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Guidelines for Designing the Physical Environment and Ensuring Safety Measures to Address Blind Corner Issues and Travel Obstacles in Transitional Spaces Between Mass Transit Stations and Buildings

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Abstract

Mass transit systems are crucial in alleviating traffic congestion and fostering economic development in the surrounding areas. Transitional spaces between mass transit stations and buildings significantly improve accessibility, especially for the BTS Skytrain. Emphasizing safe travel is of paramount importance. This research aims to investigate factors related to the design and safety of transitional spaces, involving an assessment of the environment and proposing guidelines for the physical layout. The objective is to address issues such as blind corners and travel obstacles comprehensively. The study employs identified factors to evaluate transitional spaces, identify problems based on specified criteria, and incorporate feedback from area users. The findings underscore the importance of good visibility as a crucial factor for safe journeys. Walkways with a width of two meters or more in areas with dead spots and travel obstacles are safer than narrower paths. Two approaches have been suggested to tackle these issues: first, addressing physical aspects by enabling travelers to see blind corners before reaching them, determining the boundaries of dead zones and travel obstacles, and establishing clear walking routes with navigation symbols. Second, management solutions include adding security guards and equipment in dead spots, along with effective management of transitional spaces during events to handle increased traffic.

Keywords: *Transitional Spaces, Physical Environment, Safety and Security, Natural Surveillance, Blind Corners and Travel Obstacles.*

Introduction

Mass transit emerges as a pivotal alternative for navigating through the challenges of today's congested traffic conditions. Especially, electric train mass transit systems save time efficiently and elevate overall convenience. From an economic standpoint, it is noteworthy in stimulating economic growth and nurturing commercial activities between travel connections. As one travels from a mass transit station to its surrounding area, transitional spaces operate as a transit point, establishing a seamless link between mass transit systems and neighboring locations. This integration unifies public areas, semi-public spaces, and private domains. Activities unfold during road travel connections, extending beyond their role in facilitating travel; they actively contribute to economic development along the transit route (Guthrie & Fan, 2016; Zhong & Li, 2016; Zhang et al., 2021).

However, despite economic development along the electric train route, it may simultaneously incentivize the occurrence of crime problems along that route. Nevertheless, we must maintain sight of the paramount consideration, the ultimate goal of travelling and reaching the destination safely. This encompasses evading dangers arising from inappropriate environments and potential human actions.

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Therefore, it can be asserted that economic development must be intricately coupled with the assurance of safety for the lives and property of travelers (Badiora et al., 2020; Jeffres et al., 2009). Furthermore, an insecure travel connection has the potential to generate travel anxiety, influencing commuters' perception of the service image of the provider. This, in turn, may prompt them to shift and choose alternative modes of travel. Such a transition poses a significant obstacle to resolving traffic congestion problems, hindering the overall development of the transportation system.

Beyond their role as transit points, transitional spaces serve as protective zones to mitigate potential hazards within continuous building areas. These spaces include entry and exit points, with the highest risk concentrated around stairs, train platforms, and walkways linking station platforms to park-and-ride locations (DENİZ, 2018). The physical environment introduces challenges like blind corners and narrow corridors, acting as obstacles to travel. Inadequate lighting further compounds the sense of insecurity. This emphasizes the crucial need for optimal visibility along the travel route, addressing concerns, such as blind corners that could serve as potential hiding spots. Improving visibility is a preventive measure to discourage criminals from using concealed spaces for illicit activities (Ceccato & Uittenbogaard, 2014; Cozens et al., 2003). This represents a fundamental aspect of crime prevention. Consequently, these measures actively reduce commuters' fear of travel and cultivate a sense of safety throughout the journey until reaching the destination (Ceccato et al., 2022; Newton, 2018; The National Crime Prevention Council (NCPC) of Singapore, 2003).

In the context of Thailand, especially in current economic centres, there is notable growth in office buildings and shopping centres. An observation reveals that areas with a high-risk level and crucial safety importance are prevalent in this dynamic landscape. Consequently, the imperative arises for enhanced security measures, including personnel and equipment, particularly in locations linked to main roads, electric trains, mass transit, and entry-exit points. This necessity stems from the substantial movement of people in and out of these areas (Muanhong, 2016; Samboonraung, 2010; Thongmar, 2015).

This research focuses on studying guidelines related to physical environment design and security management. The aim is to address challenges like blind corners and obstacles during travel, which significantly affect high visibility throughout the journey. A particular area of interest is the connection zone between the station and surrounding buildings on the BTS Skytrain route. This route stands out for having the highest number of connections to buildings among all mass transit systems, and it boasts the largest user base according to statistical data. The ultimate goal of this investigation is to determine whether commuters can traverse these transitional spaces safely to reach their destinations or not. Achieving this goal not only enhances the safety of the journey but also serves as a catalyst for encouraging more individuals to opt for mass transit systems. The potential increase in mass transit usage is critical for addressing traffic congestion issues, thereby contributing significantly to the overall development of the country.

Literature Review

The examination of relevant literature aims to strengthen the guidelines for designing the physical environment and enhancing security measures. Especially, the focus is on resolving challenges related to dead spots and travel obstacles in the zones that link mass transit stations to buildings. The following details are provided:

Definition of Transitional Spaces

In the context of this research, transitional spaces are defined as spaces that serve as transit points between mass transit systems and surrounding buildings. These areas act as transitional zones, accommodating public, semi-public, and private spheres. They facilitate a smooth connection for passengers between mass transit stations and nearby structures, such as office buildings, hotels, department stores, and multi-purpose buildings. Additionally, this space functions as a checkpoint, verifying access rights and screening individuals entering or exiting. This role is crucial in preventing potential dangers before individuals enter a building or a surrounding area (Benn & Gaus, 1983; Ceccato & Newton, 2015).

Definition of Safety and Security in Transitional Spaces

'Dangers' can be categorized into two main types: natural disasters, triggered by natural phenomena and adverse environmental conditions, and hazards stemming from human actions. The latter is then further subdivided into two categories: dangers arising from unintentional actions due to human negligence and ignorance and dangers resulting from intentional actions, often perpetrated by individuals who purposefully conceal their activities, such as engaging in robbery, hijacking, bombing, or theft. Consequently, the concept of "safety" conveys the idea of being free from all types of dangers (Ceccato & Newton, 2015; Purpura, 2016).

Therefore, the concept of 'safety' entails freedom from various hazards. Being safe from natural perils and unintentional or accidental human actions means protection against accidents, disasters, and health threats. While these kinds of dangers may not always be avoidable, preparations can be implemented to minimize the likelihood of accidents and mitigate potential consequences. In contrast, safety from intentional human actions pertains to the threats posed to the well-being and property of organizations and building occupants. This safety type relates to preventing or hindering malicious harm to life, peace, stability, and assets of organizations and associated individuals or groups. The prevention of deliberate hazards is termed 'security'. Concerning safety in public transportation, it encompasses the perceptions and feelings of crime risks for passengers and relevant staff. Every passenger is entitled to travel securely without exposure to any form of danger (Ceccato & Newton, 2015; Landoll, 2016; Purpura, 2016).

Theories Related to Safe Physical Environment and Security Management

Facility Management in Terms of Security Management

Facility Management originated with the primary goal of enhancing an organization's ability to navigate dynamic economic conditions and cultivate a healthy workplace. This includes adapting to new technologies by efficiently utilizing resources and minimizing environmental impacts. The evolution of Facility Management has been marked by continuous development, expanding its focus from the organization to the broader societal context, accommodating diverse cultures. This evolution is shaped by policy changes at the government level, urban area development, and the introduction of new materials (Bröchner et al., 2019). The core of Facility Management entails preparing the organization's facilities to respond to usage needs. The focus is on providing services to people within the building (People), work processes (Process), and physical spaces (Place) to work harmoniously for the maximum benefit of users and building owners. This is achieved by placing the activities and goals of the organization at the center. The building serves as a tool to support the organization's work, enhancing efficiency and effectiveness in achieving both short- and long-term goals. The physical system consists of (1) Physical Resources and (2) Operations or Facility Services (BIFM, 2005; Chotipanich, 2010; IFMA, 2022, Lowry, 2017; Nutt, 2004).

Security Management, a critical component of building operations and services, plays a pivotal role in ensuring the safety of building users. The primary goal is to protect individuals and secure assets from potential threats. Consequently, security management is centered around establishing a safe environment for building users' well-being, lives, and property, shielding them from individuals or groups with malicious intentions. The security system is comprised of three fundamental components: (1) Physical Security, which concentrates on barriers and obstacles in areas susceptible to danger; (2) Operational Security, entailing the organization of security personnel to uphold order and safety, monitor and respond to incidents; and (3) Technological Security, covering security equipment like closed-circuit television receivers, access control systems, traffic control systems, hazardous object detection systems, and incident notification systems (Roper & Payant, 2014).

Crime Prevention Through Environmental Design (CPTED)

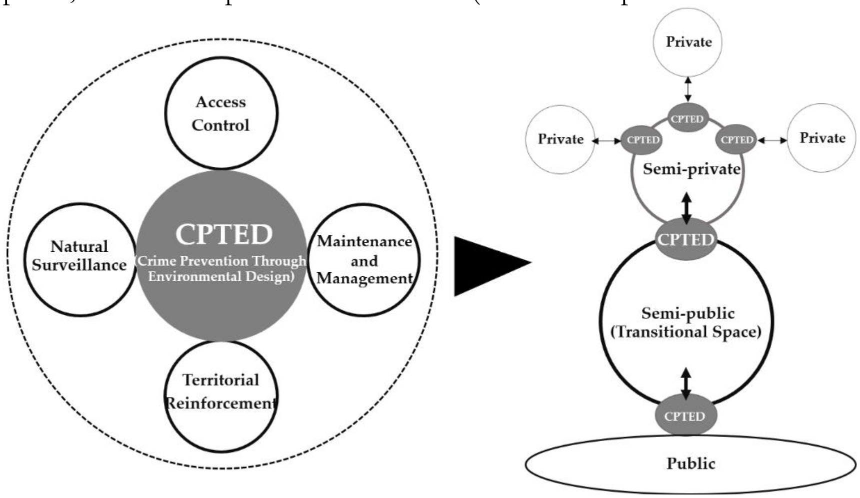
Crime Prevention Through Environmental Design (CPTED) has been continuously developed since its inception as a theory focusing on crime prevention through law enforcement and understanding the correlation between crime and community conditions. The central principle revolves around the strategic design of the environment to effectively reduce crime rates and assuage residents' fears (Mihinjac & Saville, 2019). As CPTED has evolved, its emphasis has expanded to designing physical spaces, giving importance to the alignment between the intended use of space, managing human behavior, and modifying the physical environment. This may pertain to redesigning or enhancing existing spaces for increased efficiency (Randall, 2008), aiming to segregate, limit, and regulate access to public, semi-public, and private areas. Being recognized as one of the methods contributing to safety, a well-designed area following CPTED guidelines acts as a deterrent to potential crime. The approach is grounded in essential principles, including territory, surveillance, strict control of area access, support for legitimate activities, and effective management of space positioning and image (Cozens & Love, 2015; Cozens, Love, and Davern, 2019).

The CPTED framework categorizes security into three measures: (1) mechanical measures, which revolve around hardware and technology, such as access control systems, locks, alarms, doorbells, closed-circuit television (CCTV), and metal detectors; (2) organizational or personnel-based measures refer to security strategies that designate groups responsible for and having rights to security, such as security patrols, etc.; and (3) natural measures, which stress the utilization of security zoning by dividing areas into distinct zones (Atlas, 2013). However, according to CPTED guidelines, safety is distinct from security. While installing safety equipment in an area is acknowledged to enhance safety, vibrancy, beauty, and natural aspects of an area, it can also evoke a sense of safety. Good design promotes the natural use of space and reduces the necessity to rely on additional equipment and technology (The National Crime Prevention Council (NCPC) of Singapore, 2003).

The crime prevention theory guides the design principles through environmental design, especially targeting corridor-type projects encompassing underground tunnels, sky bridges, and travel connection areas. Key concerns addressed include Territorial Reinforcement, Access Control, Maintenance and Management, and Natural Surveillance (American Public Transportation Association, 2010; Benn & Gaus, 1983; Cozens & Love, 2015). The objective is to prevent crime by strategically designing environments in travel connectivity areas. A pivotal aspect pertains to preventing, correcting, and planning guidelines to eliminate dead spots, obstacles, or impediments in these travel areas. Areas with covered spaces and challenging escape routes can evoke fear and a sense of danger. Mitigating these fears enhances the overall understanding of safety. Emphasizing natural elements further contributes to a feeling of security and reducing opportunities for criminal activities.

Additionally, highlighting the naturalness of using space safely diminishes the likelihood of wrongdoing. An open environment and good visibility are important to instil a sense of safety. Perceived safety is influenced by various factors, including personal and social characteristics, time and places concerning lighting, facilities, information systems, mobile phones, coverage, locations, and overall environmental openness and surveillance (Nasar et al., 1993; Sundling & Ceccato, 2022), as shown in Figure 1.

Figure 1: Crime Prevention Through Environment Design (CPTED) by Controlling Access to Public, Semi-public, and Private Spaces in Transit Areas (Sources: Adapted and modified from Cozens., & Love, 2015).



The two concepts explored above—Facility management in terms of security management and crime prevention through environmental design (CPTED)—are intricately linked to local safety. In the realm of building and physical resource management, three critical components of security management are identified: (1) Operational elements encompass organizations, personnel, policies, and procedures concerned in performing work, among other considerations. (2) Architectural elements comprise space positioning, lighting, exit stairs, facilities, obstacles, and travel impediments. (3) Security system elements include automatic entry and exit control systems, intrusion detection and alarm systems, and CCTV cameras (Patterson, 2005).

Surveillance at the entrances and exits of buildings, facilitated by equipment and officers, significantly reduces crime problems and alleviates customers' fear (Kajalo & Lindblom, 2010). Simultaneously, according to the crime prevention through the environmental design approach, surveillance is critical for security and is categorized into two approaches: (1) formal surveillance, which includes systems, equipment, CCTV cameras, and security guards, and (2) informal surveillance, represented by an open, bright, unobstructed, and clean environment. Studies suggest that informal surveillance is more effective, especially in retail. An environment characterized by natural surveillance makes customers more safety-conscious and inclined to use the area than formal surveillance. This implies that informal surveillance is more customer-friendly (Akinbogun et al., 2022; Kajalo & Lindblom, 2016; Özaşçılar, 2022).

The concepts outlined here play a pivotal role as essential guidelines, commencing from the design stage, rooted in crafting a physical environment secure from crime and easily manageable concerning security (Davey & Wootton, 2016). These principles establish a symbiotic relationship, reinforcing each other in their pursuit of creating a safe environment. Furthermore, laws and regulations govern the design of transitional spaces extending from mass transit stations to buildings. They prescribe specific dimensions to guarantee safety and convenience in utilizing the space. Mandated criteria include the width and height of entrances and exits in transitional spaces and the provision of unobstructed pathways on public land at all times.

However, the criteria for defining a safe physical environment remain ambiguous, stipulating that it must be safe for use (Panpet & Upala, 2020). Despite this lack of specific criteria, these concepts collectively contribute to establishing safety in travel connection areas. Their collaborative implementation ensures that commuters can securely reach their destinations, representing the ultimate goal of the entire journey.

Research Methodology

This research places an emphasis on establishing secure travel connections from mass transit stations to surrounding buildings, guided by the overarching concept of a safe environment and appropriate security management. The research objectives can be summarized as follows:

1. To study factors in the physical environment and security management to develop assessment criteria for identifying blind corners and travel obstacles in transitional spaces between mass transit stations and buildings.
2. To assess the physical environment concerning blind corners and obstacles to travel.
3. To propose solutions to issues arising from dead spots and travel obstacles, aiming to create and maintain safety in transitional spaces between mass transit stations and buildings.

The research employs a mixed method approach, combining a physical environment survey and collecting feedback from users in the connected area. The research methodology comprises four steps as follows:

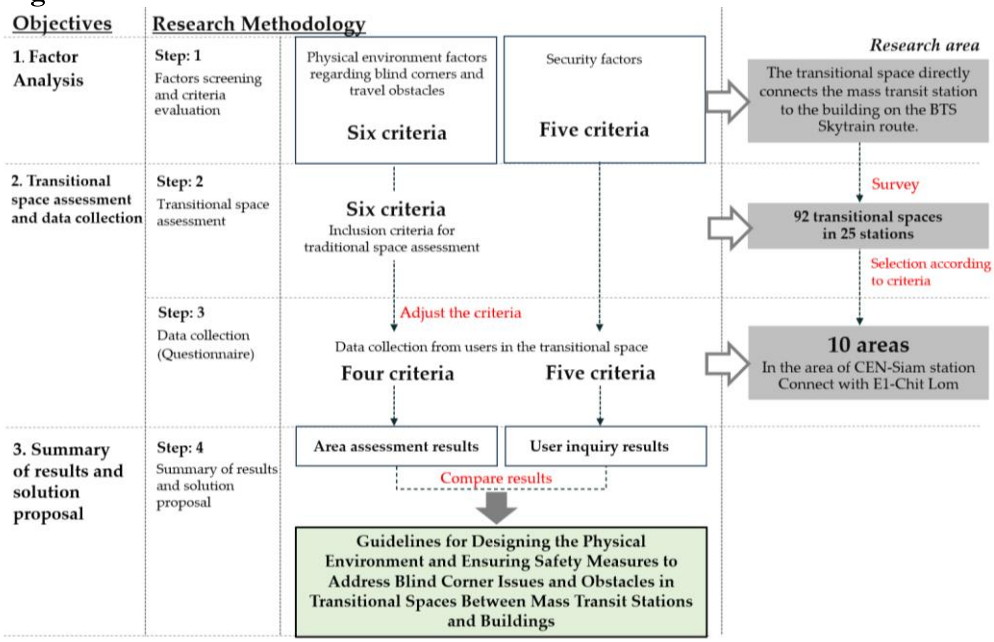
Step 1: Developing a physical environment assessment for safety and a questionnaire for users in transitional spaces between mass transit stations and buildings. This step includes a comprehensive literature review and research on the characteristics of the physical environment and security management in travel connectivity areas, summarizing the critical factors used to evaluate the physical environment. Subsequently, users in transitional spaces between mass transit stations and buildings are surveyed using this newly developed physical environment assessment and user questionnaire, marking the first implementation in an actual research area. The initial revision consists of scrutinising question consistency by three experts: designers, academics, professors, or practitioners engaged in physical resource management and security management. Based on these expert" recommendations, the assessment form and user questionnaire underwent necessary revisions. The revised physical environment assessment forms and user questionnaires were tested realistically following these adjustments. This iterative process had been repeated for a second and final revision before the tools were deployed to collect data.

Step 2: Assessing the physical environment and collecting feedback from users in transitional spaces between mass transit stations and buildings. The assessment form crafted in Step 1 was utilized for evaluating these transitional spaces. The evaluation encompasses 92 transitional spaces spread across 25 stations on the BTS Skytrain route— inaugural electric train lines in Thailand, renowned for hosting the most significant number of transitional spaces between mass transit stations and buildings.

Step 3: Surveying users of transitional spaces between mass transit stations and buildings. Based on the results obtained from the assessment of transitional spaces between mass transit stations and buildings in Step 2, problematic areas contributing to insecurity were pinpointed. Specific areas were selected based on predetermined criteria to validate the findings of this insecurity assessment with users. These chosen areas represent the connecting zones where dead spots and travel obstacles are identified— especially, ten CEN-Siam Station areas extending to E1-Chit Lom Station. The survey utilized a random sampling method to engage with users, with 35 individuals selected per area, amounting to 350 participants.

Step 4: Summarizing the research results obtained from the assessment of the physical environment and collecting user feedback to verify their alignment with identified problems that could contribute to insecurity in the area. The step also recommends guidelines for designing the physical environment and enhancing security as a result of blind corners and obstacles in transitional spaces between mass transit stations and buildings, as shown in Figure 2.

Figure 2: The Research Framework.



Analysis and Results

Physical environment, and security factors in transitional spaces between mass transit stations and buildings

The literature review identified physical environment and security factors for evaluating transitional spaces between mass transit stations and buildings. The physical environment factors, which are crucial for safety, encompass various elements like boundaries, entrances, positioning of connected areas, lighting, signs, information, cleanliness, and maintenance. A survey of 92 transitional spaces at 25 stations along the BTS Skytrain route unveiled six criteria influencing good visibility, a pivotal aspect of commuting:

1. Good visibility along the straight path.
2. Good visibility when observing transitional spaces.
3. Absence of fences, railings, fall protection, or blocking of space in the walkway. If they are present, they must be see-through, ensuring clear visibility at a height of 1.50 meters.
4. No closed areas or spots where individuals can hide; mirrors must be installed so that commuters can see in all directions if such areas exist.
5. No sharp turns exceeding 60 degrees. If they are present, full-length mirrors should be installed to aid pedestrians in seeing around the corner. The turning area must always be open and visible if full-length mirrors are absent.
6. Absence of physical obstacles like pillars and sharp corners that may pose a danger.

In addition, security factors, playing a crucial role in enhancing safety in the area, encompass equipment and security personnel, delineated by five criteria: (1) screening and monitoring at entrances and exits with CCTV cameras, (2) screening and surveillance at entrances and exits with access control equipment and hazardous substance detection equipment, (3) equipment, systems, or technology for reporting incidents when insecurity occurs, such as telephones and emergency notification buttons, etc., (4) proactive screening and surveillance at entrances and exits with stationed security personnel, and (5) proactive screening and surveillance at entrances and exits with patrolling security personnel. From these two main factors, criteria used to assess the physical environment regarding blind corners and travel obstacles in transitional spaces between mass transit stations and buildings can be summarized. The physical environment factors related to dead spots and obstacles were surveyed using six criteria and questionnaires for users of transitional spaces. The questions were adjusted to align with user inquiries (four criteria) and equipment and security personnel factors (five criteria).

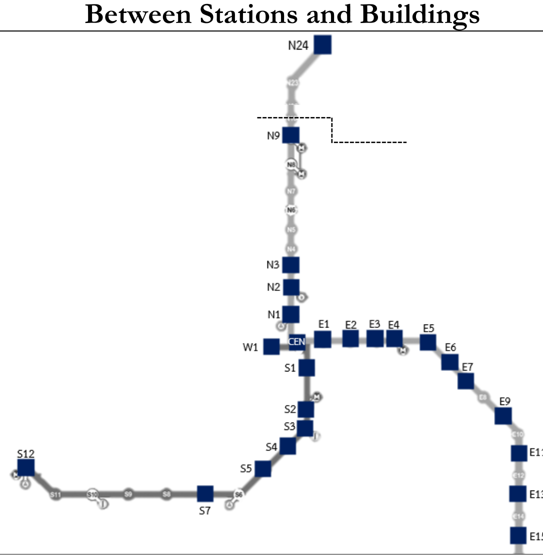
The findings from the assessment of the physical environment concerning blind corners and travel obstacles, coupled with user inquiries in transitional spaces regarding issues associated with blind corners, obstacles to travel, and security

Transitional Spaces Between Mass Transit Stations and Buildings

This research focused on surveying transitional spaces between mass transit stations and directly connected buildings along the BTS Sky Train route. Out of the total 62 stations, it was observed that 25 stations have direct transitional spaces between mass transit stations and buildings. These stations include N24-Khu Khot, N9-Ha Yaek Lat Phrao, N3-Victory Monument, N2-Phaya Thai, N1-Ratchathewi, CEN-Siam, E1-Chit Lom, E2-Phloen Chit, E3-Nana, E4-Asok, E5-Phrom Phong, E6-Thong Lo, E7-Ekkamai, E9-On Nut, E11-Punnawithi, E13-Bang Na, E15-Samrong, W1-National Stadium, S1-Ratchadamri, S2-Sala Daeng, S3-Chong Nonsi, S4-Saint Louis, S5-Surasak, S7-Krung Thon Buri, and S12-Bang Wa Station (information as of June 31, 2022). During the survey of transitional spaces between mass transit stations and buildings, it was discovered that there were 94 transitional spaces, but two were under renovation and closed for use. Consequently, this research emphasized studying 92 connected areas, as shown in Figure 3, with examples of these areas presented in Figure 4.

Figure 3: The BTS Skytrain Station Directly Connecting to Mass Transit Stations and Buildings (Source: Adapted and Modified From BTS Skytrain, 2021).

BTS Skytrain Route Map	BTS Skytrain Route Map with Transitional Spaces Between Stations and Buildings



Legend:

- ■ The mass transit station has transitional spaces between stations and buildings.
- BTS Skytrain Sukhumvit Line
- BTS Skytrain Silom Line

Figure 4: Examples of Transitional Spaces Between Mass Transit Stations and Buildings along the BTS Skytrain Route.

Results from the physical environment assessment and user inquiries in transitional spaces reveal issues related to dead spots and obstacles to travel.

The assessment of the physical environment regarding blind corners and travel obstacles in transitional spaces between mass transit stations and buildings revealed that among the 25 electric train stations with direct transitional spaces, 16 stations (64 percent) encountered issues with dead spots and obstacles to travel. In comparison, nine stations (36 percent) did not face such problems. The survey results indicate that most transitional spaces boast good visibility in a straight line, with 66 areas displaying excellent visibility and only 26 areas experiencing poor visibility. Similarly, 87 areas had good visibility when looking around, with only five areas showing poor visibility. Concerning walkways and transitional spaces, 65 walkway areas needed fences, guardrails, or barriers, whereas 27 areas featured such obstacles. In assessing closed or hiding areas, 76 areas were devoid of such spaces, while 16 areas had closed or hiding areas. Moreover, there were no physical obstructions, such as pillars and sharp corners, in 65 areas, but 27 areas had these obstructions. The overall area exhibited no sharp turns exceeding 60 degrees, reflecting the results of the physical environment assessment concerning blind corners and obstacles to travel, as shown in Table 1.

Table 1: The Results of the Physical Environment Assessment Regarding Blind Corners and Travel Obstacles in Transitional Spaces Between Mass Transit Stations and Buildings Covering 92 Areas at 25 Stations.

No.	Factors: Blind Corners and Travel Obstacles	Assessment Result (Transitional Space)	
		No problems found	Problems found
1	Good visibility along the straight line of the walkway	66	26
2	Good visibility when looking around the walkway	87	5
3	No fences, guardrails, or barriers around the walkway	65	27
4	No closed areas or hiding spots	76	16
5	No sharp angles exceeding 60 degrees	92	0
6	No physical obstacles, such as pillars and sharp corners	65	27

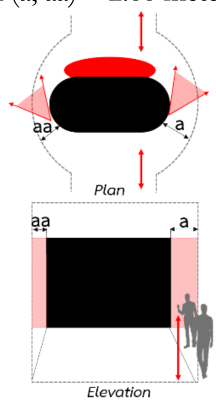
Types of areas with blind corners and travel obstacles in transitional spaces between mass transit stations and buildings

The analysis of areas with blind corners and travel obstacles yielded significant findings. Upon evaluating the physical environment in transitional spaces between mass transit stations and buildings, it was observed that most issues arose beneath the BTS Skytrain route. The station structure, including pillars and other elements, posed obstacles along the route, leading to problems with dead spots and travel hindrances. As a result, visibility during travel was compromised. Further investigation revealed that narrower walkways near obscured areas exacerbated visibility issues.

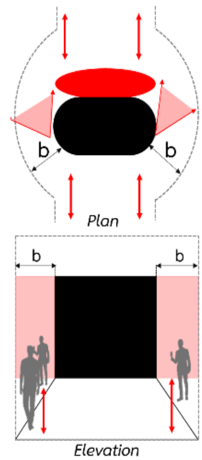
Maintaining good visibility is crucial for ensuring safety. Therefore, these findings allow for the classification of areas with dead zones and obstacles to travel. The width of the walkway in these problematic areas led to the identification of two types: Type 1 includes areas where the walkway width in the dead zone and obstacles to travel is less than 2.00 meters. Type 2 comprises areas where the width of the walkway in dead zones and obstacles to travel is 2.00 meters or more, as shown in Figure 5.

Figure 5: Types of Areas with Corners and Travel Obstacles in Transitional Spaces Between Mass Transit Stations and Buildings.

Type 1: Areas with the walkway width in the dead zone and obstacles to travel (a, aa) < 2.00 meters.



Type 2: Areas with the walkway width in the dead zone and obstacles to travel (b) ≥ 2.00 meters.



Legend:

- The mass transit station structure.
- The view of the walkway, the point around the pillar of the mass transit station structure.
- The blind corners near the mass transit station structure pillars.
- The boundary of the walkway around the pillar structure and transitional area.

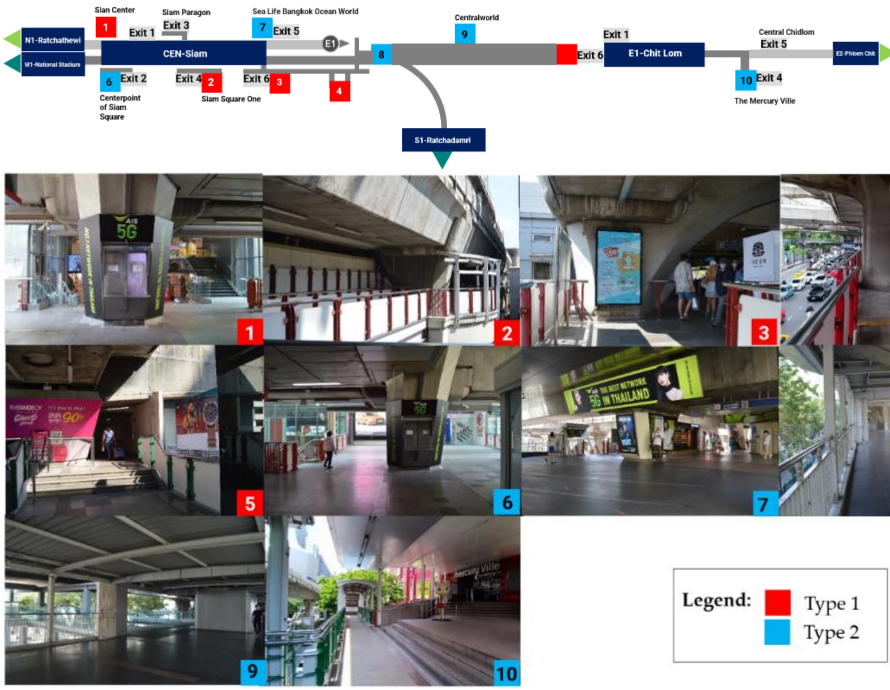
Results from user inquiries regarding blind corners, obstacles to travel, and security in transitional spaces between mass transit stations and buildings

Upon assessing the physical environment of transitional spaces between mass transit stations and buildings, we identified areas requiring help with blind corners and travel obstacles. These areas can be categorized into two types, as mentioned earlier. This presents a significant concern as it directly impacts visibility along the travel route, posing crucial obstacles to safety within the area.

To better understand and address this issue from the user's perspective, in addition to evaluating the physical environment, inquiries were conducted using a user questionnaire specific to transitional spaces. The user inquiry area was selected based on specific criteria: (1) a station with many users and (2) areas encountering problems with blind corners and obstacles in both types. Consequently, 10 areas at CEN-Siam Station, including those continuous to E1-Chit Lom Station, were chosen for user inquiries.

These areas were further classified into two types: Type 1 areas where the width of the walkway in dead zones and obstacles to travel is less than 2.00 meters (Areas 1-5), and Type 2 areas with walkway widths in dead zones and travel obstacles of 2.00 meters or more (Areas 6–10), as shown in Figure 6.

Figure 6: Inquiring About User Experiences in 10 Transitional Spaces in the CEN-Siam Station Area Continuous to E1-Chit Lom Station.



The results of surveying a sample group of users about dead spots, obstacles to travel, and security in transitional spaces between mass transit stations and buildings, covering 10 areas with 35 participants each, totalling 350 people, revealed that the sample group was predominantly female, constituting 206 individuals (58.90 percent) compared to 144 males (41.10 percent). The mean age of the sample group was 30.20 years, the oldest age was 50 and the youngest was 19. Regarding educational attainment, 149 people had an education level below a bachelor's degree (42.60 percent), 123 individuals held master's degrees (35.10 percent), 57 had bachelor's degrees (16.30 percent), and 21 possessed doctorate degrees (6 percent), respectively. In terms of marital status, a significant portion of the sample group identified as single, totalling 279 individuals (79.70 percent), followed by individuals who were married, numbering 60 (17.10 percent), and the least common status was divorced, with 11 individuals (3.10 percent). Concerning the occupational distribution within the sample group, students constituted the highest number, with 151 individuals (42.38 percent), followed by civil servants/state enterprise employees/government agency employees (133 people or 38.00 percent), private company employees (48 people or 13.70 percent), freelancers/for-hire individuals (16 people or 4.60 percent), and private business owners (two people or 0.60 percent).

The primary purpose of the sample group was public transportation use, with 91 people (26.00 percent) travelling to department stores or stores, followed by 91 individuals (22.90 percent) engaging in tourism, and 73 people (20.90 percent) commuting to educational institutions. Additionally, 54 people (15.40 percent) used public transportation for work, 33 individuals (9.40 percent) for social activities, 15 people (4.30 percent) for connecting to other transportation systems, and three people (0.90 percent) for residential travel. Business purposes had the fewest participants, with only one person (0.30 percent). The sample group demonstrated a higher frequency of using public transportation less than two times per week, involving 206 people (58.90 percent). Following this, 98 people (28.00 percent) used the service two to six times per week, and 23 people (6.60 percent) utilized the service seven to 10 times per week. A minority used the service more than 10 times per week. Concerning the periods for public transportation, the majority, comprising 182 people (52.00 percent), preferred the period from 9:01 a.m. to 5:00 p.m. The evening rush hour (17:01 – 20:00) attracted 72 people (20.60 percent), the morning rush hour (06:00 – 09.00) engaged 71 people (20.30 percent), and the period from 20:01 to 24:00 hr had the fewest participants of 25 people (7.10 percent)

The paragraph explores the safety of areas linking mass transit stations to buildings by surveying users about physical environmental and security factors. The results provide valuable insights specific to this area. Concerning physical environmental factors for safety, particularly regarding dead spots and travel obstacles (four criteria) and security factors (five criteria), the findings highlight that Type 2 areas are more visible along a straight-line route and exhibit a higher safety level (Mean = 4.07) compared to Type 1 areas (Mean = 3.59) in terms of clear visibility around transitional spaces. In addition, Type 2 areas demonstrate more excellent safety (Mean = 3.97) compared to Type 1 areas (Mean = 3.73) regarding the absence of obstacles that induce feelings of insecurity. Addressing the risk of collisions or accidents, Type 2 areas consistently show a higher safety level (Mean = 3.79) compared to Type 1 areas (Mean = 3.59) and fulfill the criterion of having no obstructions that create closed areas for hiding, causing feelings of insecurity. Concerning the risk of harm from others, Type 2 areas exhibit a higher safety level (Mean = 3.65) than Type 1 areas (Mean = 3.45). In summary, the analysis suggests that transitional spaces between mass transit stations and Type 2 buildings consistently maintain a high level of safety across all criteria related to physical environmental factors, such as dead spots and obstacles. This indicates a secure journey for users, surpassing those in Type 2 areas in every criterion.

Furthermore, it was observed that both types of areas display significant disparities in physical environmental factors affecting the safety of users in transitional spaces between mass transit stations and buildings. These variations are noteworthy at a significance level 0.05 across all four criteria, namely, the capacity to perceive clearly along distinct straight lines (t = -7.053, p = 0.000*), the ability to have a clear line of sight when surveying transitional spaces (t = -2.942, p = 0.003*), the absence of obstacles contributing to feelings of insecurity and the risk of accidental collisions (t = -2.089, p = 0.037*), and the absence of obstacles creating enclosed spaces for concealment, leading to heightened feelings of insecurity and an increased risk of being subjected to attacks by others (t = -2.004, p = 0.046*), as shown in Table 2.

Table 2: The Safety Analysis Results for Users in Transitional Spaces Between Mass Transit Stations and Buildings, and Physical Environment Factors for Safety from Blind Corners and Travel Obstacles.

No.	Factors	Type of Area				t	p
		Type 1		Type 2			
		Mean	S.D.	Mean	S.D.		
1	Good visibility along the straight line of the walkway	3.59	0.671	4.07	0.616	-7.053	0.000*
2	Good visibility when looking around the walkway	3.73	0.784	3.97	0.742	-2.942	0.003*
3	No obstacles that cause feelings of insecurity or risk of collision/accidents	3.59	0.872	3.79	0.868	-2.089	0.037*
4	No obstructions that create hidden areas, causing a feeling of insecurity or the risk of being hurt by others.	3.45	0.926	3.65	0.941	-2.004	0.046*

Notes: *Significant at p, 0.05. The safety level for users in transitional spaces between mass transit stations and buildings aligns with the selected answer. This evaluation explicitly relates to factors within the physical environment addressing blind corners and travel obstacles. The rating scale spans from 5 (highest) to 1 (lowest).

In evaluating the security factor, a criterion addresses the necessity for security equipment for users in transitional spaces between mass transit stations and buildings. The findings from the inquiry indicate that, within Type 2 areas, the sample groups have articulated a demand for screening and surveillance at entrances and exits. In particular, safety equipment, notably closed-circuit television (CCTV) (Mean = 4.09) is required, in comparison to Type 1 areas (Mean = 4.02). Moreover, a need for screening and surveillance at entrances and exits is identified, incorporating safety equipment like access control equipment and dangerous object detection. Type 2 areas (Mean = 3.83) demonstrate a slightly elevated need compared to Type 1 areas (Mean = 3.82) for equipment, systems, or technology to report incidents in situations of insecurity. Furthermore, Type 2 areas (Mean = 3.59) manifest a slightly greater need than Type 1 areas (Mean = 3.55) for proactive screening and surveillance at entrances and exits with stationed security guards. Additionally, Type 2 areas (Mean = 3.84) surpass Type 1 areas (Mean = 3.81) in demand for proactive screening and surveillance at entrances and exits involving patrolling security personnel. Notably, the need in Type 1 areas (Mean = 3.65) is marginally higher than that in Type 2 areas (Mean = 3.62).

Furthermore, it has been established that, within the security factor, there is a demand for security equipment in transitional spaces between mass transit stations and buildings. In both types of areas, no statistical differences were observed at a significance level of 0.05 for all five criteria. There is a demand for screening and surveillance at entrances and exits with safety equipment, closed-circuit cameras (CCTV) (t = -0.739, p = 0.461), as well as a demand for screening and surveillance at entrances and exits with safety equipment, such as access control equipment and hazardous object capture (t = -0.167, p = 0.867). Additionally, equipment, systems, or technology are needed to report incidents in situations of insecurity (t = -0.338, p = 0.736). Moreover, proactive screening and surveillance at entrances and exits with security guards stationed (t = -0.338, p = 0.735), and aggressive screening and surveillance at entrances and exits with security guard patrolling (t = 0.227, p = 0.821) are required, as shown in Table 3.

Table 3: The Results of Needs for Security Factors, Equipment and Security Guard for Users of Transitional Spaces Between Mass Transit Stations and Buildings due to Blind Corners and Obstacles to Travel.

No.	Factors	Type of Area				t	p
		Type 1		Type 2			
		Mean	S.D.	Mean	S.D.		
1	Screening and surveillance at entrances and exits with safety equipment, especially closed-circuit cameras (CCTV) are required.	4.02	0.830	4.09	0.905	-0.739	0.461
2	Screening and surveillance at entrances and exits, employing safety equipment, such as access control and detecting hazardous objects are required.	3.82	0.916	3.83	1.001	-0.167	0.867
3	Equipment, systems, or technology dedicated to reporting incidents in situations of insecurity are required	3.55	0.907	3.59	0.990	-0.338	0.736
4	Proactive screening and surveillance at entrances and exits with stationed security guards are required.	3.81	0.939	3.84	0.957	-0.338	0.735
5	Proactive screening and surveillance at entrances and exits with patrolling security guards are required.	3.65	0.916	3.62	0.968	0.227	0.821

Notes: *Significant at p, 0.05, The level of options for response is the demand for equipment and security guards, ranging from 5 (highest) to 1 (lowest).

Conclusion

The study on physical environment factors and security management in transitional spaces between mass transit stations and buildings highlights the importance of establishing and maintaining safety in these spaces to ensure optimal visibility along the travel route. The assessment of the physical environment factor of transitional spaces related to blind corners and travel obstacles (six criteria). The results demonstrated that as the walkway approaches obscured areas, it progressively narrows, reducing visibility. Consequently, areas with dead zones and obstacles to travel are categorized based on the width of the walkway. Two distinct types emerge. Type 1: areas where the width of the walkway in the dead zone and obstacles to travel is less than 2.00 meters, and Type 2: areas where the width of the walkway, dead zones, and obstacles to travel is 2.00 meters or more.

Subsequently, 10 areas with identified issues within the CEN-Siam Station connected to E1-Chit Lom Station were selected based on specified criteria. These criteria were utilized to refine the wording of the questions, ensuring their suitability for the questionnaire administered to the sample group. Despite these adjustments, the questionnaire likely covers the same factors as the initial evaluation criteria. Factors related to the physical environment, precisely blind corners and travel obstacles (four criteria), were examined. The results from the sample questionnaire revealed that Type 2 areas are safer than Type 1 areas across all four criteria. This confirmation suggests that sufficient width in areas with obstructions and obstacles can alleviate problems and dangers associated with such impediments.

Furthermore, in this investigation, security management factors were introduced, encompassing requirements for equipment and security personnel (five criteria). The findings indicated no significant differences across all five criteria between the two types of areas. This implies that irrespective of the width of the walkway or the presence of obscured spots and travel obstacles, equipment and security personnel are consistently needed. This underscores commuters' considerable attention to security management in their travel connections.

The assessment results of the physical environment regarding blind corners and travel obstacles revealed a moderate to high level of perceived safety when investigating problematic areas and consulting with users. However, safety diminishes in areas where walkways have dead zones and obstacles less than 2 meters, as indicated by the specified criteria for obscured points and obstacles to travel. Additionally, determining the width of the walkway is crucial for enhancing overall visibility during the journey.

Throughout the survey, it was observed that most obscured transitional spaces are part of the electric train track structure. Consequently, recommendations for addressing issues related to obscured points and travel obstacles were proposed in the two following solutions:

The Physical Solution deals with systematically resolving issues within the physical environment, aiming to fulfil requirements precisely. Nonetheless, implementing this solution will likely demand a substantial investment of time and financial resources, with no assurance of entirely mitigating the inherent physical characteristics of dead spots and obstacles to travel. In particular, in the context of transitional spaces between mass transit stations and buildings under investigation in this research, the unalterable nature of chokepoints and travel obstacles was dictated by structural stability and spatial limitations. To address physical challenges, three guiding principles were recommended:

1. Facilitating travellers in anticipating blind corners before covering a substantial distance, employing measures, such as heightened illumination, installation of mirrors to enhance visibility into blind spots from a distance, and strategic placement of early warning signs.
2. Establishing boundaries to dissuade travellers from approaching dead zones and obstacles to travel, potentially involving restricting access to surrounding areas or creating confined spaces.
3. Designating pedestrian routes with discernible navigation symbols to prevent collisions among individuals proactively.
4. The Management Solution is deployed when the physical problem cannot be resolved due to various limitations. It functions as a complementary approach to tackle the problem, encompassing the following strategies:
5. Provision of security guards stationed at transition spaces, boarding and disembarking points in public areas, and security officers patrolling the transitional spaces. This involves an intensified screening process for individuals entering and exiting those spaces.
6. Installation of additional CCTV cameras in areas identified as dead zones and obstacles to travel.
7. Addressing areas where the size of the entrance walkway changes, leading to smaller spaces. This may

result in the concentration and crowding of passengers, especially during peak hours in the morning and evening. Therefore, managing passenger traffic in an organized manner becomes crucial.

8. Management of commuter movement during periods of organized activities in broad areas within transitional spaces, in addition to regular times.
9. The most effective approach to overcoming the issue of dead spots and travel obstacles is to start comprehensive efforts during the project planning and design phases. This proactive methodology is critical to ensuring the authentic safety of transitional spaces and protecting them from potential hazards. Moreover, these guiding principles are transferable and can be applied to areas with obscured spots and travel obstacles with similar local conditions.

Limitations and Further Research Avenues

The current study has some limitations that need to be addressed in future research. Firstly, the study focuses only on exploring the transitional spaces between mass transit stations and buildings, mainly highlighting spaces that are densely populated and have various uses. However, there is a research gap concerning areas with less dense traffic, which may also pose safety risks. The study concentrates on the impact of heavy and light traffic areas on different physical and security environments, particularly in transitional spaces between mass transit stations and buildings. It is notable that different modes of mass transit systems, such as buses, subways, and airplanes have different physical and security environments. Therefore, travelling between these transit systems and different areas have distinct implications for safety and security. In conclusion, improving safety in transitional spaces can increase public transportation usage, which ultimately contributes to resolving the traffic congestion problem.

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