Enhancing female pedestrians’ safety perceptions through the permeability of building frontages (case study: blok M area)

C Dameria and A H Fuad

1Department of Architecture, Faculty of Engineering, Universitas Indonesia, Depok 16425, Indonesia

Abstract. This study investigates the relationship between the permeability of building frontages and female pedestrians’ perceptions of safety on the sidewalk. A case study is conducted in two commercial streets with different settings in the Blok M area, Jakarta. Perceived meanings are evoked by the elements of the urban environments, which then form a subjective perception that differs due to several factors, including gender. Women in developing countries tend to exhibit more fear and insecurity in public places. Therefore, considerations that create a sense of security and safety for women in public places are essential. Natural surveillance, also known as the eyes on the street strategy, can improve one's safety perception and is often triggered by a range of functions along the street, especially the ground floor and also an active building frontage. Permeability is one of the key features of an active building frontage that supports natural surveillance and a safe urban experience. Permeability differs according to the building’s uses and can be identified both physically and visually. The expected results suggest that permeability, through its openness and its transparency, can create a safe walking experience for female pedestrians in an urban context.

1.Introduction

The concept of a smart city intends to achieve the sustainable development, safety, and health of its inhabitants with the aim to increase its citizens’ quality of life [1]. The quality of life can be measured by the subjective well-being (SWB) of the citizens, and it determines the importance of smart cities in people’s lives. Furthermore, safety perceptions can directly affect people’s subjective well-being [2]. Simultaneously, public space should be accessible by everyone regardless of the race, ethnicity, religion, or gender of its users [3]. Therefore, in order to improve people’s subjective well-being and to reach the goal of a smart city, the design of public space needs to take into account the interests of each user so that the space can be considered safe and inclusive.

Sidewalks are one of the most commonly used public spaces. However, on certain sidewalks, criminal acts still occur frequently. In most of these cases, the victims are women. A brief report published by the United Nations in 2016 revealed that women in developing countries tend to feel insecure in public places [4]. In fact, in big cities like Jakarta, women still feel unsafe on the sidewalks and they risk of experiencing sexual harassment [5]. This shows that insecurity and fear in public spaces are still perceived by women pedestrians in Jakarta. Lacking a sense of security often makes women reluctant to walk and thus limits their walking behavior. Safety perception is an aspect of individual reactions that play a role together with physical features and the quality of urban design in influencing walking behavior [6]. Natural surveillance is a way to improve safety perceptions in public spaces [7]. It can be achieved through the presence of active building frontages [21]. Blok M was chosen for this case study due to its potential as a mixed-use area that supports pedestrian activity with various types of building frontages.
Research Objectives
The objectives of this study are: (1) to review the safety perceptions of female pedestrians on the sidewalk, (2) to research the sidewalks and building frontages in the Blok M area, and (3) to identify the characteristics of the building frontages’ permeability that can trigger the safety perceptions of female pedestrians.

2. Literature Review
2.1 Sidewalk
Pedestrian paths or sidewalks are very important city elements in terms of pedestrian mobilization. Sidewalk is a space for pedestrians to perform activities and provides services to pedestrians so as to improve their ease, safety, and comfort [8]. Jacobs (1961) argues that the sidewalk, as a public space, is a place where all levels of society can take part in city life socially and economically [7]. Thus, a safe sidewalk is a pedestrian-friendly space that increases the safety, comfort, accessibility, and efficient movement of all of its users. The consideration of constant surveillance on the sidewalk can also encourage a sense of security for the pedestrians.

2.2 Safety Perceptions
2.2.1 Perception in an Urban Context
Robbins (2003) argues that perception is a process that occurs in every individual, by which a person organizes and interprets their sensory impression to give meaning to their environment [9]. Perception is also a process of gaining awareness or understanding sensory information that results in different reactions in different people [6]. Lynch (1960) argues that a city is not only a physical element, but also an element that moves like humans and their activities [10]. In this study, it is seen that perception plays a role in intervening with the physical features of the environment and walking behavior.

Physical features of sidewalks and the aspects of the quality of urban design, such as transparency and imageability, can be measured objectively, whereas individual reactions cannot [6]. Individual reactions – such as sense of comfort, safety perceptions, and level of interest – can only be measured subjectively because they reflect how individuals react to a place and how a person assesses the conditions there, considering only their own attitudes and preferences. All of these factors – physical features, the quality of urban design, and individual reactions – can influence an individual's feelings about the environment as they walk through it [6]. By measuring these intervening variables, researchers can measure the unmeasured by articulating the relationship between physical features of the street environment and walking behavior.

2.2.2 Female Pedestrians’ Safety Perceptions
Perceptions of security, which are distinct from actual security, constitute a feeling that is experienced [11]. These perceptions are subjective and differ based on who experiences them. Factors that distinguish them include age, ethnicity, lifestyle, and also sex [3]. Clifton and Livi (2005) concluded that in terms of security reactions, women are more sensitive than men to their environment and its associated security risks when they walk in it [12]. Feminist geographers point out that the cultural conditioning that makes women feel most insecure in public space is a form of spatial patriarchy that still operates today [13]. Patriarchy becomes a distinction between the genders, where the implication of its abjections is that, when it comes to navigating a city, women will be inclined to avoid certain places and consequently assume certain walking behaviors. Distinctions, abjections, and implications together form a sense of fear among women in experiencing public space [14].

Safety perceptions influence pedestrian behavior. Several studies [15, 16] indicate how women have the tendency to change their walking behavior to how they perceive the environment. For example, nighttime entails special fears for women, therefore, women are less likely to walk at night. In another case, women who feel unsafe walking during the day tend to walk or travel less. Another study has shown that pedestrians who are afraid of crime and threats are also more likely to adapt their behavior, like choosing another route, than pedestrians who have no such fear [17]. Accordingly, safety perception can influence one's decision to walk [16]. That is to say, people who think their environment is safe tend to walk more often because of reduced perceived risk, and vice versa.
2.3 Natural Surveillance

Jacobs (1961) describes natural surveillance as a strategy in which human presence is needed to increase the level of surveillance of the street, as well as to invite people who are in buildings along the street to feel compelled to see and observe the situation on the sidewalk [7]. The concept of eyes on the street is also seen in Newman's (1972) ideas, specifically the theory of defensible space. Natural surveillance is a connection between interior and exterior spaces as well as window placements that allow residents to naturally oversee the exterior and interior public areas of their living environment and areas for which their use has been determined [18]. This concept was later developed by C. Ray Jeffery through Crime Prevention Through Environmental Design (CPTED), which plays a role in reducing crime rates and fear of criminal acts [19]. The main principle of natural surveillance, according to CPTED, is to reduce the fear of space users while discouraging potential offenders by increasing the risk that they are being watched [29]. The presence of natural surveillance is able to improve one's security perception and is triggered by the physical and environmental features of a place [20].

Yeang (2007) suggests that making the front of a building a public domain and designing an integrated street network encourage natural surveillance [21]. An active building frontage is a facade of a building or block that borders a pedestrian path and allows direct connection to the interior of a building visually through windows, or physically through doors, or transparent elements or other building facades [22]. Whether a facade can be considered active or not can be evaluated through the permeability of a building frontage. The building frontage’s permeability is a property of frontiers that enables interpersonal interactions between the areas bounded by the frontiers, in this case, the public space (sidewalk) and the private property (buildings), which can be measured visually and physically [23]. Permeability can be examined via two aspects, that are: (1) physical permeability, related to accessibility; and (2) visual permeability, related to transparency [24].

2.4 Openness and Transparency

An active building frontage with high openness and transparency can encourage the sense of a safe, comfortable, lively, pleasant, pedestrian-friendly, active, and attractive sidewalk. Increasing sidewalk use and visibility can increase the likelihood of natural surveillance [25]. It also prompts pedestrians to feel safer because it ensures that the street is always observed by the occupants of the building [26]. Openness or physical permeability refers to the accessibility of a building. It can be measured based on:

1. The adjacency variable describes whether the position of the building frontage lies close to or far from the sidewalk. The closer the building frontage is to the sidewalk, the more permeable the building frontage is to pedestrians. On the contrary, buildings with a setback which are far from the sidewalk are considered not permeable [27].

2. Boundaries describe the presence or absence of unqualified barriers on the building frontage. Barriers indicate the existence of a public and a private area between a particular building and its sidewalk [22]. The more visible the public and private boundaries between the building frontage and the sidewalk, the less permeable the building frontage is. Pedestrians also feel discouraged from entering a building with a difficult access [21].

3. Activities on the sidewalk refer to the presence of activities on the sidewalk. A building frontage is said to be active if there is an expansion of building activities on the sidewalk [22].

Meanwhile, transparency or visual permeability is related to visibility. Visual permeability is measured by these three variables:

1. The number of openings. The more windows or openings, the higher the transparency is. Transparency allows for surveillance between interior and exterior spaces. On the contrary, opacity indicates a more private area and something that is hidden [28].

2. Quality of openings. According to Yeang (2007), the use of transparent glass on windows, if possible, performs better in activating building frontages when compared to mirror glass or frosted glass, which is only beneficial to residents who are looking outside [21]. This variable also increases the transparency of the building frontage.

3. Blank or passive facades (massive walls). This variable inversely correlates to the number of openings. If the number of openings is small, the massive wall is more dominant, and vice versa. Empty facades are often associated with a lack of vitality, identity, and security [28].

3.0 Methodology
The observation was made in the Blok M area, focusing on the sidewalks along Jalan Melawai Raya and Little Tokyo. To better understand the topic of discussion, the method of writing that will be carried out by the author is to conduct a literature study on the openness and transparency of the buildings and their role in providing natural surveillance and enhancing the safety perceptions of female pedestrians. The author examined the elements of permeability that affect women’s safety perceptions. Then, the author made direct observations and also gathered secondary data on buildings and pedestrian paths in the Blok M area. The field study was performed by making observations on April 8th and April 22nd, 2020, from 13:00 to 16:00. The secondary data was collected from newspapers, social media, and journals. Observations would be made by comparing the types of building frontages and pedestrian paths and the perception of a sense of security that would subsequently be formed from them. The author also collected data through a questionnaire aimed at 122 women pedestrians who have crossed the Blok M area to be able to understand their perceptions of security in the area. This research intends to seek a typology of the permeability of building frontages and discover the characteristics that trigger positive perceptions of security for women who go through the area.

3.1 Area of Study
As for the location, we chose two areas with different characteristics as seen in Fig. 1: Jalan Melawai Raya and the Little Tokyo area. Jalan Melawai Raya is filled with buildings with functions that are more diverse than the Little Tokyo area. Jalan Melawai Raya is also a public commercial street that is used by various modes of transportation, while the street in the Little Tokyo area is located within the Blok M Square area and are rarely traversed by public transportation. Therefore, the Melawai Raya street is more open to the public, while the corridors in the Little Tokyo area are rather secluded. The conditions of the building frontages and sidewalks along the two locations are also different in accordance with the uses of their respective buildings.

![Figure 1. Buildings’ uses along (a) Jl. Melawai Raya (b) Little Tokyo](Source: Author)

4.0 Result and Discussion
4.1 Female Pedestrians’ Safety Perceptions in Blok M Area
According to the survey conducted by the author on 122 female pedestrian respondents who have passed the Blok M area, 107 respondents agreed that the sidewalks in Blok M are safe enough to walk on, while the rest believed in the opposite. It was then found that the main cause of fear of walking in Blok M was street harassment, such as being subjected to catcalling. Respondents have a tendency to choose crowded over deserted sidewalks. Jacobs (1961) has stated that the crowd and the number of eyes watching the street contributes to providing safety perceptions among female pedestrians. It was later found that her argument can also apply to Blok M. In another case, 50% of respondents prefer sidewalks
that are far from the buildings, while 30% of them prefer buildings that are close to the sidewalks. This can be further explained by the fact that the buildings’ adjacency to the street may or may not increase the safety perceptions of women pedestrians, although according to Van Nes (2018), adjacency might trigger social control and natural surveillance [27]. The survey also found that there are no significant preferences towards the presence or absence of activity on the sidewalk. Although respondents who chose the presence of high activity have claimed that they feel safer because the higher visibility. Furthermore, 109 out of 122 respondents concurred that buildings with transparent facades and many openings provide a sense of security to them. This indicates that transparency brings a sense of security among female pedestrians. Out of all the factors, buildings with crowded frontages that are actively used were found to be the most important factor in providing a sense of security for a walking experience by respondents.

4.2 Relationship between Permeability and Safety Perceptions
Using the parameters of openness and transparency, the building frontages in Jalan Melawai Raya and Little Tokyo are categorized into four layouts, as seen in Fig. 6, which are: (1) open and transparent, (2) open and non-transparent, (3) closed and transparent, and (4) closed and non-transparent.

4.2.1 Open and Transparent

This open and transparent frontage layout can be found in cafes, supermarkets, and stalls in Little Tokyo, as well as in shops and malls in Melawai Raya. The open quality is shown in the proximity of the building to the sidewalk, where the building is connected directly to the street, and the entry access is adjacent to the sidewalk (Fig. 2A). This makes it easy for pedestrians to enter the building or at least observe the building frontage up close. Some of the buildings with this layout also have an expansion of activity on the sidewalk, which is an outdoor space (Fig. 2B). The outdoor space allows visitors to sit around and watch the sidewalk. The frontage is also permeable visually because around 90% of the frontages are transparent openings. Pedestrians can clearly see the activities that take place on the inside of the building. Likewise, people inside the building can also see the situation on the sidewalk. High transparency can increase the vitality of sidewalks, and this transparency is triggered by the presence of commercial activities [30]. The sidewalks along Melawai Raya shops are livelier, with interesting activities along the sidewalks such as street vendors selling. High transparency also supports the active building frontage, so this layout is considered transparent. According to the survey, 90% of the respondents feel safer with a transparent facade because it gives wider visual access and the impression of openness. This shows that high-level, two-way directional natural surveillance in this layout enhances the safety perceptions of most women.

4.2.2 Closed and Transparent
The closed but transparent building frontage layout has a low physical permeability, yet a high visual transparency. This layout is found in several offices and hotels in Melawai Raya. In terms of physical permeability, the building is located quite far from the street with a setback of about 8 meters, so the building is not close to the street (Fig 3A). The area that lies between buildings and streets is also limited by parking areas. Therefore, the building frontage has a closed quality that does not allow pedestrians to access the building directly. Visually, the building has the optimal number of openings on the side of the building frontage, and most of the openings are made of transparent glass, including the door. This allows pedestrians to see the activities that are in the building. Along the building frontage, there are several blank walls, but they are few in number and very rarely found. People from inside the building can still observe the sidewalk, but their view may be blocked by a parking lot, and since the building frontage is not located on the ground floor, people in the building cannot quite see clearly (Fig. 3B). Similarly, pedestrians cannot see the situation inside the building clearly either, but during certain times, e.g. when pedestrians approach a part of the parking lot or when the parking lot is not crowded with cars, they can see the situation inside the building through openings in the building frontage. This layout also enables two-way surveillance, but it is not as optimal as the first layout because the building is far from the sidewalk. This layout confers enough safety, but not at a high level because the sidewalk lacks constant surveillance.

![Figure 3. Closed and Transparent Building Frontage Layout at Offices in Melawai Raya (a) Plan (b) Section](source: Author)

4.2.3 Open and Non-Transparent

This open yet non-transparent layout has a high physical permeability, although it has a low visibility. This layout is found in several offices and hotels in Melawai Raya and Little Tokyo, as well as in restaurants and bars in the Little Tokyo area. In this layout, the building frontage is connected directly...
to the sidewalk, resulting in its proximity to the building and the high street (Fig. 4A). The building frontage also has no barriers, so pedestrians can access the building directly. However, knowing that this layout is dominated by office and hotel functions, the building does not have activity expansions on the street, so the front of the building is exclusively used as a sidewalk. In terms of visual permeability, this layout is considered not permeable. The visibility of an open space layout allows for natural surveillance, but the presence of non-transparent openings minimizes this possibility. This layout only allows surveillance that occurs through one direction, i.e. from inside the building to the outside (Fig. 4B). It is still possible for people in the building to watch the streets, but this does not make female pedestrians feel safe because the presence of people in the building cannot be observed by the pedestrians, so they feel as if they are walking alone without surveillance.

4.2.4 Closed and Non-Transparent

The closed and non-transparent building frontage layout has low physical and visual permeability. This layout is found in several offices, a restaurant, and a church on Jalan Melawai Raya, as well as around the edge of the mall in Little Tokyo. The physical permeability means that this layout can be considered closed. Based on its proximity, the building frontage is located far from the sidewalk within a setback of 8-10 meters (Fig. 5B). Due to the private buildings’ functions (such as offices and a church) in this closed layout, the building does not generally have an expansion of activities on the sidewalk. Furthermore, the visual quality of its permeability lacks transparency. The building frontage is mostly dominated by passive walls alongside it, and there are only a few openings such as windows and entrances. Compared to the other types, the layout of a closed and non-transparent frontage has a low or even nonexistent level of natural surveillance. In this layout, the low permeability of the building frontage, both in the physical and visual sense, does not allow for two-directional surveillance for pedestrians and building occupants (Fig. 5A). People in the building have limited vision because of the distant location of the sidewalk and building frontage, as well as parking lots and fences that block their range of vision. The function of the buildings, such as the offices and church, also tends to keep the sidewalk quiet and does not trigger other activities in front of them, such as street vendors making sales, etc. Because it is not crowded, the informal surveillance that comes from fellow pedestrians is also not optimal.

Figure 5. Closed and Non-Transparent Building Frontage Layout at Offices in Melawai Raya (a) Plan (b) Section
Source: Author

5. Conclusion and Recommendation

Blok M is a mixed-use area with fair vitality and security in its public spaces. Based on a survey that has been conducted, female respondents who walked around the Blok M area agreed that a sense of safety was an important factor while walking. Safety perceptions can be enhanced when women are able to watch their surroundings and feel watched over when they walk in the place. Based on a case study conducted on the sidewalks and building frontages in two areas in Blok M, which comprises Jalan Melawai Raya and the Little Tokyo area, the authors found four categories of permeability layouts, each measured by openness and transparency.

Overall, most of the building frontages in Blok M have a closed-transparent and open-non-transparent layout. This indicates that the frontages in Blok M are considered quite permeable for pedestrians, but not at an optimal level. The analysis shows that building frontages with high openness
and transparency can promote greater natural surveillance than closed and non-transparent frontages. This finding corresponds to the argument of Yeang (2007), which stated that active building frontages can provide higher safety perceptions for pedestrians compared to passive ones [21].

The main analysis is shown in Fig. 6: (1) The open and transparent building frontage layout produces natural surveillance in two directions and enables female pedestrians to have safety perceptions; (2) The closed and transparent layout results in suboptimal two-way surveillance and a fair level of safety perceptions; (3) The open and non-transparent layout results in one-directional surveillance, and female pedestrians feel quite safe when walking in front of the sidewalk; (4) and natural surveillance is not triggered optimally or even at all in a closed and non-transparent layout, making female pedestrians feel insecure.

Figure 6. Typology of Building Frontage Permeability Layouts
Source: Author

In conclusion, the authors have investigated the role of frontages’ permeability in women’s safety perceptions that can contribute to triggering natural surveillance. The types of building frontages’ permeability that have been discovered can be associated with the enhanced safety perceptions of women who walk in front of it. This study also found that optimal natural surveillance can enhance female pedestrians’ safety perceptions as openness and transparency allow them to observe their surroundings. The openness and transparency can also encourage the ‘eyes on the street’ strategy that contributes to their safety perceptions.

6. References
[1] Maroš L Jozef R 2017 Smart City, Safety and Security Procedia Engineering Volume 192 522-527 ISSN 1877-7058
[2] Lin C et al 2019 Smart City Development and Residents’ Well-Being Sustainability 11, no. 3: 676.
[3] Carmona M et al 2010 Public Places, Urban Spaces, 2nd Ed.: The Dimensions of Urban Design
[4] UN Women 2016 Safe cities and global initiative (Accessed at https://asiapacific.unwomen.org/en/digital-library/publications/2016/10/in-brief-safe-cities-global-initiative)
[5] Oetama N 2018 22 Januari Serba Salah Jadi Perempuan dan Pejalan Kaki, Perempuan Pejalan Kaki Lebih Serba Salah (Accessed from https://voxpop.id/perempuan-pejalan-kaki/)
[6] Ewing R and Handy S 2009 Measuring the Unmeasurable: Urban Design Qualities Related to Walkability Journal of Urban Design 14 (1) pp 65 – 84
[7] Jacobs J 1961 The death and life of great American cities (New York: Vintage)
[8] Ashadi et al 2012 Analisa Pengaruh Elemen - Elemen Pelengkap Jalur Pedestrian Terhadap Kenyamanan Pejalan Kaki Studi Kasus: Pedestrian Orchard Road Singapura Nalars vol 11 No 1 77 - 90
[9] Robbins S P 2003 Prinsip-Prinsip Perilaku Organisasi (Jakarta: Erlangga)
[10] Lynch K 1960 The image of the city Cambridge (Mass: MIT Press)
[11] Jansson M Fors H Lindgren T Wiström B 2013 Perceived personal safety in relation to urban woodland vegetation — A review Urban For Urban Green 12 127 – 133
[12] Clifton K J & Livi A D 2005 Gender differences in walking behavior, attitudes about walking, and perceptions of the environment in three Maryland communities. Research on Women’s Issues in Transportation: Report of a Conference: November 18-20, 2004: Chicago, Illinois. Volume 2, Technical Papers, 79-88
[13] Gómez R T & Usandizaga A (Eds.) 2008 Inside Out (Leiden, The Netherlands: Brill)
[14] Epstein D 1997 A Story of Fear, Sex, and Architecture. In N. Ellin (Ed.), Architecture of fear (1st Ed.) (New York: Princeton Architectural Press)
[15] Foster C Hillsdon M Thorogood M 2004 Environmental perceptions and walking in English adults. J. Epidemiol Commun Health 58 924–928
[16] Hong J Chen C 2014 The role of the built environment on perceived safety from crime and walking: examining direct and indirect impacts. Transportation 41, 1171–1185 2014
[17] Fyhri A et al 2010 The influence of perceived safety and security on walking. In: Methorst R, Monterde-i-Bort H, Risser R, Sauter D, Tight & Walker (eds) Pedestrians’ quality needs Final report of the COST project 358 Cheltenham: Walk 21 part B.2 perceived needs pp 49–69
[18] Newman O 1972 Creating Defensible Space.
[19] Ekblom P 2011 Deconstructing CPTED... and Reconstructing It for Practice, Knowledge Management and Research European Journal on Criminal Policy and Research 17 7-28
[20] Gnasasambandam S & Tadepalli S 2012 Natural surveillance for perceived personal security: the role of physical environment. American Transactions on Engineering & Applied Sciences 673 (2021) 012040 doi:10.1088/1755-1315/673/1/012040

Acknowledgments
We would like to thank the Directorate of Research and Development of Universitas Indonesia for funding this research under the grant of Hibah UI through PUTI PROSIDING 2020. We would also like to thank all our friends and the female respondents who have helped us to finish this paper on time.