

PREFERENCES AND SATISFACTION OF ARTIFICIAL LIGHTING IN MALAYSIAN SHOP OFFICE

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ABSTRACT

The work environment significantly impacts the productivity of office workers. A healthy and comfortable workspace is essential to achieve positive outcomes in a stressful environment. By investigating the lighting preferences and satisfaction levels of office workers in intermediate shop offices in Malaysia, this study aims to improve the quality of workplace environments by enhancing the properties of artificial lighting and its effects on employee performance. This study focuses on the intermediate shop office, a popular office type in Malaysia that often has poor lighting. Most intermediate shop offices are long and narrow, with windows only at the front and rear of the shops. Good daylight design can save up to 75% of the energy used for electric lighting. However, natural lighting is an uncontrollable source that can cause glare and visual discomfort for office workers using VDTs. Therefore, artificial lighting plays an important role in increasing visual comfort in Malaysian intermediate shop offices. Questionnaires were distributed to office occupants in intermediate shop offices, and significantly lower satisfaction levels were found in the lighting properties and working environment. The average level of illuminance satisfaction among office workers was 2, which is below average. Meanwhile, the correlated colour temperature satisfaction level was approximately 1.29. According to 41% of respondents, the colour temperature in their current office was 3000k, and the satisfaction levels for the number of illuminances and lighting type



were 1.83 and 1.66, respectively. These findings indicate a need to improve the lighting conditions in Malaysian intermediate shop offices.

Keywords: *Shop Office, Visual Comfort, Artificial Lighting Configuration, Preferences, Satisfaction,*

INTRODUCTION

Nowadays, most of the world's population resides in cities; people spend most of their time indoors and work in offices (al Horr et al., 2016). Indoor environmental quality (IEQ) is an important consideration in design as it significantly impacts office occupants' productivity and job satisfaction (Kang et al., 2017). The shop office is popular for small and medium-sized businesses. This type of office is more spacious and personalised and is more affordable to rent than a conventional cubicle office.

However, research has shown that many office workers experience adverse health effects due to their working environment (Kang et al., 2017). Visual comfort is an important factor to consider in creating a conducive working environment in a Malaysian shop office. The quality of light is crucial, especially in the shop office, as adequate lighting is essential for human health, productivity, comfort, and function. Lighting accounts for approximately 20% of the electric energy consumed in buildings, so it is vital to consider both the value of light and energy issues.

This study aims to examine the preferences and satisfaction of office workers in Malaysian intermediate shop offices regarding their lighting configuration. Previous research identified factors that affect employee satisfaction concerning lighting in the office, but there is a lack of studies focused specifically on shop offices in Malaysia. These buildings often have a long and narrow layout, which can prevent access to natural light in some areas and make the visual comfort of workers highly dependent on artificial lighting.

Problem Statement

Shop offices are a common type of commercial building in Malaysia,

particularly in urban areas. These buildings are typically multi-storey structures that combine ground-floor retail space with upper-floor office space. While they can provide a convenient and cost-effective way for businesses to operate, they often have a significant drawback: many office spaces are windowless. The problem of windowless shop office spaces in Malaysia is a serious concern that needs to be addressed.

The lack of natural light can seriously affect workers' health and well-being (Ping et al., 2020; Rechel et al., 2009). Prolonged exposure to a windowless environment can lead to various problems, including eye strain, headaches, and fatigue. It can also increase the risk of more serious health issues, such as depression and heart disease. In addition, a lack of natural light can negatively impact worker productivity and morale (Khairul et al., 2020).

One potential solution to this problem is to provide artificial lighting in windowless office spaces, which can provide consistent light levels throughout the day. Unlike natural light, which can vary in intensity and quality depending on weather conditions, artificial light can be controlled and adjusted to provide a consistent level of illumination (Al-Ashwal & Hassan, 2018). This can help reduce eye strain and other health problems associated with insufficient lighting.

Another potential benefit of artificial lighting is that it can create various lighting scenarios for different tasks or moods. For example, brighter, cooler light can be used for tasks requiring concentration and attention to detail, while warmer, softer light can create a more relaxed and comfortable atmosphere. This flexibility can help improve worker productivity and morale.

Additionally, modern artificial lighting systems can be energy-efficient and environmentally friendly. Many of these systems use LED bulbs, which consume less electricity and produce less heat than traditional lighting technologies. This can help reduce a building's carbon footprint and save costs on energy bills.

In summary, while natural light is generally considered the best option for office environments, artificial lighting can provide certain benefits in

windowless working environments. These benefits include a consistent illumination level, the ability to create different lighting scenarios, and energy efficiency.

The number of office spaces in Malaysia lacking windows has increased. Once considered a relatively low-key land use in central business districts, the number of serviced offices has increased significantly in recent years. The factors driving the demand for serviced offices have shifted, and service providers have swiftly adapted to meet these demands. This trend has been facilitated by the growth of several multinational companies that specialise in providing serviced offices, offering a flexible range of office types and costs.

History of Shop Houses in Malaysia

In 2008, the city of George Town was added to UNESCO's list of world heritage sites in recognition of its rich cultural heritage, which includes a distinctive townscape and architectural style along the Straits of Melaka. Additionally, because of the agreement with UNESCO, shophouse owners are not allowed to demolish and rebuild their shophouses (Li, 2020). Early shophouses had higher levels and relatively narrow widths. Typically, the width will be six to seven metres wide, followed by 30 metres of length, which can occasionally be up to 60 metres long. The narrow façade, which is usually less than ten metres wide, is due to British taxation rules (Ahmad, 1994). The tax was assessed based on the number of windows on each façade. Shophouses were constructed side by side with a shared party wall. Bricks were used to construct and plaster the walls. The courtyard (air-well), also known as the 'deep well', is an interior courtyard space rising from a sunken well or sink and is one of the most common interior features of shophouses.

Shop Houses Style Timeline

As a developing country, Malaysia's urban landscape faces the same trends as many other cities worldwide: rapid and unchecked modernisation. Due to the demand for new infrastructure and buildings, many vernacular building types are rapidly disappearing from the urban fabric, including the Malaysian shophouse. The shophouse was a common building style for over

a century, from 1840-1960s, and is perhaps a typology of a previous era. Figure 1 shows the development of shophouses from the 1790s to the 1960s.



Figure 1. Different Styles of Shophouses from the 1790s to 1960s

Source: Wagner (2017)

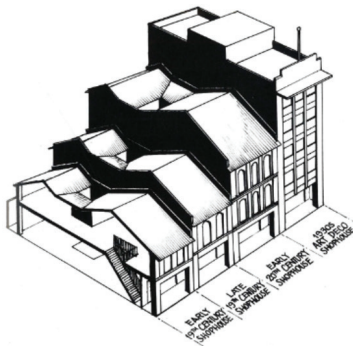


Figure 2. Evolution from shophouse to shop office

Source: Sanyal (2003)

Figure 2 illustrates that during the 1930s, courtyards were no longer a popular shophouse design. In the past, some courtyard shophouses with poor planning and development led to issues like inadequate ventilation and daylight. Only a few courtyard layouts could satisfy the demands of the physical environment. Nowadays, people are more concerned with the quality of life, so air conditioners are installed inside buildings, making courtyards a redundant architectural element. Previously, people used shophouses as places to live and conduct business because developers had not yet separated housing and commercial areas.

Transformation of Shophouse to Shop Office

The transformation of shophouses into shop offices in Malaysia has

been driven by a combination of economic growth, changes in the needs of businesses, and shifts in the way people work. This transformation has provided businesses with cost-effective and flexible options for establishing their operations and has helped support the continued growth of the Malaysian economy. Table 2 shows modern shop offices designed with a different number of storeys.

Table 1 Modern Shop Office Design with Different Numbers of Storeys

Types of Modern Shop Offices	
2 Storeys	
3 Storeys	
4 Storeys	
More than 4 storeys	

Source: Google Earth

Impact of Correlated Colour Temperature (CCT)

Lighting condition is one of the most influential factors on human vision, health, and emotions, both visually and non-visually, and optimal lighting can lead to visually comfortable perception and well-being (Loe et al., 1994; Veitch et al., 2008). Over the years, numerous researchers (Boyce et al., 2003; Cockram & Collins, 1970; Iskra-Golec et al., 2012; Juslen, 2006; Wilhelm et al., 2011) have devoted a significant amount of time and effort to examining the relationship between lighting conditions and work performance.

Juslen (2006) investigated the influence of correlated colour temperatures (CCTs) on visual preference in an industrial working environment and found that higher CCTs significantly increased worker productivity. Mills et al. (2007) discovered that fluorescent lights with higher CCTs could enhance the well-being and productivity of office workers.

Since Kruithof's pioneering study (1941), many researchers have worked to determine the best lighting for specific scenarios. Han (2002) confirmed the validity of Kruithof's curves for lighting in office and conference rooms, indicating that illuminance and CCT were the most significant factors in determining lighting acceptability. Other researchers, however, offered opposing viewpoints. (Boyce & Cuttle, 1990; Davis & Ginthner, 1990) discovered that illuminance, rather than CCT and colour rendering, influenced subjective preference. Even so, McColl and Veitch (2001) published two articles in 2001 claiming that lamps with high colour rendering properties could improve mood, behaviour, and health.

METHODOLOGY

This study sample comprised 100 office occupants (61 males and 39 females) from a Malaysian intermediate shop office. Data collection was conducted using a combination of online and physical questionnaires, resulting in 90 usable online questionnaires and 10 physical questionnaires. No data omissions were observed during the data collection process. The primary objective of the descriptive analysis was to comprehensively understand the respondents' profiles, including demography, working environment

background, preferences, and satisfaction levels regarding the existing artificial lighting.

The collected data were analysed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were employed to summarise and interpret the data, allowing for a detailed exploration of the respondent characteristics. Age distribution revealed that most respondents fell within the 25 to 34 age bracket, comprising 31 individuals (31%). This was closely followed by the age range of 45 to 54, with 26 respondents (26%). Relatively fewer respondents were found in the age groups of 18 to 24 years, 55 to 64 years, and 35 to 44 years, comprising 8, 10, and 25 participants, respectively, representing 8%, 10%, and 25% of the total sample size. Notably, respondents between the ages of 25 and 54 accounted for approximately 82% of the overall sample size in this study.

FINDINGS

Good lighting is required for visibility and should provide a luminous environment that is comfortable for occupants to use and appropriate for the visual task at hand. Preference for lighting is related to various human responses to lighting, including comfort, aesthetics, and performance (Butler et al., n.d.). Improving office lighting to enhance overall luminous conditions positively affects workers, resulting in increased performance, productivity, creativity, and social behaviour (Baron et al., n.d.; environment & 2007; Veitch et al., 2008). Table 2 indicates the preferences of office occupants for lighting configuration.

Table 2. The preferences of office occupants on lighting configuration

		N	Mean	Std. Deviation
Type of Artificial Lighting	CFL	100	2.34	0.831
	Fluorescent	100	2.75	1.019
	Incandescent	100	2.73	1.136
	LED	100	4.87	0.485

Preferred Correlated Colour Temperature (CCT)	1000k	100	2.16	0.707
	2000k	100	2.32	0.790
	3000k	100	3.94	1.118
	4000k	100	4.50	0.810
	5000k	100	4.43	0.902
	6000k	100	3.22	1.252
	7000k	100	2.26	0.895
	8000k	100	2.03	0.797
	9000k	100	1.84	0.721
	10000k	100	1.81	0.720
The Preferred Distance from Desk To Ceiling Light	Ceiling light close to the desk	100	2.29	1.597
	Ceiling light far from the desk	100	4.23	1.399
Preferred Type of Workspace	Open Planning	100	4.52	1.123
	Closed Planning	100	2.05	1.424

Source: Author

Existing Lighting Configuration in Malaysian Shop Office

Table 3 shows the existing lighting configurations and background working environment in Malaysian shop offices. This study's findings suggest that most Malaysian shop offices are open-plan and have high ceilings, with limited access to natural light. These conditions may be influenced by several factors, including space constraints, location, and cost considerations.

While open-plan office layouts and high ceilings may be beneficial for maximising the use of space, they also have potential drawbacks. For example, high ceilings may reduce the effectiveness of artificial lighting, as light fixtures may be too far above the workspace to provide adequate illumination. Additionally, open-plan layouts can reduce privacy and increase ambient noise levels, leading to lower concentration and productivity levels.

Furthermore, limited access to natural light may have negative consequences for the health and well-being of office workers. Research has shown that exposure to natural light can have a number of benefits, including improved mood, reduced stress levels, and enhanced cognitive performance

(Baron et al., 1992; Küller et al., 2006) . The finding that 45% of respondents have difficulty receiving daylight indicates that a significant proportion of office workers in Malaysia may not be benefiting from these effects.

Overall, these findings highlight the need to carefully consider lighting design in Malaysian shop offices. This may involve a combination of artificial and natural lighting and strategies to improve the quality and distribution of light in the workspace to ensure that the potential drawbacks do not outweigh the benefits of open-plan layouts and high ceiling heights.

Most shop offices in Malaysia are located in buildings with four or fewer storeys, and the most common correlated colour temperature (CCT) is 3000k. Additionally, the majority of shop offices have six to ten light fixtures, indicating that these spaces do not require much lighting.

Fluorescent lighting is the most commonly used type of lighting in Malaysian shop offices, with 42% of offices using this technology. In contrast, only 22% of shop offices use LED lighting, which is a more energy-efficient and long-lasting option. Despite being more expensive than other lighting technologies, LED lights are generally considered to have higher-quality light output.

Findings indicate that Malaysian shop offices are relatively small and do not require extensive lighting systems. Additionally, the prevalence of fluorescent lighting suggests that energy efficiency may not be a significant consideration in designing these spaces.

Table 3. The Existing Lighting Configuration in Malaysian Shop Office

		Frequency, N	Percent (%)
Height from Desk to Ceiling Light	1-2meters	9	9.0
	2meters and above	90	90.0
	Less than 1meter	1	1.0
Type of Working Space	Closed Planning	25	25.0
	Open Planning	75	75.0

Distance from Desk to Window	0-1 meter	24	24.0
	1-2 meter	6	6.0
	2-3 meter	2	2.0
	3-4 meter	6	6.0
	4-5 meter	17	17.0
	More than 5 meter	45	45.0
Office Level (Storey)	First Floor	39	39.0
	Second Floor	56	56.0
	Third Floor	5	5.0
Correlated Colour Temperature (CCT)	2000k	19	19.0
	3000k	41	41.0
	4000k	10	10.0
	5000k	5	5.0
	6000k	19	19.0
	7000k	6	6.0
Number of Existing Lighting Fixtures	1-5	34	34.0
	6-10	56	56.0
	11-15	10	10.0
Type of Lighting	CFL	34	34.0
	Fluorescent	42	42.0
	Incandescent	2	2.0
	LED	22	22.0

Source: Author

Correlation Analysis on Satisfaction in Current Workspace

The results of the correlation analysis in this study suggest a strong positive relationship between window glare and visual comfort while using a computer ($r = .894$). This means that when glare from windows increases, visual comfort decreases. This is particularly relevant for office workers in Malaysia who use computers, as most of these workers are likely to be affected by the glare from windows. The results of this study suggest that office workers in Malaysian shop offices often experience discomfort while using a computer, as the increased light reflection from windows can impede

their ability to see their computer screen clearly and concentrate on their work. As a result, many office occupants in these buildings may need to close the curtains to reduce glare and improve their visual comfort while using a computer.

The findings of this study focus on the visual comfort of office workers in shop offices in Malaysia. The results indicate a strong positive correlation between visual comfort in relation to glare and window glare in these buildings ($r = .879$). This suggests that window glare is a major contributor to visual discomfort for office workers in Malaysian shop offices. The study also found that most of these buildings do not have tinted windows, which can help to reduce heat gain and glare. Additionally, the long and narrow layout of these buildings often results in an uneven distribution of lighting, with some office workers sitting very close to the windows while others are positioned far away. This can create areas of excessive glare and areas of inadequate lighting, both of which can contribute to visual discomfort. Overall, these findings suggest that improving the window glazing and the lighting configuration in Malaysian shop offices could help enhance office workers' visual comfort.

This study's results indicate a strong positive correlation between office illumination and the distance from the desk to the window ($r = .866$). This means that the closer an employee's workspace is to a window, the higher the illuminance will be in that area. Conversely, employees who sit farther away from windows experience lower levels of illumination in their workspace.

These findings suggest that the indoor illumination in shop offices in Malaysia is generally inadequate and that the lighting quality in these buildings is poor. This is likely due to the long and narrow layout of these buildings, which can prevent access to natural light in some areas. Additionally, the lack of tinted windows in these buildings may contribute to heat gain and glare, which can further impair visual comfort and productivity.

The survey results also indicate that most office workers in Malaysian shop offices need additional task lighting on their desks to work comfortably and efficiently. This suggests that the current lighting configuration in

these buildings may be insufficient to support the needs of office workers, and additional lighting may be necessary to improve visual comfort and productivity. Overall, these findings highlight the importance of carefully designing and installing artificial lighting in shop offices in Malaysia to enhance the work environment and support office workers' health and well-being.

The results demonstrated a strong positive correlation ($r=.721$) between visual comfort in relation to glare and office level and a strong positive correlation ($r=.732$) between glare from the window and office level. These findings suggest that office level can significantly impact the visual comfort of office occupants, with upper office levels being more susceptible to glare than lower office levels.

These results highlight the importance of considering the impact of office level on visual comfort and glare in the design of office spaces. In the case of Malaysian shop offices, it may be necessary to implement additional measures, such as using window treatments and strategic building orientation, to reduce glare and improve the working environment for occupants. Further research is needed to confirm these findings and explore potential solutions for mitigating the effects of glare on visual comfort in office spaces.

The study found that the office lighting in Malaysian shop offices is inadequate, with a greater distance between desks and windows requiring more lighting fixtures. This relationship is reflected in the moderately positive correlation ($r=.646$) between the number of lighting fixtures and the distance from desk to window. Additionally, the study found a moderately positive correlation ($r=.610$) between the number of lighting fixtures and office illuminance. This suggests that artificial lighting plays a crucial role in providing sufficient illumination for office occupants in Malaysian shop office buildings, which often have long and narrow layouts.

These findings have important implications for designing and managing office lighting in Malaysian shop office buildings. In order to ensure adequate illumination and improve the working environment for occupants, it may be necessary to increase the number of lighting fixtures or adjust their placement in such buildings.

The study found a moderately negative correlation ($r = -.527$) between the distance from desks to windows and the amount of glare experienced by office occupants in Malaysian shop office buildings. This indicates that desks closer to windows in these buildings are more susceptible to glare than those farther away. The study also found a moderately negative correlation ($r = -.531$) between glare from windows and office illumination in Malaysian shop offices. This suggests that glare from windows can reduce the overall illumination in offices in these buildings unless blinds or drapes are installed to block the glare.

These findings have important implications for the design of Malaysian shop office buildings. In order to reduce the amount of glare experienced by office occupants and improve overall office illumination, it may be necessary to strategically position desks and windows within these buildings. This could involve placing desks farther away from windows or installing blinds or drapes to block glare from windows.

This study's findings indicate a moderately negative correlation ($r = -.532$) between the distance between a desk and lighting fixtures and satisfaction with computer usage in Malaysian shop office buildings. This suggests that desks located farther away from lighting fixtures may be less conducive to comfortable and effective computer use. The study also found a weakly positive correlation ($r=.654$) between office level and computer usage satisfaction, indicating that higher office levels may be associated with greater satisfaction with computer use. However, a moderately negative correlation ($r = -.522$) was found between computer usage satisfaction and office illumination, suggesting that high levels of office illumination may not necessarily lead to increased satisfaction levels with computer use.

Table 4. Correlation on the Satisfaction of Office Occupants in Malaysian Shop Office

Correlations on Satisfaction of Office Occupants							
	Distance From Desk to Window	Office Illuminance	Visual Comfort (Glare)	Visual Comfort by Level of Office	Window Glare	Visual Comfort (Using Computer)	The number of lighting fixtures

Distance From Desk to Window	r	1	.866**	-.480**	-.293**	-.527**	-.532**	.646**
	Sig. (2-tailed)	0.000	0.000	0.000	0.003	0.000	0.000	0.000
	N	100	100	100	100	100	100	100
Office Illuminance	r	.866**	1	-.493**	-.368**	-.531**	-.522**	.610**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000
	N	100	100	100	100	100	100	100
Visual Comfort (Glare)	r	-.480**	-.493**	1	.721**	.879**	.813**	-.414**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000
	N	100	100	100	100	100	100	100
Visual Comfort by Level of Office	r	-.293**	-.368**	.721**	1	.732**	.654**	-.278**
	Sig. (2-tailed)	0.003	0.000	0.000		0.000	0.000	0.005
	N	100	100	100	100	100	100	100
Window Glare	r	-.527**	-.531**	.879**	.732**	1	.894**	-.447**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000
	N	100	100	100	100	100	100	100
Visual Comfort (Using Computer)	r	-.532**	-.522**	.813**	.654**	.894**	1	-.427**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000
	N	100	100	100	100	100	100	100
The number of lighting fixtures	r	.646**	.610**	-.414**	-.278**	-.447**	-.427**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.005	0.000	0.000	
	N	100	100	100	100	100	100	100

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Source: Author

CONCLUSION

Based on the findings discussed above, it can be concluded that the design of Malaysian shop office buildings significantly impacts the visual comfort and satisfaction with computer usage of office workers. The study found that the distance between desks and windows and between desks and lighting fixtures can affect the amount of glare experienced by office workers and their satisfaction with computer usage. Additionally, the study found that office level and office illumination can also impact visual comfort and satisfaction with computer usage.

These findings have important implications for designing and managing Malaysian shop office buildings. In order to improve the working environment and productivity of office workers in these buildings, it is necessary to consider the placement of desks, windows, and lighting fixtures, as well as the overall level of illumination in the office.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Surat kami : 700-KPK (PRP.UP.1/20/1)

Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak



Tuan,

**PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK
MELALUI REPOSITORI INSTITUSI UiTM (IR)**

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

Setuju.

27.1.2023

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
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