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THE ROLE OF OPENINGS AND THEIR IMPACT ON USER INTERACTION

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ABSTRACT

The evolution of building openings, particularly windows, has expanded beyond basic functions like light and ventilation to include energy efficiency, aesthetics, and technology integration, influencing user behavior and interactions. However, these interactions remain underexplored. This study examines how windows impact user behavior in Yogyakarta City and Sleman Regency. Using qualitative field observations at 12 locations and 22 window points, interactions were categorized into three types: openings as objects of attention without physical interaction, openings approached with physical interaction, and openings approached with unusual interactions. These categories were analyzed based on physical, spatial, and psychological aspects. The influence of each element was evaluated by comparing the similarities within interaction categories across different cases. The research identified three types of interactions: attention without interaction, physical interaction, and unusual interaction. Findings reveal that window characteristics, spatial context, and psychological perceptions collectively shape user engagement. The study emphasizes the importance of these factors in window design, offering valuable insights for creating more user-centric, interaction-oriented window designs in modern architecture.

Keywords:

Openings, architectural design, window, human interaction, behavior.

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1. Introduction

The purpose and functionality of building openings, particularly windows, have undergone continuous transformation driven by technological advancements, cultural changes, and evolving environmental needs. Initially designed to fulfill fundamental roles such as providing light and ventilation, windows have expanded their scope to include energy efficiency, aesthetic enhancements, and integration with advanced technologies. This evolution has redefined the physical aspects of window design and influenced occupant behavior and interaction with these openings.

Historically, windows have served as a crucial interface between interior and exterior spaces, reflecting cultural, artistic, and architectural values. Their design has embodied societal preferences from antiquity to modernism, advancing from essential ventilation solutions to complex systems that address multifaceted user needs (Strzałka-Rogal, 2023). The term "window" itself, derived from the Norse Vindauga or "wind eye," underscores their origin as tools for natural ventilation, highlighting their enduring significance in architectural design (Oxford Advanced Learner's Dictionary, n.d.).

Environmental factors, such as temperature and humidity, and non-environmental factors, including psychological comfort and personal preferences, also shape window-opening behavior. These complex influences necessitate probabilistic models to describe window states accurately.

Beyond its functional purposes, windows are pivotal for ecological well-being. Their design influences emotional responses, cognitive performance, and overall satisfaction. More extensive window views have been shown to increase prices among occupants, whereas restricted views can lead to dissatisfaction (Yeom et al., 2020). Additionally, decisions regarding window usage are not solely based on environmental factors but are significantly influenced by social and psychological dynamics (Kim & Park, 2023).

The evolution of windows reflects a balance between technical advancements and human-centric considerations. As windows adapt to emerging challenges, they remain vital for achieving sustainable, efficient, and

occupant-focused building design.

Studies that focus on interactions generated through openings are still few. It is necessary to study the role of openings today in shaping user interactions in modern buildings. This paper aims to identify the impact of openings on human behavior, both user interactions with openings and interactions between users involving openings. So, it is determined how the architectural elements of openings influence the user experience in the contemporary environment of Sleman Regency and Yogyakarta City. Hopefully, this study will provide new knowledge regarding the role of openings today and become a consideration for designing openings based on user interactions and perceptions.

2. Literature Review

The relationship between building openings, such as windows, and occupant behavior is multifaceted, involving environmental, personal, and psychological dimensions. Natural views, particularly those featuring sky, water, and greenery, enhance visual satisfaction by offering a richer sensory experience than less diverse views (Sfaksi et al., 2022). The operation and adjustment of windows are strongly influenced by temporal and occupancy patterns, as seen in varying preferences across geographic locations. In some regions, such as Ningbo, occupants commonly open windows in the morning and close them before leaving, while in Nigeria, windows are predominantly kept open during the morning and afternoon to mitigate thermal discomfort (Cheng et al., 2023; Kunle et al., 2021).

Personal preferences and habitual routines significantly shape window interaction. Window operation is often linked to specific daily activities rather than fixed schedules, emphasizing the role of individualized behavior in determining usage patterns (Verbruggen et al., 2019). Non-environmental factors, such as seasonal changes, further influence these behaviors, as seen in studies conducted in Beijing (Pan et al., 2021). In suburban and rural settings, local climatic conditions and cultural practices dictate window-opening behaviors, with environmental factors such as humidity and temperature serving as key determinants (Han et al., 2024; Yang et al., 2022).

Psychological factors also play a crucial role in shaping occupant interaction with windows. Control over one's environment enhances comfort and satisfaction, motivating occupants to adjust windows based on their needs (Weerasinghe et al., 2022). Furthermore, the spatial arrangement of windows, including orientation, floor level, and furniture layout, influences occupant behavior, reinforcing the importance of thoughtful design to align with psychological needs and improve energy efficiency (Nazmy et al., 2023). This aligns with the broader understanding that environmental elements profoundly affect individual behavior and interactions within their surroundings (Mahmoud, 2018).

Overall, the interaction between occupants and windows is a dynamic process influenced by environmental, personal, and spatial factors. This necessitates a holistic approach to architectural design to optimize functionality and occupant satisfaction.

2.2 Research Gap

Based on the literature search, it can be seen that the role of openings for users continues to develop, which also influences changes in design. This development also triggers research on openings to continue identifying new knowledge on future openings and innovations. In pre-modern times, openings were introduced through tripartite windows, elaborate brickwork, and pointed arches. The Renaissance introduced symmetrical and classic designs to openings. The modern era introduces opening designs that focus more on function and construction. Opening innovations, such as the development of smart glass, can influence energy efficiency, privacy, and security, significantly affecting the user experience (Strzałka-Rogal, 2023). Many studies today are developing opening designs by exploring designs, shapes, and systems, which are closely related to the development of opening technology in dealing with energy and comfort. However, user interactions involving openings today still need to be studied further. The research opportunity chosen by this study is the opportunity to examine how user interactions with openings or fellow users involve users. Seeing that the design continues to develop nowadays, it will undoubtedly impact how users treat openings that are closely related to everyday interactions caused by the presence of openings.

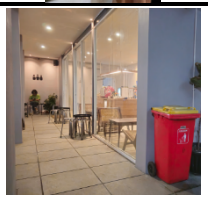
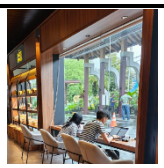
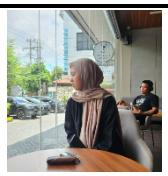
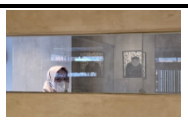
3. Research Method

This research was conducted in the Yogyakarta City and Sleman Regency areas in the Special Region of Yogyakarta Province, Indonesia. Data was collected through field observation methods at 12 locations and 22 opening points. The next step is to identify the interactions that occur, both interactions between users through openings and user interactions when using openings. These interactions are then analyzed qualitatively and categorized according to the type of user interaction found. Three categories of interactions were found: openings as a direction of attention without any physical interaction, openings as an object being approached and physical interaction occurring, and openings as an object being approached and an unusual interaction occurring.

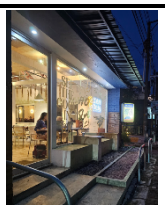
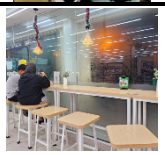
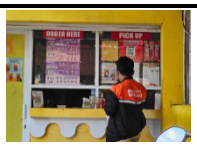
After the interaction categories are identified, an analysis of the opening aspects is carried out to look for similarities in the opening elements in each case of locations in the same category. The opening aspects that are parameters include the opening's physical aspect (opening dimension, opening system, and transparency), surrounding supporting aspects (spatial relationship, furniture layout, and view elevation), and psychological aspects (user perception and attractive elements). The similarity percentage (influence power) is calculated for each location case with the same opening aspect. This method determines what aspects of the openings are most influential in shaping interactions in each category. The following is the physical data for each opening point in various locations.

Table 1. Openings data

Location	Opening Description	Opening Image
Public Elementary School 2 Experiment	Wood swing fence The fence as the main entrance to the school area	
	Brick and metal fence with roster Fences that limit the inner and outer areas of the school. Breezeblock holes act as an aesthetic element of the wall.	
	Swing double-door Double doors as access to the classroom.	
	Swing window Windows serve as a means of lighting and natural airing of the classroom.	
Pogung Kidul State Elementary School	Swing double-door Double doors as access to the classroom.	
	Swing window Windows serve as a means of lighting and natural airing of the classroom.	
Vocational High School 2 Yogyakarta	Swing window Windows serve as a means of natural lighting and air in the classroom.	

Location	Opening Description	Opening Image
Cafe Arka	Folded window Windows serve as a means of lighting, natural air, and framing a visual view of the inner space.	
	Folded window The window serves as an access for communication between the cashier and visitors.	
Cafe Old Friends	Fixed-window Windows serves as a means of natural lighting in space and visually connects the outside space with the inside.	
Cafe Cosan	Fixed-window Windows serves as a means of natural lighting in space and visually connects the outside space with the inside.	
	Fixed-window Windows serves as a means of natural lighting in space and visually connects the outside space with the inside.	
Bura Bura Cafe	Fixed-window Windows serves as a means of natural lighting in space and visually connects the outside space with the inside.	
	Fixed-window The window serves as a visual link between rooms and the space.	
	Fixed louver The grille serves as a visual divider to protect user privacy in the space without closing the visual out entirely.	

Location	Opening Description	Opening Image
	Hole Long holes serve as natural air in space.	

Coffee Shop Hoja	Fixed window with stickers Windows serves as a means of natural lighting in space and visually connects the outside space with the inside.	
	Folded window Windows serves as a means of natural lighting in space.	
Indomaret Point Cafe	Fixed-window Windows serves as a means of natural lighting in space and visually connects the outside space with the inside.	
Mardhiyah Islamic Center	Void Void will be the visual liaison between the mosque's 2nd-floor and 1st-floor rooms for the convenience of the worship process.	
Pharmacy K24	Fixed-window with a round hole Windows visually links the outer and inner spaces. The circular hole provides access for communication between visitors and pharmacy staff.	
Ombein Retail Store	Fixed window stuck with menus and rectangle hole. Windows and holes are a means of communication between officers and buyers.	

4. Results and Discussions

Based on the observation results, there are three types of user interaction with openings (Table 2). It is the type of interaction that determines the categorization of openings. These interactions are openings as objects that are approached without physical interaction with the user, objects that are approached with physical interaction, and openings that are approached with unusual interactions. These three categories are influenced by certain aspects, including the physical aspects of the opening, surrounding supporting aspects, and psychological aspects. The physical aspect of openings is the opening design system and the features that physically accompany the operation of the openings. Supporting aspects around the opening include the presence of objects and the condition of the space around the opening. The psychological aspect is the user's perception of the opening, which is influenced by its design and specific elements accompanying it. This affects the user's perception of treating openings. These aspects are identified in each opening case and find the influence power. The similarity of values influences the level of influence power in an aspect. The higher the similarity of values in one aspect in one category, the higher the influence power generated.

4.1 Opening as a direction of attention without physical interaction

This category includes finds at Teman Lama Cafe, Bura-Bura, Cosan Cafe, and Hoja Cafe. Openings that fall into this category are openings that attract attention but are not touched by the user. Similar user behavior was found where visitors tend to position themselves toward the opening. Many aspects attract users to look at openings in this category. Uniquely, all openings in this category are found in the cafe typology. Of course, this is the cafe's success, as its function is to provide a visually comfortable workplace. Based on Table 2 with the additional information in Table 3, three aspects greatly influence the categorization of openings with an influence strength of 100%. These three aspects are the absence of attractive elements, the perception of openings that are not friendly to touch, and the view elevation presented as equivalent to the room the user is in. The following describes these aspects and how each aspect builds interaction with users.

4.1.1 The equal viewing elevation means the window is often looked at

The equal view elevation means that openings in the first category often become the direction of the user's attention. All openings in this category provide a view whose elevation is equivalent to the user behind the opening. At Cafe Cosan, there were six visitors who each chose tables A and B - which were not directly adjacent to the opening, with facing layout chairs where one chair faced towards the opening and the other chair had its back to the opening. The six visitors tend to choose chairs facing the opening. Meanwhile, four other visitors chose seats C and D directly adjacent to the opening as if they were bringing themselves closer to being integrated with the outside space (Figure 1 and Figure 3). This behavior was also found at Cafe Hoja and Cafe Bura-bura, where visitors chose to sit in chairs facing the opening and have a view of the outside space (Figure 2, 4, 5). Likewise, in the case of Cafe Teman Lama, this is influenced by the view presented, which is equivalent to the room the user is in so that the view on the other side of the opening can be seen clearly by the user from various angles of the room (near the opening or far from the opening).

The tendency of users to see interesting things behind this window is in line with the research of Chawla (2008) and Abdelwahab et al. (2023), which shows that with a

fascinating view of the surrounding environment, such as green elements, openings have a more significant value to look at. So, the opening can also act as a restorative element of Bolivia, increasing productivity in specific typologies such as cafes, workspaces, and schools.

In some openings, user behavior occurs conditionally if particular objects or events exist in outer space. For example, there was an opening at Cafe Bura-bura. An opening that leads to an outdoor space where there is an intersection four and a busy and noisy highway traffic light. The dimensions of the openings tend to be minor, making visitors interested in peeking outside and finding out what events are happening on the highway. (Figure 5). Through an elevation view strategy equivalent to the room the user is in, users can see traffic activities through the window.

4.1.2 Perception of aversion to touch and absence of attractive elements in openings

Apart from the equal view elevation, which makes the window frequently looked at, a psychological aspect prevents users from physically touching the opening. This impression is a strong influence because it is found in all cases in this first category. In Hoja, Teman Lama, Bura-Bura, and Cosan, the openings are large in design and give the impression that they are not objects commonly touched. The window has a sterile feel, so users are worried it will leave fingerprints if they touch it. Typologically, all buildings in this category are cafes with limited access only to buyers. So those who don't buy cannot freely explore the cafe (especially touching the windows). This type of typology and management gives an exclusive impression that makes visitors reluctant to touch objects in the cafe, including the windows. Windows are like luxury items that need to be touched because of their luxury and limited access.

Table 2. Categorization of opening types and aspects that influence them

No	Category Based on User Interaction	Case Location	Opening Case	Opening's Physical Aspect			Surrounding Supporting Aspects			Psychological Aspect	
				Opening Dimension	Opening System	Transparency	Spatial Relationship	Furniture Layout	View Elevation	User Perception	Attractive Elements
1	Opening as a direction of attention without physical interaction	Hoja Cafe	Fixed-Window								
		Cosan Cafe	Fixed-Window								
		Bura-bura Cafe	Front Fixed-Window								
			Louvre								
			Side Fixed-Window								
			Hole								
		Teman Lama Cafe	Fixed-Window								
			Influence Power	57%	71%	57%	57%	43%	100%	100%	100%
2	Openings as objects that are approached and physical interaction occurs	Arka Cafe	Swing window (guest)								
			Swing window (cashier)								
		Ombein Retail	Window with hole								
		Experimental State Elementary School 2	Classroom Window								
			Steel fence								
			School gate								
		Pogung Kidul State Elementary School	Classroom door								
			Classroom window								
		State Vocational High School 2 Yogyakarta	Classroom window								
		Mardhiyah Islamic Center Mosque	Glass railing around void between floors								
		K24 Pharmacy	Window with hole								
			Influence Power	55%	100%	64%	91%	18%	73%	100%	82%
3	Openings as objects are approached and unusual interactions occur	Experimental State Elementary School 2	Classroom door								
			Roster on fence								
		Indomaret	Fixed-Window								
			Influence Power	67%	67%	33%	33%	33.00 %	67%	100%	100%

Table 3. Legend from Table 2
=1
=2
=3
Opening Dimension 1 medium and does not reach the floor or/and ceiling, 2:Large and reach the floor or/and ceiling
Opening System 1:Fixed/cannot be opened/no hole, 2:Flexible/there is a hole
Transparency 1: Clear 2: Frosted/Stickerized 3: No glass
Spatial Relationship 1 There are objects/views to be seen without people in the near distance, 2:There are people in the near distance
Furniture Layout 1:Not supporting the expected activity, 2:Supporting the predicted activity, 3:There is no furniture around the opening
View Elevation 1:Different level of height, 2:Similar levels of height
User Perception 1:Reasonable to touch, 2:Unreasonable to touch
Attractive Elements 1 There are no attractive elements. 2: There are attractive elements

Figure 2. Observations at Cafe Cosan show that visitors tend to move towards the opening. (1) Visitors in seats A and B (2) Visitors in seat D (3) Visitors in seat C

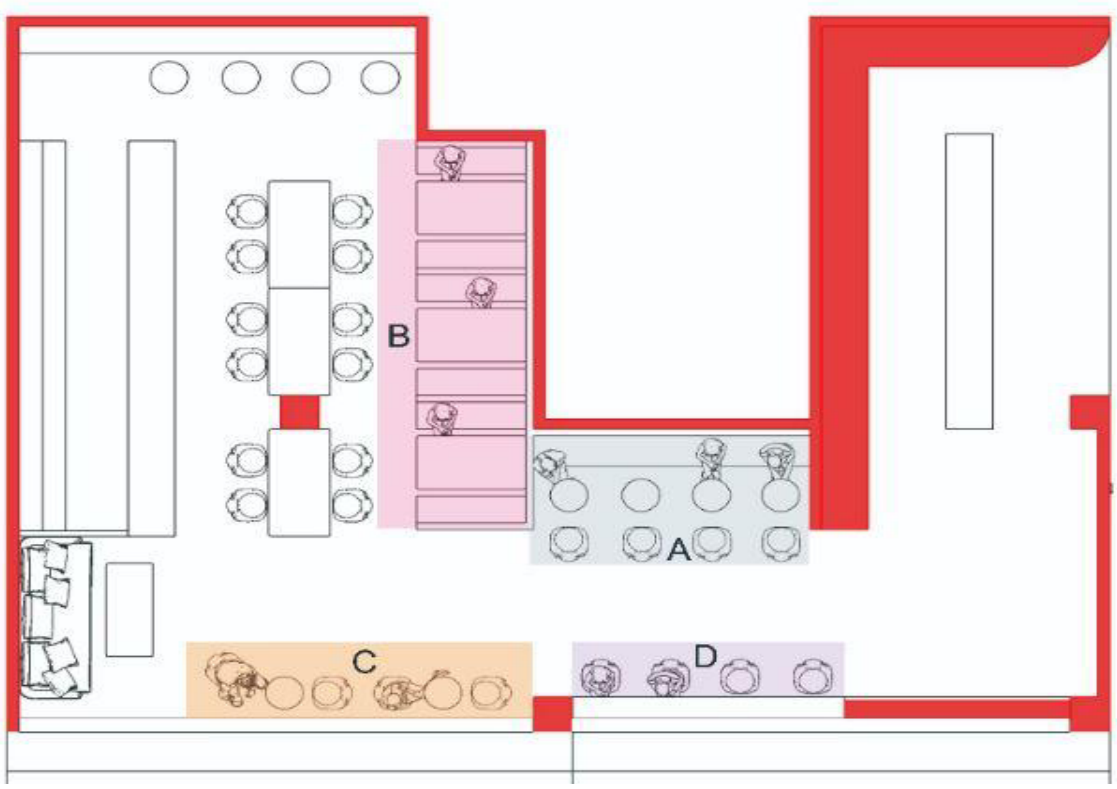


Figure 1. Floor plan of Cosan Café

4.1.3 The fixed system and transparent window make it easy to view but not to operate

Five of the seven openings in this category are window openings with a fixed system, which does not allow them to be opened, and holes can occur. Regarding transparency, 4 of the seven openings in this category are windows with a transparent system without stickers or frozen glass. This combination of a fixed-window system and openness makes viewing the window up close or from a distance easy. In addition, this category opening connects users to spaces with mesmerizing views. Four of the seven openings in this category also have large dimensions, expanding the viewing distance. The availability of furniture layouts close to and/or oriented towards the opening allows users to sit facing the opening.

4.1.4 Special case: openings as avoided objects

A unique case was found at the Old Friends Cafe. In this case, the openings are treated the same as in the previous Cafe Cosan, Cafe Hoja, and Cafe Bura-Bura. Therefore, the Teman Lama Cafe openings are included in the category of openings concerning opening interaction. However, a unique thing happened in the case of Cafe Teman Lama: one side of the opening was avoided, while the other was not. The case at Teman Lama Cafe is a sizeable fixed-window-type opening. Window height starts from floor to ceiling. This window is on the cafe's front wall, which divides the arrival terrace area and the inside room. The furniture around the window is a small table and chair, available on both the outside and inside sides. (Figure 6).

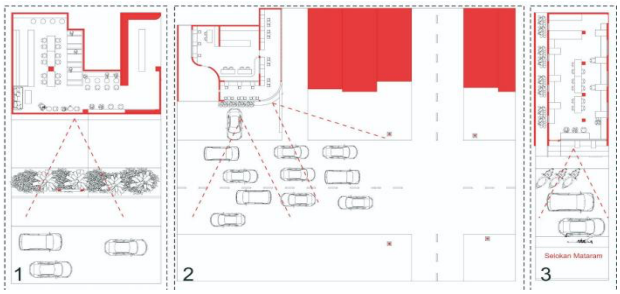


Figure 3. Neighborhood plan around Hoja, Bura-bura, and Cosan Cafe (1) Cosan Cafe opening has a garden view, and Jl Mangkubumi which is a historical area in the Malioboro neighborhood (2) Bura-bura Cafe has a highway view with intersections and traffic lights

Figure 4. Observations at Cafe Hoja and Cafe Bura-bura show visitors tend to move towards the opening. (1) Visitors to Cafe Hoja (2) Visitors to Cafe Bura-bura

Figure 5. Observation at Bura-bura Cafe (1) Visitors peeking the long hole-shaped openings (2) Visitors peeking through lattice gaps

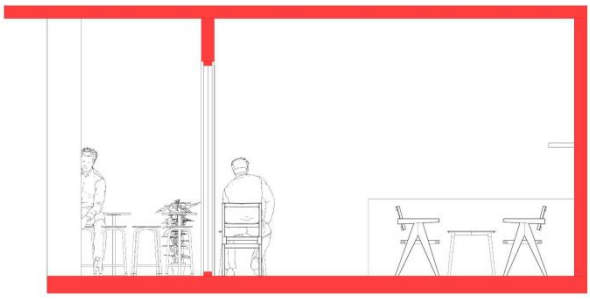


Figure 6. Section of Teman Lama Café

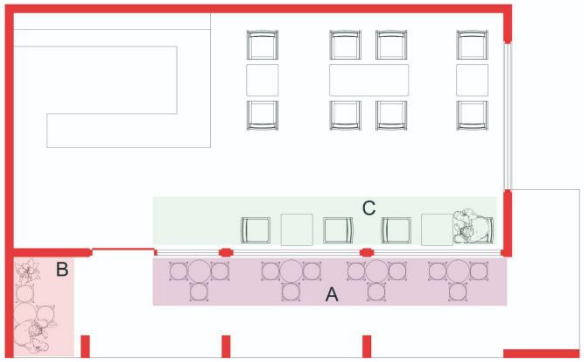


Figure 7. Floorplan of Teman Lama Cafe

Figure 8. Observation at Old Friends Cafe for 6 days shows front porch seats that were never occupied

Based on observations made during six-day visits, visitors never occupied the chairs on one side of the window (outside). This incident was discovered when there were busy or quiet conditions. The seats that visitors tend to choose to sit on are on the side of the terrace area outside wall B and seat C on the inside window side, a significant difference from seat A, which is never even sat on (Figure 7).

Visitors in seats B and C play with cellphones while leaning against the wall (in seat B) or with the back of a chair (in seat C). All of these behaviors cannot be accommodated by chair A. Chair A, which is directly opposite chair C, is limited by a large window with high transparency from floor to ceiling. A window design like

this creates an uncomfortable feeling regarding privacy. The user in seat A is worried that the user can see his cell phone in seat C and vice versa. Although windows demarcate two different spaces, this strategy does not accommodate the privacy needs of both users. Privacy requires smaller windows with higher floor distances, openings, and lower transparency.

Likewise, the behavior of leaning against the wall is not available in chair A. This is because the chair has no backrest, and visitors cannot lean against the window glass because they are worried about breaking it. Visitors are more comfortable leaning against the wall, such as in chair B or with the back of chair C. 4 aspects influence behavior in this special case, namely:

1. Layout furniture, chairs, and tables on both sides of the opening arranged next to each other as if not far away
2. The high level of opening transparency makes the visual of the inner and outer space connected to the maximum as if there were no dividers
3. The huge opening dimensions and attaching to the floor make all the activities of visitors who sit around the opening visible
4. The dead window system limits the possibility of users communicating from two sides. Although the table and chairs layout is adjacent, it is not ideal for group visitors because of the lack of communication possibilities.

The design of openings that accommodate non-communal activities must be considered a barrier between privacy spaces between users. Openings must also present an attractive view that users from various corners of the space can easily see.

This finding is in line with Abdelwahab et al. (2023) finding that the value of an opening depends heavily on the user's needs in activity. In this case, users build calmness and concentration when working in the cafe, so the presence of windows precisely contradicts users' needs. Another strategy that can help increase the value of an opening in maintaining privacy is through variations in space elevation. So that the opening can still present a view while maintaining privacy from height (Abdelwahab et al., 2023).

4.2 Openings that are approached by physical interaction

This category represents openings that the user approaches, touches, and operates. The findings included in this category are openings at Public Elementary School Experimental 2, Public Elementary School Pogung Kidul, SMKN 2 Yogyakarta, Apotek K24, Retail Ombein, Masjid Mardhiyah Islamic Center, and Arka Coffee. Table 4, with additional illustrations in Figures 6-8, comprehensively explains the influence power of the opening system and user perception. The following describes these aspects and how each element builds interaction with users.

Table 4. Activities that trigger physical interaction

Location	Activities that trigger physical interaction with
Public Elementary School 2 Experiment	Communication between users in different spaces
	See the view more clearly.
Pogung Kidul State Elementary School	Communication between users in different spaces
Location	**Activities that trigger physical interaction with**
State Vocational High School 2 Yogyakarta	See the view more clearly.
Pharmacy K24	Communication between users in different spaces
Retail Ombein	Communication between users in different spaces
Mardhiyah Islamic Center Mosque	See the view more clearly.
Cafe Arka	Communication between users in different spaces

4.2.1 Flexible opening system and open communications

Based on Table 2, 2 activities trigger physical interaction, namely communication between users and seeing the view more clearly. Communication activities between users can occur when openings connect two spaces that users actively use. Thus, both users in each room can communicate through openings. As for the system, all openings in this category have a system of hollow openings. This hole allows sound to be heard more clearly in both spaces and accommodates communication between users. This communication activity is the reason the user is physically approached and touched. The use of a flexible opening system also opens the opportunity for users to adjust the openings as desired.

4.2.2 Perception of touch-friendly openings

A flexible opening system that triggers the user to operate creates this perceptual aspect. Management policy factors also influence perceptions. All cases in this category have policies that encourage users to use openings. In the case of the Arka cafe, Ombein retail, and K24 pharmacy, the openings are directed as a means of purchasing (Figure 10). The manager blatantly asks buyers to order through the hole and window provided. So, users do not hesitate to touch the hole where to order.

In the case of Experimental State Elementary School 2, Pogung Kidul State Elementary School, and Yogyakarta Vocational State High School, students were directed to

become "familiar" with the openings through the high intensity of user activity around the openings—the high intensity of student activities with opening fosters a sense of belonging among students to opening. In the case of elementary schools, students are also directed to decorate windows with various origami to create the impression of friendly openings. Users do not feel reluctant to touch the opening. In contrast to the second category, users are sure that the touch made does not cause anxiety to dirty the opening glass.

For Arka Cafe, the window design also uses swing windows and wooden frames that are familiar to users. The wooden frame gives the impression of being safe and firm to the touch and does not give the appearance of soiling. This window design has a shape similar to the school window, which is the window preference of past cafe visitors when they were in school. Thus, there are similarities in user perception and treatment of openings in the past and present.

In the case of Mardhiyah mosques, the impression of "legal to touch" is built through the manager's policies and user perceptions of the mosque. A mosque is a public place of worship that every worshipper can access. This condition raises the perception that worshippers can also touch the mosque's railing. All the "legal to touch" impressions create a sense of familiarity between the user and the opening.

Figure 9. A "legal to touch" impression built from user intensity along with openings
Source: Author (2024)

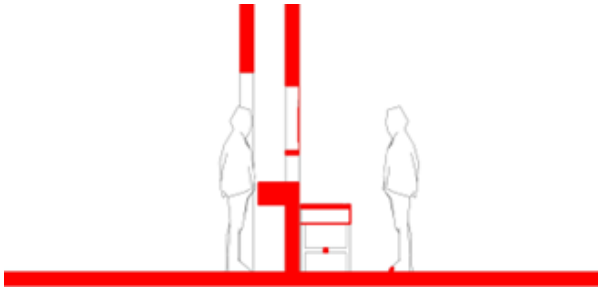


Figure 10. Building management policy for using Windows as a means of communication
Source: Author (2024)

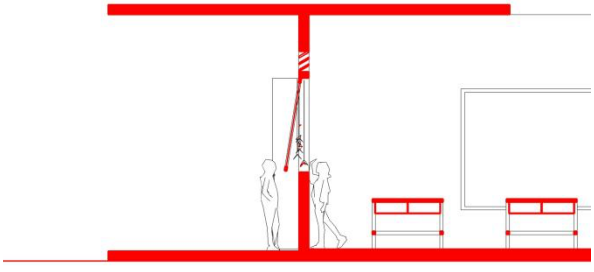


Figure 11. Section of a classroom window at Public Elementary School Pogung Kidul showing communication between users in different rooms

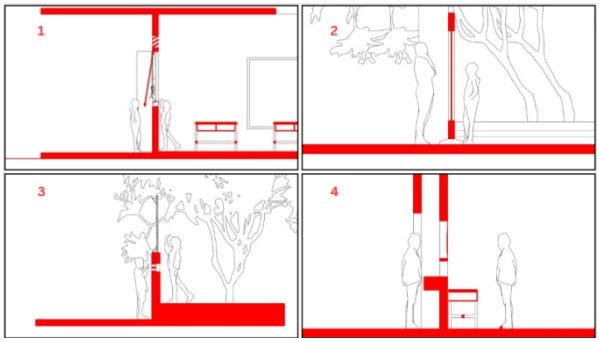


Figure 12. Communication behavior between users in various locations. (1) classrooms of Public Elementary School Experimental 2 and Pogung Kidul, (2) gate of Public Elementary School Experimental 2, (3) fence of Public Elementary School Experiment 2, and (4) Ombein retail order counter

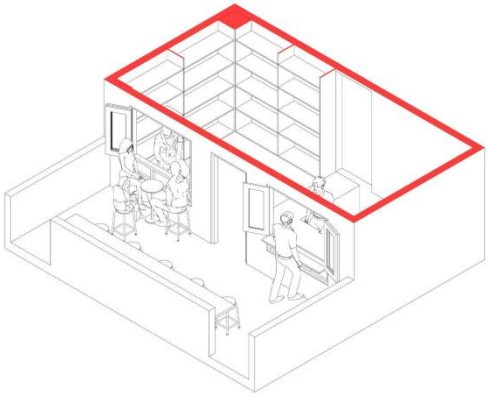


Figure 13. Cafe Arka Isometry

4.2.3 Openings connecting two active rooms with elevations that are not always equal

Ten of the eleven openings that fall into this category are openings that connect two spaces that are actively used by the user (there are other humans on the other side of the opening). This opens up communication opportunities between users on both sides of the opening. Unlike the first category, the openings in this category are intended for viewing and as a means of communication. Because the openings are not dominated by openings that provide views. In the case of elementary schools, openings connect classrooms and corridors that are actively used by students passing by. In the case of Ombein retail and K24 pharmacy, the opening connects the seller's and buyer's spaces. As for the case of visitors to Cafe Arka, some windows limit the terrace space and indoor reading room. Both sides of the window are provided with chairs that trigger users to sit opposite each other and talk to each other through the window (Figure 16). The side of the window in the indoor reading room has a power outlet, but not on the terrace side. This condition triggers users on the terrace to charge their devices on the side of the inner window with a cable connected through the window.

Another activity that triggers physical interaction is the user's desire to see the view across the opening more clearly. This is because the elevation of the object you want

to see (on the other side of the opening) is not always equivalent to the room the user is in. In the case of SMKN 2 Yogyakarta, students can hear the sound of traffic outside but cannot see it from inside the room because the student's position is on the third floor of the building. Therefore, students approach the window to attach their bodies to enjoy the view for a long duration. In the case of Public Elementary School Experiment 2, students who want to communicate with their friends through the school fence need to get closer because of the difference in elevation between the inside and outside areas of the school. The parents who were about to pick up their children approached and touched the gap in the fence so that they could see the view inside the school (higher elevation) more clearly. Similarly, in the case of the Mardhiyah Islamic Center Mosque, users on the 2nd floor can hear the sound of lectures delivered by speakers on the 1st floor, but users cannot see the lecturers. So, users approach the void and stick their hands on the railing to watch lectures and see the atmosphere of the mosque from the top floor. In Masjid Mardhiyah's case, children touched the railing more often than other users.

Figure 14. The user gets up close and touches the opening to see a more transparent view in the case of Public Elementary School Experiment 2

Figure 15. Users approach and touch the opening to see a more transparent view in the case of SMKN 2 Yogyakarta

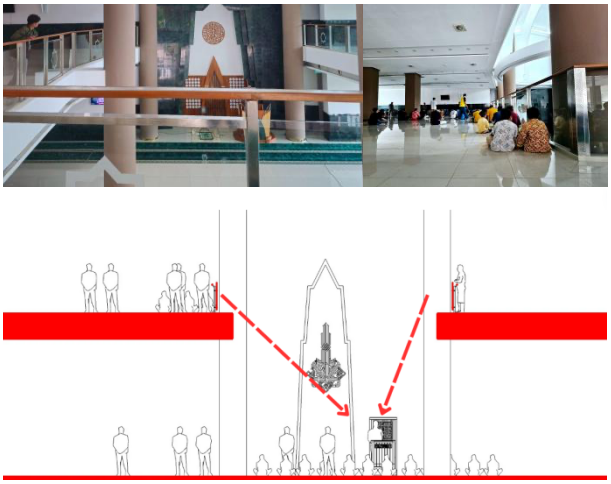


Figure 16. Users approach and touch the opening to see a clearer view of the case of the Mardhiyah Mosque

4.2.4 Transparent openings make communication easier

Although the strength of the influence is not as muscular as other aspects, 7 of the 11 openings in this category are transparent openings without stickers. This supports users to see the other side, interact, and communicate through the opening. Transparency also shows that the opening can function like an opening optimally.

4.3 Openings approached with unusual interactions

This category is an opening that is approached, touched, and operated unusually by the user. This study's user treatment of openings was a "play with openings" interaction. This category is found in Public Elementary School Experimental 2 and Indomaret. The form of interaction can be seen in Table 5, with the additional illustration shown in Figure 9-17.

Table 5. Unusual interaction with openings

Location	Unusual forms of interaction	User
Public Elementary School 2 Experiment	Door pushes	Children 8 years old
	Fight over items and play battles through the roster on the fence	Children 11 years old
Indomaret	Draw cartoons and dinosaurs when windows are foggy	Adolescence and adulthood

Based on Table 5 and Figures 9-17 illustrations, all interactions are activities children usually carry out, and two of the three users are also children in elementary school. This shows that openings can accommodate children's motor activities to explore and play with friends. The existence of openings has a significant meaning and role for children. This finding is helpful for architectural design that accommodates children's activities to consider aspects of openings in their design. Openings need to provide a sense of comfort and can operate flexibly to accommodate diverse children's activities. The safety aspect also needs to be considered because children are inquisitive about openings to approach and touch them.

However, something unique happened in Indomaret, where the users are teenagers and adults. Surprisingly, Indomaret visitors draw on the dewy window like a "canvas." The resulting images are cartoons and dinosaur characters attached to children's favorite imaginations. These findings show that every human being has a hidden side of creativity. Openings can manifest past play behaviors, and they can repeat themselves.

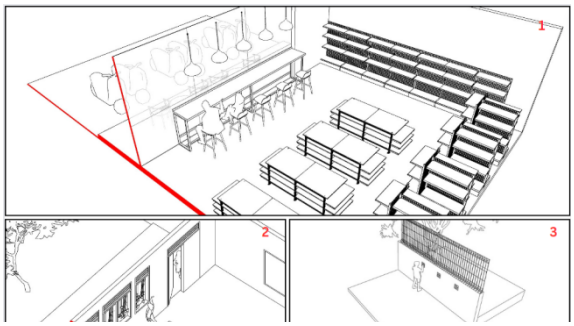


Figure 17. The behavior of drawing with Indomaret window dew (1), playing door pushes at Public Elementary School Experiment 2 (2), and playing throwing through roster holes at Public Elementary School Experiment 2 (3)

4.3.1 Perception of Touch-friendly Openings

The openings in this category all have a "legal to touch" feel. In the case of Public Elementary School Experiment 2, students felt "legal" to touch openings because school policies supported them and the intensity of being in school was very high (described in subchapter 4.3). As for the case of Indomaret, all visitors, both buyers and non-buyers, can freely access the area around the opening. Even all parts of Indomaret, such as terraces, cafe areas, and toilets, can be accessed by anyone. Thus, users perceive Indomaret windows as part of a public building. Users also do not worry if they leave traces of images in the window. This impression of being legal to touch" fosters a "sense of belonging" in openings.

4.3.2 The presence of attractive elements accompanying the openings

All openings in this category have attractive elements attached to and accompanying the opening. Attractive elements are only found in this category and not in other categories. This attractive element influences the user's perception of the opening, not to see it as limited as an opening. The door leaf becomes an attractive element for students at the school door. The door leaf acts like a "fortress door" that is pushed so that friends cannot leave the classroom. Almost similar to the door, the breezeblock on the school fence is also used as a gap to throw objects and fight for objects like playing war. Small holes in the roster become an element that attracts students' attention to play. As for the case of Indomaret, the condition of the dewy window is considered like a canvas for visitors. Based on the visitors' preferences, rubbing the dew leaves finger scratch marks. The traces of touch can be abstract or resemble certain things that can satisfy those who touch them. Therefore, dew becomes an attractive element that sticks to the window. The attractive elements accompanying the openings provide a particular perception that triggers the user's curiosity.

The openings included in this category are all very different types in shape, function, system, and hole. This shows that any opening with attractive elements and a "legal to touch" impression can trigger various physical interactions. This condition opens the user's imagination to perceive openings as playing tools, canvases, or other perceptions.

Large opening dimensions do not affect the user's tactile interaction with the opening. This is proven in the case of openings on minor rosters and large Indomaret windows found in Category 3, which have a high intensity of use and are played by users. Meanwhile, in Category 1, large windows were also found that were only looked at and not touched. These findings indicate that the attractive element aspect is more influential than the size aspect in influencing the user's tactile interaction with the opening.

Building managers can build interactive perceptions of openings through policies that legalize the touch of openings and do not restrict users from exploring indoors. This is proven through cases in categories 2 and 3, such as pharmacies, elementary schools, and minimarkets. In the case of pharmacies, users are directed to use openings as a medium for transactions and communication. In the case of elementary schools, students are directed to decorate the windows so that a familiarity arises between the students and the windows so they enjoy operating them. As for Indomaret, there are no restrictions for visitors to access all parts of the building, including the area around the openings. Thus, regulations established by building managers do not limit user interaction with openings.

Figure 18. Playing throw-and-throw through the fence roster at Public Elementary School Experiment 2

Figure 19. Playing with the Door at Public Elementary School Experiment 2

Figure 20. Visitors draw cartoons and dinosaurs on the foggy windows at Indomaret

5. Conclusion

Based on the findings of this study, openings today not only act as architectural and structural elements that support aesthetics, lighting, and air. They also shape user perception and interaction. User perception of openings includes positive perceptions of liked objects, but they are also viewed negatively as objects that need to be shunned. Openings impact not only interactions between users but also interactions between users and the openings themselves.

It is essential to identify user preferences to determine appropriate openings in architectural designs. Studies have shown that age differences cause different behaviors regarding openings. For example, children who play using openings tend to operate them naturally, while adults do the same.

Operable windows are more interactive than fixed windows in creating an interactive opening design for users. To support interactive openings. In private rooms, openings need to maintain user privacy in their activities. In a school context, openings must be designed to be comfortable and safe for use in play. In public spaces, interactive openings must be designed inclusively to operate comfortably. This is necessary to foster a sense of ownership in users towards their openings.

Users in building typologies accessible to everyone and occupied by high-intensity users tend to interact more with openings. In contrast, users in building typologies with limited access are less likely to interact with openings.

Future research can discuss other types of openings, such as skylights. The skylight discussion will open new insights about user perception and interaction with the view above the room. Future research can also discuss the impact of openings on the perception and interaction of elderly users, which is a limitation of this study. So, knowledge about user interactions and openings can cover all user populations, including children, teenagers, adults, and older people.

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