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Analyzing The Effects of High-Rise Buildings with Glass Façades on Outdoor Human Comfort in The Jakarta Metropolitan Area

Nisrina Dewi Salsabila[1], Ismar M. S. Usman[1,*], Mohd Iskandar Abd Malek[1], Nik Lukman Nik Ibrahim[1], Nangkula Utaberta[2]

[1] Department of Architecture and Built Environment, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
[2] School of Architecture and Built Environment, Faculty of Engineering, Technology and Built Environment, UCSI University, UCSI Heights, Jalan Puncak Menara Gading, Taman Connaught, 56000 Cheras, Wilayah Persekutuan Kuala Lumpur, Malaysia

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ABSTRACT

The current trend of urbanization forces building development in urban areas, but the limitation of land in the area forces the development to be conducted upwards instead of sideways; thus, high-rise buildings will continue for decades. The façade of a high-rise building plays the most significant role in connecting the indoors and outdoors, therefore, having the most direct effect on the surrounding environment. Nowadays, glass is one of the most popular materials used in a high-rise building's façade. The abundance of high-rise buildings with glass façades is also found in the Jakarta Metropolitan Area. However, the climate condition of the Jakarta Metropolitan Area proposes challenges in designing high-rise buildings with glass façades to accommodate outdoor human comfort. This study aims to review whether people achieve human comfort in an outdoor area of high-rise buildings with glass façades in the Jakarta Metropolitan Area. Using literature review through content analysis, this study found that theoretically, high-rise building with glass façade does not naturally respond to the climate condition of the Jakarta Metropolitan Area in providing human comfort. However, human psychological factors need to be considered in determining whether a condition is perceived as comfortable, as occupants of an outdoor environment have different expectations than those indoors. Thus, further assessments need to be conducted to determine whether developing high-rise buildings with a glass façade is appropriate to support outdoor human comfort in the Jakarta Metropolitan Area.

1. Introduction

With the current trend of urbanization, building development in urban areas becomes inevitable. However, the limitation of land in the area forces designers and developers to build upwards instead of sideways; thus, high-rise buildings will continue for decades to come [1-3]. The multitude of high-rise buildings in a city will impact the environment at various scales. On a city scale, the height and density of buildings become one of the main contributors to Urban Heat Island, meaning that the air

* *Corresponding author.*
E-mail address: ismarms@ukm.edu.my

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temperature in an area with many high-rise buildings tends to be higher than in the surrounding [4-6]. On a smaller scale, a high-rise building can also affect the environmental quality of its surrounding area [7-9].

Concerning its surroundings, a building's façade is the most significant in connecting the outdoor and indoor environment. To neutralize the possibly heavy visual effect of high-rise buildings, glass has become one of the most popular materials used in the façade. Using a glass façade or large windows instead of other more solid or opaque materials such as masonry could make the building appear less bulky, thus contributing to the aesthetics of the building [3,9,10]. However, the characteristics of glass can cause changes in environmental conditions. Its reflectivity could affect the distribution of sunlight, leading to a rise in air temperature. In addition, façade geometry could also impact the surrounding air movement. These conditions are considered environmental factors affecting human comfort [11-14].

The development of high-rise buildings with glass facades is also a phenomenon often found in the Jakarta Metropolitan Area. Also known to the locals as the *Jabodetabek* area, the Jakarta Metropolitan Area is Indonesia's most populated metropolitan area. It consists of the capital city of DKI Jakarta, as well as the surrounding satellite cities, including Bogor, Depok, Tangerang, and Bekasi. As the largest metropolitan area in Indonesia, the Jakarta Metropolitan area faces many developments due to urbanization [15-17]. Figure 1 illustrates the different appearances of downtown Jakarta from five decades ago and now. In the 1970s, it was seen that the area around the *Semanggi* Bridge was still primarily green open land. There are several low-rise buildings in the vicinity, with the *Gelora Bung Karno* Stadium being the largest building at that time, and can be seen clearly from afar. Fifty years later, in the same area, many buildings have been built on a much larger scale—many of them with glass as facade material—and the green land has been reduced significantly.

(a) (b)

Fig. 1. Aerial view of *Semanggi* Bridge in the 1970s (a) and the 2020s (b) Showing the high-rise building development in Jakarta city center [17]

This area is in the tropical rainforest or hot-humid climate region, according to the Köppen Climate Classification [18-20]. It has characteristics of constant sun radiation, high air temperature and humidity, also relatively low air velocity. These conditions also affect the area's environmental quality, affecting human comfort. Various theories and previous studies have shown that the climate condition of tropical hot-humid regions proposes many challenges in designing buildings using glass façades, especially for high-rise buildings [12,21]. The constant sun radiation is generally considered an advantage to a building's passive design through natural lighting. However, light is always followed by heat which adds a challenge to cooling, especially considering that the air temperature is already relatively high. Therefore, it can be concluded that the climate condition of Jakarta may not be well fitted for designing high-rise buildings with glass façades to accommodate outdoor human comfort. However, in actual condition, many high-rise buildings in Jakarta have glass façades which contribute

to increasing air temperature and reflective glare. Thus, it can be said that the existing conditions seem to contradict what is suggested in theory. This could be a problem as the use of glass façades for high-rise buildings in the Jakarta Metropolitan area may not be able to provide outdoor human comfort for users of the space.

Based on the issue, this study aims to review whether people achieve human comfort in an outdoor area of high-rise buildings with glass façades in the Jakarta Metropolitan Area. By conducting this study, the author hopes to understand the current design of glass façades in high-rise buildings within the Jakarta Metropolitan Area and how they would affect human comfort outside the building. Several keywords were discovered based on the background theories (Figure 2). This study uses content analysis to answer the research questions [22,23]. A preliminary literature review was done to understand the advantages and challenges of designing glass façades for high-rise buildings in the Jakarta Metropolitan Area. Theories and previous studies regarding the keywords—high-rise building, glass façade, human comfort, outdoor environment, and Jakarta Metropolitan Area—are included in this study. It was found that there had been many studies discussing the effect of glass façades in high-rise buildings on the indoors, but few discuss the effect on outdoor comfort [13,24]. As for those studies discussing the outdoor effect, it is mainly limited to the effect of glass façades in high-rise buildings on the environmental condition; not many discuss further the effects on outdoor human comfort [4,7]. In addition, few studies were conducted in tropical hot-humid climate regions, none in the Jakarta Metropolitan Area.

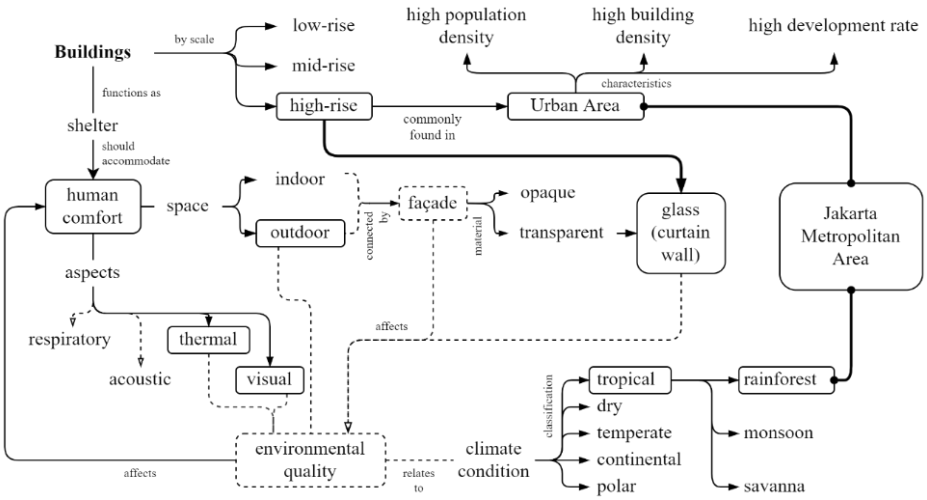

Fig. 2. Conceptual framework of keywords relating to the study

This study aims to fill the research gap by specifying the scope of the study by reviewing human comfort in outdoor areas surrounded by high-rise buildings with glass facades in the Jakarta Metropolitan area. The result of this study is expected to provide more specific knowledge and insights for future high-rise developments in the Jakarta Metropolitan Area, as well as raise awareness for high-rise building designers to create façade designs that respond better to the condition of the environment to accommodate human comfort.

2. Research Method

This study uses a literature review through content analysis as its research method. A literature review is an excellent way of synthesizing research findings as it can summarize existing knowledge through a collection of writings regarding a specific topic [23,25]. Conducting a literature review is

essential in research: it is necessary to consider all relevant works that had been done prior to the newly proposed research, as it can help motivate the aim of the study and justify the research questions and hypotheses [23]. Several benefits of conducting a literature review include giving a general overview of a body of research, revealing what has already been done within the field, and determining what issues or problems were faced in previous research [25]. Content analysis is a method of literature review that has been widely used in social science, mainly to identify and summarize trends [26,27]. In conducting content analysis, researchers should begin with a specific statement of objectives or research questions to be studied, as these would determine the choice of literature samples relevant to the purpose of the study [26,27].

Based on the objective of this research, several key ideas to be reviewed are: 'high-rise buildings with glass façade', 'outdoor human comfort', and the 'Jakarta Metropolitan Area'. Each key idea would first be reviewed individually to gain a deeper understanding of each concept. From these key ideas arose three minor questions—each of which questioned the relationship between two key ideas—and one main question, which combines all three (Figure 3). The questions were used as a guideline in the synthesizing process and were hoped to answer this research's objective.

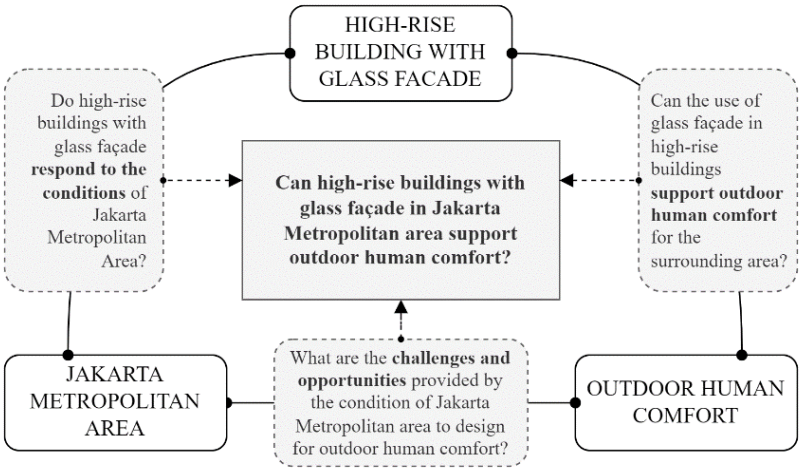

Fig. 3. Mind mapping of main key ideas relevant to this study and the questions they propose

3. Literature Review

3.1 High-rise Buildings with Glass Façade

Nowadays, people tend to migrate from rural to urban areas because cities are major centers of urban development, innovation, culture, and economic activity, making them ideal for seeking employment, raising a family, and, overall, a better future [2,16,28]. The United Nations estimated that 2007 was the year when more people started to live in urban areas. By 2020, the number had increased to about 55% in urban areas and is expected to continue increasing up to over 2/3 of the world population to occupy the urban area in 2050 [29,30]. This migration trend leads to growth and development within the urban area, also known as urbanization. Urbanization leads to various changes in the ecosystem. Considering people migrate to urban areas in search of a "better life", residents of urban areas have a higher living standard than those in rural areas. This leads to the development of structure and infrastructure—which converts undeveloped lands into a built environment—as well as higher consumption of energy and resources to support urban living: both of which lead to several environmental problems such as loss of agricultural land, increase in carbon emission, increase in waste and pollution, and even contributing to the climate change [16,28,31].

In addition, the population growth in an urban area is met with limited land availability, leading to higher population density and land scarcity. This condition forces development to be done vertically in the form of high-rise buildings. High-rise buildings are defined as tall buildings with a small footprint and a small roof area with tall façades, which rise above their surrounding context [1,32,33]. Positively, high-rise development allows more availability of land on ground level for natural preservation and pedestrian life. Building vertically—instead of horizontally—could also reduce the risk of urban sprawl, and high-rise buildings tend to have higher efficiency and effectiveness regarding urban services such as transportation [1,3,32-34].

However, developing high-rise buildings can also cause negative impacts on the environment. Due to their high intensity, high-rise buildings tend to consume more energy and resources, and produce more waste [1,32,34]. In addition, high-rise buildings also cause changes in environmental quality. To the immediate surrounding outdoor area, a high-rise building can cause an increase in air pollution, increase in air temperature, and alter wind movement [7-9]. On a larger scale, the development of high-rise buildings within an area would increase the overall air temperature of the area and can contribute to Urban Heat Island, whereas the alteration in air movements may cause "wind channelling" (Figure 4) [4,35,36].

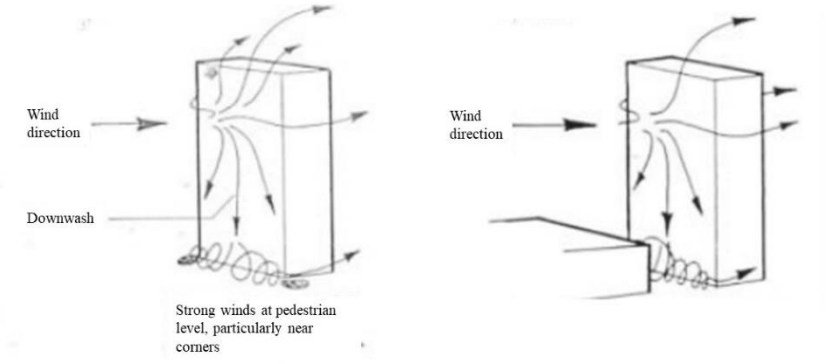

Fig. 4. Illustration of wind hitting high-rise building: altering wind movement and creating turbulence on ground level [36]

Out of all elements in a building, the facade is its outermost layer that interacts directly with the surrounding environment. A building's façade is defined as the exterior part of a building, comprising of rear, frontal, or sides of a built form [37]. The façade of a building acts as its "envelope," which not only establishes the building's visual image but should provide shelter for the building's occupants [1,3,13,37-39]. This role is enhanced even more in high-rise buildings with a primary characteristic of a vast facade. A high-rise building's facade should be designed with great consideration of the surrounding, so it becomes both responsive and responsible; meaning that the façade should be designed with consideration to its impact, both on the indoor and outdoor environment [1,8,39].

The use of glass façades in high-rise buildings is now ubiquitous and was driven by the human desire for more natural light and visual access to the inside of the building, supported by various developments in building material technology [3,12,38,40,41]. To understand the use of glass in architecture, it is better to start by understanding glass itself and its general properties. Glass is an inorganic product composed of basic constituents that undergoes the process of crystallization to make it solid [40-42]. Based on the composition of the basic ingredients, different types of glass can be produced with various properties—different strengths, transparency, and even colors. Several properties of the glass material must be considered to determine the best type of glass and design strategy.

Considering that the main reason for using glass as façade material is related to visual advantages, optical properties need to be taken into account. Optical properties relate to how glass interacts with light in the form of absorption, transmission, and reflection [41]. Table 1 shows the different absorption, transmittance, and reflectivity capability of several different types of glass found in buildings. It can be seen on the table that the less transparent a glass is, the more reflective it becomes. In addition, glass has a relatively low thermal conductivity meaning that they poorly transfer heat through the process of conduction: however, we must remember that light is followed along by heat, meaning that using transparent glass could benefit in providing a view and light entry, but it brings heat from the outside to inside of the building [12,41,42]. Thus, it is essential to consider what glass type and properties would fit in different climate conditions.

Table 1
Optical properties of several typical architectural glasses [41]

Glass Type	Transmission Capability, T_{sol} (%)	Reflective Capability, R_{sol} (%)	Absorption Capability, A_{sol} (%)
Clear Glazing Window (CGW)	77	7	16
Bronze Glazing Window (BZGW)	49	6	45
Green Glazing Window (GGW)	42	6	52
Bronze-Reflective Glazing Window (BZRGW)	36	14	50

The use of a glass facade has several advantages. To support a façade's function in establishing a building's visual image, glass gives a "lightweight" appearance, and its flexibility and versatility—various colors, textures, shapes, etc.—could enrich the building's image [12,41,43,44]. In addition, glass allows daylight to enter the building, which supports human activities inside the building while maximizing passive lighting strategies. However, with more light also comes more heat; thus, a glass façade can increase indoor air temperature, which affects occupants' comfort & well-being as well as increase the cooling load [8,12,21,38,42]. To reduce light and heat entering the room, glass with lower transmissive capability can be chosen. Unfortunately, less transmissive means that the glass is possibly more reflective, which causes a negative impact on the environment around the building, such as increasing the possibility of reflective glare and increasing the air temperature of the surrounding area [4,8,9,40,44,45].

3.2 The Jakarta Metropolitan Area

Urbanization may lead to the emergence of "megacities", as found in the Jakarta Metropolitan area. With a total area of over 7.000km^2, the Jakarta Metropolitan Area is the largest in Indonesia and the second largest in Asia [15-17]. This megacity consists of DKI Jakarta province and eight surrounding cities and regencies: Tangerang Regency, Tangerang City, South Tangerang City, Bekasi City, Bekasi Regency, Depok City, Bogor City, and Bogor Regency. As of 2020, the population of DKI Jakarta province itself is recorded at approximately 10,56 million; this number could increase up to 12 million on working days, counting the residents of the surrounding city who works in Jakarta as well as residents of Jakarta who works outside of the city [17].

The urban development in the Jakarta Metropolitan Area and its population growth have led to the development of buildings, especially in areas with high activities. As in most cities, Jakarta Metropolitan Area also adapts the development of high-rise buildings in response to the issue of population density vs. land scarcity. Most high-rise buildings in the Jakarta Metropolitan area are found along the Jakarta Golden Triangle (Figure 5). The Jakarta Golden Triangle is an economic centre

extending from Central to South Jakarta, integrating building areas with green open space to maintain the sustainability of the environment [46]. The area obtained its nickname due to its roughly triangular shape, surrounded by Rasuna Said Road on its east side, Gatot Subroto Road on its southwest, and Jenderal Sudirman Road on its northwest. Along the golden triangle area are several more specific central business districts, including the Sudirman CBD and Mega Kuningan CBD area. Both areas have been developed since the early 1990s and are still experiencing development; thus, containing plenty of newly constructed high-rise buildings with glass façades [17].

Fig. 5. Map of Jakarta Golden Triangle, surrounded by three main roads: Rasuna Said, Gatot Subroto, and Jenderal Sudirman. In the surrounding area are two major CBDs, namely the Sudirman CBD and Mega Kuningan CBD [17]

As in all cities in the world, the province of DKI Jakarta also stipulates various rules for building construction, including high-rise buildings. According to the Government of DKI Jakarta, a building is defined as "a physical embodiment of an architecture that is partially or wholly located above and/or in the land and/or water and used as a place for human activities", whereas tall or high-rise buildings are "those that have a height of more than eight layers". Several government rules mentioning high-rise building regulations include Regulation of The Special Capital Regional Region of Jakarta Number 7 of 1991, Regional Regulation of The Special Capital Province of Jakarta Number 7 of 2010, and Regulation of The Governor of Jakarta Capital Special Region Number 135 of 2019 [47-49]. Out of the three, only the second regulates the use of the material and mentions the importance of human comfort. It states that materials must be safe and not cause negative impacts; including that they should avoid reflective glare and the increase in surrounding air temperature. As for comfort, it is noted that the regulation requires building planning to consider visual comfort, both inside-out and outside-in.

In addition to the government regulation, Green Building Council Indonesia also developed Greenship for New Buildings (NB) and Existing Buildings (EB) as rating tools for green building certification. Both Greenship NB and EB consist of six assessment categories, namely (1) Appropriate Site Development (ASD); (2) Energy Efficiency and Conservation (EEC); (3) Water Conservation (WAC); (4) Material Resources and Cycle (MRC); (5) Indoor Health and Comfort (IHC); (6) Building and Environmental Management (BEM) [50]. The Greenship rating tool suggests that human comfort is crucial in determining green buildings. Unfortunately, the human comfort aspects considered for this assessment are only for users of the building's indoor space and not its outdoor area.

In addition to the urban condition of the Jakarta Metropolitan area, its climate condition is also something to consider. Based on the Köppen-Geiger climate classification, the Jakarta metropolitan area is classified as a tropical rainforest. Figure 6 is a map that illustrates the climate classification division in the Jakarta Metropolitan area. This climate area has characteristics of all months have an average precipitation value of at least 60mm, relatively low air velocity, mean temperature of all months exceeding 20°C, and the sun shines from the south for half the year and from the north for the other half [12,18,19,51].

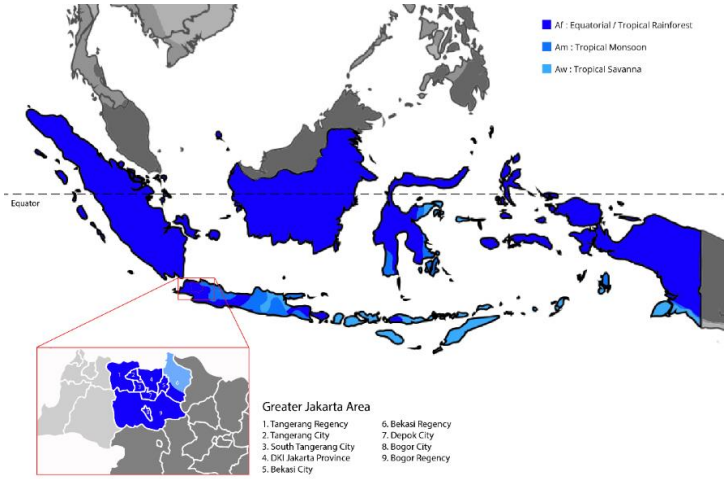

Fig. 6. Jakarta Metropolitan area in Indonesia on the updated climate division map based on the Köppen-Geiger Classification [20]

These climate characteristics present challenges and opportunities for building design. Positively, it rarely gets cold enough in the tropics to require heating systems—thus, the solar design focuses only on shading and daylighting—and implementing passive lighting strategies could be easier because there are no days where the daylight hours are too few [12]. However, the abundance of sunlight—along with the high air temperature and low air velocity—presents challenges for cooling, and the tremendous amount of sunlight may cause high brightness and glare [7,12,21,43].

4. Human Comfort in the Outdoor Environment

Comfort has been defined as “a pleasant state of physiological, psychological, and physical harmony between a human being and the environment” [52]. However, the concept of comfort cannot be easily explained, and some argue that the best way to understand comfort is by viewing it as the absence of discomfort [52,53]. Comfort is perceived through a network of sense organs: the skin senses thermal comfort, the eyes sense visual comfort, and so on [11,53]. However, comfort is highly subjective as it is perceived differently by different people considering that humans have different sensitivity to their surroundings. Discomfort occurs when one of these sense organs receives any distraction or disturbance, possibly from the surrounding environment.

As human does activities within a space, any condition within that space—their environment—can easily influence them. The term ‘environment’ is best explained as “everything that is outside the human body, and that can have some influence, no matter how slight, on it” [52]. Human beings inhabit different environments: indoor, semi-outdoor, and outdoor. The Merriam-Webster English Dictionary defines the outdoors as “a place or location away from the confines of a building”. As it is less confined, the outdoors tends to have more extreme environmental conditions than the indoors.

This, of course, means that the outdoor environment affects human comfort differently than how the indoors would. In the outdoors, people are directly exposed to local microclimate conditions, and environmental controls to provide for human comfort are very limited [24,54]. In addition, human psychology plays a significant role in determining human comfort. As people naturally expect different things outdoors than indoors, environmental conditions deemed uncomfortable indoors may be acceptable outdoors [54,55].

In relation to space, human comfort aspects include—but are not limited to—thermal and visual comfort. Thermal comfort is best defined as "that condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation", as stated in ASHRAE-55. Because it is a condition of the mind, thermal comfort is a complex matter, but it can be understood physically as the condition when the body can maintain its optimum temperature; meaning that the amount of heat entering and leaving the body is within a narrow range [12]. Thermal comfort is affected by various internal and external factors. Internal or personal factors include rate of metabolism, clothing/insulation, and activity level, whereas external or environmental factors include air temperature, air humidity, and air movement [12,53,56,57]. Certain combinations of these factors—affected by their rate of change—are what one perceives as comfortable or uncomfortable.

Visual comfort is defined by The European standard EN 12665 as "a subjective condition of visual well-being induced by the visual environment". In short, if we look at comfort as an absence of discomfort, visual comfort refers to "being free from sensitivity, pain, and distraction" [13]. Like thermal comfort, visual comfort is also affected by environmental factors, including lighting factors such as luminance, contrast, and light distribution, as well as other factors like colors, textures, and patterns [11,13,14,58]. One of the main contributors to visual discomfort is the existence of glare. Based on its negative impact on the perceiver, glare can be classified into two: disability glare, which reduces visibility and visual performance, and discomfort glare, which simply causes disturbance or annoyance [12,43,58].

Based on the light distribution from the source to the eye of the perceiver, glare can be either direct or indirect [12,43]. Direct glare occurs when the light source is within the field of the view; whereas in reflection glare, the light is reflected from the source to a surface elsewhere before hitting the visual field [12,43]. Figure 7 illustrates the possibility of direct and indirect glare in an outdoor setting. One of the leading causes of indirect glare in an outdoor setting is the sunlight reflected from specular or reflective building façades, which could cause thermal and visual discomfort [59]. The use of a reflective façade, though it might be beneficial for the indoors, may cause glare that is unpleasant, even harmful, for the outdoor dwellers [8,43,59]. Another factor contributing to reflected glare in the outdoor environment is the building geometry—the form of individual buildings and the overall relationship between neighboring buildings [59,60]. Reflected glare is best avoided by minimizing the use of reflective surfaces—using flat or matte finishes instead—and by working with geometry, such as adjusting the angle of reflective materials to diffuse the reflection [12,59].

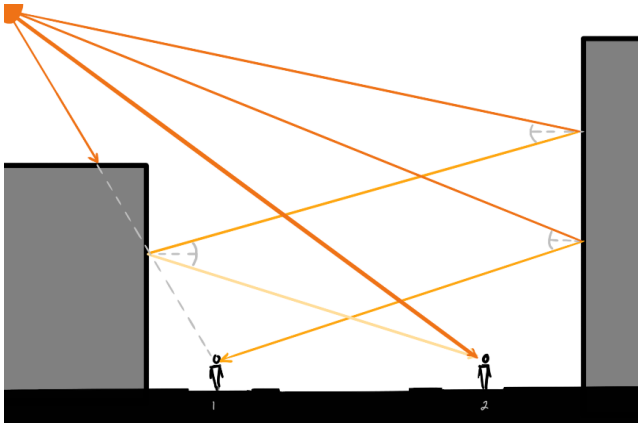

Fig. 7. Possible direct and indirect (reflected) glare happening in outdoor space. Based on the perceiver's position from the light source, person 1 (one) may not be exposed to direct glare because it is blocked by an existing building, while person 2 (two) may get it. However, person 1 may be exposed to reflected glare if the building on the opposite side has a reflective façade

5. Discussion

The previous theoretical reviews raised the question of whether high-rise buildings with glass façades can support outdoor human comfort in the Jakarta Metropolitan area. To answer said question, the conditions provided by the Jakarta Metropolitan area—including its urban development and climate condition—should be considered. Figure 8 illustrates the mind mapping of the concepts contained in the literature review.

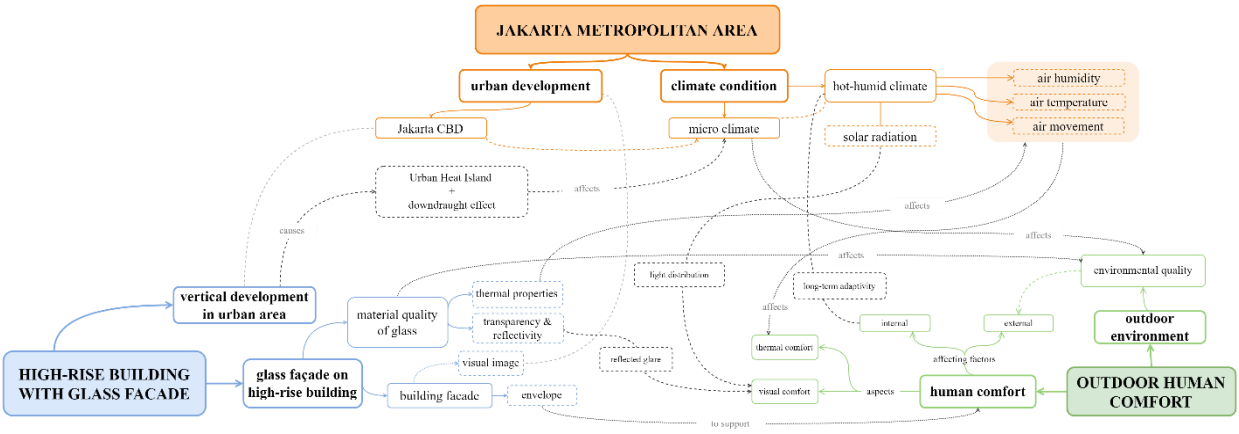

Fig. 8. Mind mapping for literature review synthesis

First, the hot-humid climate condition of the Jakarta Metropolitan area proposes several challenges—along with opportunities—in providing human comfort in the outdoor environment. The combination of high air temperature, high air humidity, and low air movement is often deemed thermally uncomfortable because it highly affects heat release from the body [12]. In addition, high solar radiation may also contribute to visual discomfort, especially in outdoor areas with less shading obstructing the light, which also means a higher possibility for glare to occur. On the other hand, the constant solar radiation throughout the year means there are fewer differences in weather

conditions between seasons; thus, people living in the tropics have less need to adapt to the environment repeatedly and are usually more adapted to the local climate [12,61].

Considering the challenges and opportunities posed by climatic conditions, it is then necessary to take into account the importance of constructing high-rise buildings with glass facades in the Jakarta Metropolitan Area. As the number of populations continues to increase in the Jakarta Metropolitan Area, the availability of land stays the same; this leads to a high increase in population density which pushes building developments to be constructed upwards in the form of high-rise buildings. Therefore, the development of high-rise buildings is considered necessary as there has been no better alternative to respond to the population density issue.

However, the need for glass as the main façade for material is still debatable. As the façade plays a significant role in a high-rise building—establishing a visual image and responding to its surrounding environment—its material choice becomes crucial [1,3,13,38]. The use of glass is beneficial in creating a "lighter" and more futuristic visual image of the building and connecting the indoor and outdoor environment [12,38,43,44]. On the other hand, extensive use of glass in a high-rise building façade affects the surrounding environment: many of which can be considered undesirable. Thus, using glass façades in Jakarta as a developed urban area is not considered necessary; but if proper design strategies are implemented, it could be beneficial as it supports the function of a façade as a building envelope and visual image.

High-rise buildings—especially those using glass façades—cause changes to the microclimate of the surrounding area. The development of many high-rise buildings in an area leads to the emergence of the Urban Heat Island phenomenon, in which the built surfaces of the area store more heat during the day to be released during the night, keeping the urban lands hotter than surrounding rural areas [5,6]. Using glass as the façade material can further increase this effect, as glass tends to have high solar reflectivity, which increases the surrounding air temperature [4,7,9,44]. In the Jakarta Metropolitan Area, which is naturally warm, these conditions may lead to higher thermal discomfort.

In addition, high-rise buildings are also known to cause changes to the wind movement of the surrounding area by creating a "downdraught effect"; in addition, when several high-rise buildings are built closely, it could lead to wind "channelling", which is caused by air having to be squeezed through a narrow space [35]. Considering that the Jakarta Metropolitan Area has a naturally low wind movement, the changes in wind movement could be both a challenge and an opportunity. To a certain extent, the increase in wind speed—especially in the outdoors, where the wind tends to move more freely due to the lack of barrier—can be considered more desirable as it can assist with heat release from the body [12,61]. However, if the wind speed gets too high, it may cause disturbance to the occupants of the area surrounding the buildings.

In short, the theories suggest that high-rise buildings with glass façades cause changes to the surrounding environmental quality that can elevate the discomfort level of the occupants, especially in areas of hot-humid climate such as the Jakarta Metropolitan Area. However, high-rise buildings are still considered beneficial to the urban development of the Jakarta Metropolitan Area, and the use of glass façades brings generous advantages. Thus, proper design strategies must be implemented to ensure the best result—maximizing its advantages while minimizing the negative impacts.

6. Conclusion

Based on the theoretical review, it was suggested that the development of high-rise buildings with glass facades causes changes to the quality of the surrounding environment, which increases the possibility of outdoor discomfort. Thus, it can be concluded that high-rise building with glass

facade does not naturally respond to the climate condition of the Jakarta Metropolitan Area in providing for human comfort.

However, human psychological factors need to be considered in determining whether a condition is deemed comfortable. Inhabitants of a local area are more likely to have adapted to the environmental condition; thus, the environment is considered fitted to their comfort level. In addition, occupants of an outdoor environment have different expectations than those indoors; thus, their comfort range should also differ. A certain combination of environmental quality—such as air temperature, air humidity, and light distribution—found outdoors might be considered comfortable, whereas indoors, the same combination is considered uncomfortable.

These considerations prompted the need for an assessment to be carried out within the existing condition by directly involving occupants of the area to determine whether the development of the high-rise building with a glass façade is appropriate to support human comfort in the surrounding outdoor area.

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