequate for office workers to perform their tasks effectively without being too bright or too dim. Overall, the simulation results indicate that the lighting in office 3 is suitable for office workers, and appropriate measures should be taken to maintain this lighting level.

4.1 Proposed Lighting Configuration

The results of the simulation study showed that LED lighting was the most suitable type for enhancing visual comfort in Malaysian shop offices. Based on the findings, it was proposed that LED lighting with a brightness level of 400lux and a color temperature of 4000k is the most appropriate lighting for shop offices. The simulation study, conducted using Revit, confirmed the benefits of this lighting configuration. It was noted that the office size of Malaysian shop offices is relatively similar, with only minor differences. The size of the model used in the Revit simulation was 20245mm x 6980mm, which was found to be representative of the office size in the case study. The Revit simulation results showed that the proposed LED lighting provided optimal visual comfort throughout the day, with lux levels of 400 at 9am, 12pm, 3pm, and 6pm. The simulation showed that only 5 LED lights were needed in the open workspace, and each private office only needed 1 LED light. The 4000k color temperature of the LED lights was found to be the most suitable for enhancing visual

comfort. The area of glare was also found to be smaller after reducing the use of lighting and changing the type of lighting to LED.

Figure below shows the simulation results of propose lighting configurations. The proposed LED lighting configuration, with a brightness level of 400lux and a color temperature of 4000k, was found to be the most appropriate lighting for Malaysian shop offices. The results showed that 5 LED lights in the open workspace and 1 LED light in each private office provide optimal visual comfort throughout the day, reducing the risk of eye strain and headaches by reducing glare and improving lighting conditions. The findings of this study can be used to guide the implementation of LED lighting in shop offices, enhancing employee productivity and satisfaction.

According to the simulation study conducted, LED lighting was found to be the most suitable type for improving visual comfort in Malaysian shop offices. Based on the results, it was recommended that LED lighting with a brightness level of 400lux and a color temperature of 4000k would be the most appropriate for these spaces. The Revit simulation study confirmed the benefits of this proposed lighting configuration.

The study found that the size of Malaysian shop offices was relatively consistent, with only minor variations. The model used in the Revit simulation, which was 20245mm x 6980mm, was deemed representative of the office size in the case study.

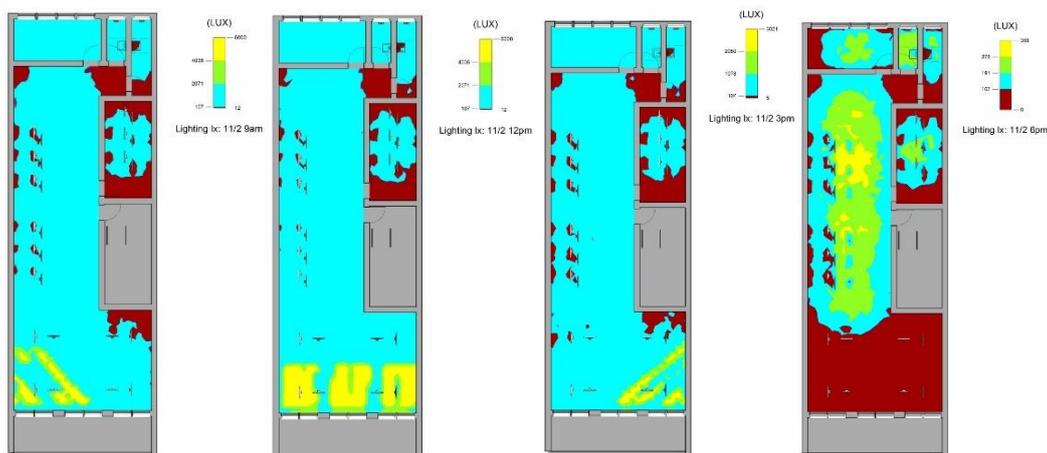


Figure 6. Simulation of proposed lighting in office

The Revit simulation results indicated that the proposed LED lighting provided optimal visual comfort throughout the day, with a lux level of 400 at 9am, 12pm, 3pm, and 6pm. Only 5 LED lights were required in the open workspace, while each private office needed only 1 LED light. The study found that a 4000k color temperature was most suitable for enhancing visual comfort. Furthermore, by reducing the use of lighting and changing to LED, the area of glare was also found to be smaller. The simulation results of the proposed lighting configurations are depicted in the figure below.

In conclusion, the recommended LED lighting configuration with a brightness level of 400lux and a color temperature of 4000k was found to be the most appropriate for Malaysian shop offices. The findings suggest that using 5 LED lights in the open workspace and 1 LED light in each private office would provide optimal visual comfort throughout the day, reducing the risk of eye strain and headaches by minimizing glare and improving lighting conditions. This study's findings can assist in the implementation of LED lighting in shop offices, thereby enhancing employee productivity and satisfaction.

4. Conclusion

The simulation study on lighting conditions in three shop offices in Johor Bahru, Malaysia, reveals that insufficient lighting negatively affects task performance, causes visual discomfort, and potentially contributes to Sick Building Syndrome symptoms. This emphasizes the significance of incorporating proper lighting design in Malaysian shop offices to ensure occupants' well-being (Mohamad, M. S., Abdullah, S. S., Yaacob, M. E., & Mohamad, 2021). The findings identify issues like glare and dark areas due to improper lighting configuration, suggesting adjustments in lighting units and window placement for optimal lighting and natural light entry. This research underscores lighting's pivotal role in shop office design for comfort and productivity, urging the adoption of high-quality lighting solutions for occupant health and workplace efficiency.

Addressing artificial lighting challenges within the scope of sustainable development is vital, encompassing energy efficiency, lighting controls, maintenance, and regulations compliance, contributing to both a greener environment and enhanced workspace quality. In conclusion, this study accentuates the importance of adequate and well-designed lighting for modern Malaysian shop offices, promoting sustainability and occupants' overall performance and satisfaction.

Based on the simulation study of the lighting conditions in three shop offices in Johor Bahru, Malaysia, it is evident that inadequate lighting can lead to poor task performance, visual discomfort, and potentially contribute to Sick Building Syndrome (SBS) symptoms. The findings from this study highlight the importance of considering lighting in the design of shop offices in Malaysia to ensure that they provide adequate levels of lighting and visual comfort for occupants (Mohamad, M. S., Abdullah, S. S., Yaacob, M. E., & Mohamad, 2021).

5. Scope of Limitation

However, this research has certain limitations that should be acknowledged. Firstly, the simulation study focused solely on three shop offices in Johor Bahru, which might limit the generalizability of the findings to a broader range of shop offices in Malaysia. Additionally, the study predominantly examined the impact of lighting on task performance and visual comfort, without delving into potential psychological or physiological effects on occupants.

Furthermore, the research did not consider the diverse preferences and needs of different types of occupants, such as those with varying age groups, occupations, or visual impairments. To address these limitations and further advance the understanding of lighting's role in shop office environments, future research should adopt a more extensive and diverse sample of shop offices across multiple locations in Malaysia. This could involve a longitudinal study to assess the long-term effects of lighting on occupant well-being and performance.

Additionally, incorporating qualitative research methods, such as surveys, interviews, or focus groups, could provide insights into occupants' subjective experiences and preferences regarding lighting conditions. Exploring advanced lighting technologies and their effects, such as circadian lighting or dynamic lighting systems, could also be a valuable avenue for future investigation. Lastly, investigating the potential interaction between lighting design and other factors, like interior design elements, furniture layout, and air quality, could offer a more comprehensive understanding of how these factors collectively contribute to a comfortable and productive workspace.

6. Acknowledgements

I would like to express my deepest gratitude to my advisor for their guidance and support throughout this project.

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