Journal for Developing the Social and Community, 12 (1), 275-300 : January-April 2025
(สถาบันวิจัยและพัฒนา มหาวิทยาลัยราชภัฏมหาสารคาม)

Urban Rail Transit Safety Assessment: The Case of Railway Passenger in Bangkok

Oranicha Buthphorm

Burapha University

E-mail: oranicha@buu.ac.th

Received	Reviewed	Revised	Accepted
19/11/2024	05/01/2025	23/01/2025	11/02/2025

Abstract

Background and Aim: This study explore passenger perceptions of safety within Bangkok's urban rail networks, emphasizing safety operations and management. The research aims to identify areas of strength and weakness in the system to provide actionable recommendations for improvement.

Material and Methods: Data were collected from 394 respondents using a survey-based methodology. The survey assessed various safety dimensions, including operational safety, station facilities, security measures, and services for disabled passengers.

Results: The findings reveal high satisfaction levels for operational safety, particularly in signals, signage, and safety equipment, reflecting a strong commitment to passenger protection. However, moderate ratings were noted for station facilities, security measures, and services for disabled passengers, indicating significant areas for enhancement.

Conclusion: This study evaluated passenger perceptions of safety in Bangkok's urban rail transit system across six key dimensions: station facilities, signals, signage, safety equipment, security, and accessibility for disabled passengers. While operational safety, such as signals (4.45) and signage (4.26), received high satisfaction ratings, moderate scores for station facilities (3.53), security measures (3.54), and accessibility services (3.49) reveal significant areas needing improvement. Notably, low ratings for some attributes such as platform safety features (2.96), luggage checks (2.79), and disabled-friendly restrooms (2.36) indicate critical gaps in safety, security, and inclusivity. Addressing these deficiencies through enhancements in infrastructure, such as ADA-compliant facilities,

better lighting, and upgraded security systems, is essential for ensuring a safer and more inclusive urban rail system. These findings provide actionable insights for policymakers and rail operators to align urban rail safety improvements with international best practices, fostering sustainable urban development and boosting passenger trust and ridership.

Keywords: Urban Rail Safety; Passenger Perception; Accessibility for Disabled Passengers; Station Facility Improvement; Security Measures in Public Transit

Introduction

Urban rail systems are crucial components of modern urban transit, offering eco-friendly solutions to pollution, traffic, and road safety issues while also supporting urban economies (Ferreira et al., 2021; Ibrahim et al., 2022). Light rail transit (LRT) is a crucial system for achieving sustainable transportation. Nonetheless, due to its impact on public safety, operational reliability, and urban sustainability, ensuring the safety of urban rail systems remains a critical issue. While urban rail safety is important, it's also crucial to assess the overall impact of urban traffic safety, as mistakes in one sector may raise dangers in others. Dealing with these linked safety issues could result in a broader strategy for managing urban transit security. Effective safety management techniques must find a balance between strict safety regulations and operational efficiency to avoid service interruptions and maintain high user satisfaction. Passenger perceptions of safety significantly affect ridership and public confidence, influencing the social and economic structure of urban areas.

In global assessments of city train systems, factors such as ticketing, communication, architecture, and safety that are linked to user experience have been found; safety is often rated lower on user satisfaction surveys (Taecharungroj, 2022). Creating a balance between robust safety measures and a welcoming environment is necessary to build public trust and increase ridership. Urban rail safety is essential for the efficient functioning of major cities globally, as it directly affects public safety, urban transportation, and infrastructure stability. Understanding the importance of urban rail safety involves various elements such as evaluating risks, improving safety systems with advanced technology, and analyzing operating data statistically.

Urban rail safety is crucial due to the rapid urbanization and increasing dependence on rail transit in Bangkok, Thailand. Ensuring safety not only builds public trust in the urban rail system but also safeguards passengers. Safety issues related to urban train systems in Bangkok stem from environmental conditions, infrastructure reliability, and passenger attitudes. Despite immediate concerns, ongoing improvements to infrastructure and public health initiatives are expected to enhance safety perceptions and attract more users in the future. This study aims to investigate how passengers view safety in Bangkok's urban rail networks to identify strengths, weaknesses, and guide improvements for overall user satisfaction in urban rail safety management.

Urban rail systems are critical to modern urban transit, providing eco-friendly solutions to pollution and traffic congestion while supporting economic growth. Despite their benefits, ensuring passenger safety remains a significant challenge due to the complexity of safety management and operational risks. In Bangkok, rapid urbanization has increased reliance on rail transit, highlighting the importance of addressing safety concerns stemming from infrastructure reliability, environmental conditions, and passenger perceptions.

Research Objectives

1. To assess the passenger perceptions' level of safety of urban rail in Bangkok
2. To identify strength and weakness in safety operation and management within urban rail system, focusing on critical factors influencing passenger satisfaction and confidence.

Literature Review

By growing public transportation networks that put passenger safety and accessibility first, SDG 11 highlights access to safe, economical, and sustainable transportation systems (United Nations Development Programme, 2016). Considering operational mishaps are becoming more complex and frequent, urban train safety is a serious concern. Numerous approaches and frameworks have been highlighted in recent research with the goal of improving risk assessment and safety management in urban rail

networks. This objective is directly met by Urban Rail Transit (URT) systems, which provide a more environmentally friendly substitute for road-based transportation and make a substantial contribution to sustainable urban expansion. Safety quality in URT is assessed through standardized frameworks like the Rail Safety Quality Index (RSQI), which evaluates parameters such as incident response time, equipment maintenance standards, and operational readiness, factors essential for passenger assurance and efficient urban planning (Chai et al., 2022). Perceived safety levels in URT systems have a major impact on passenger happiness, and features like conspicuous signage, well-kept facilities, and dependable staff support enhance both perceived and real safety (Ibrahim et al., 2022). As cities grow and depend more on public transportation for everyday movement, the perception of quality of safety in urban rail systems has emerged as a crucial research topic. Passenger, management, equipment, environment, and disaster are some of the indices that assess URT operational safety (Chai et al., 2022). A two-pronged approach is needed to assess safety in URT systems, considering both subjective passenger perceptions of safety in high-density environments and objective operational criteria such as equipment reliability and emergency procedures (Wu et al., 2020).

In addition to structural and equipment-based safety measures, the focus on urban rail safety has recently broadened to encompass accessibility and inclusivity of train services. Crowds and safety are the least desirable elements of traveler experiences, per recent research of 127 urban rail transport networks globally (Taecharungroj, 2022). To increase station platform safety, automated announcements, visual alerts, and platform barriers have been the subject of international research. Particularly at congested stations, these technologies lower accident rates, enhance communication, and control platform crowding (Global Railway Review, 2023).

Inclusivity features like tactile guiding systems and accessible ramps are not only crucial for compliance with legal accessibility requirements but also play a significant role in minimizing safety risks, enhancing safe navigation for disabled passengers (JR-East, 2023). Rail systems in the US, Europe, and Japan have implemented a variety of support services for passengers with disabilities, including advanced ramps, tactile guiding systems, and dedicated staff. Effectively controlling pedestrian flows at train stations is becoming increasingly difficult as rail transit grows in popularity and efficiency. To

guarantee passenger comfort and safety, integrated technological solutions are required (Cornet et al., 2019). URT safety relies heavily on real-time monitoring technologies, like AI-enabled crowd control systems and CCTV cameras. Through the prevention of crowding and the maintenance of safety protocols during peak hours, these tools improve station safety and provide quick reaction capabilities (Sundling & Ceccato, 2022). This includes station architecture and platform design, information displays and directional signage, CCTV cameras, and even station employees and security guards (Padovano et al., 2024).

The efficiency and smoothness of passengers' journeys are directly impacted by the guide signs in rail transport stations. The station system, which can effectively guide passengers' walking routes, cut down on their walking time, provide efficient traffic guidance within the station, and greatly facilitate passengers' travel, is influenced by the sensible arrangement of guidance signs. Passengers can find the optimal ride and transfer routes more quickly and safely in a particular underground space environment thanks to the rail transit guidance sign, a type of public facility identification symbol with orientation and guidance (Ouyang et al., 2021). As the Beijing Metro system demonstrates, efficient signage is essential for preserving passenger flow and reducing accidents in congested stations, particularly when it incorporates universal symbols and multilingual possibilities (Jing & Bai, 2017). In the metro environment, well-designed guiding signage is crucial because it guarantees that travelers may get to their destination fast and stress-free (Hu et al., 2022). The universal design of wayfinding signage has become a crucial component in improving accessibility for aging populations as urban rail transit systems play a bigger role in city dwellers' everyday mobility (Kong et al., 2024).

Mobility requires a sense of security when using public transportation, and fear of crime might cause more problems for an individual than actual crime (Sundling & Ceccato, 2022). Railway operators have put in place a number of stringent rules and preventive measures that railway employees are taught to adhere to in order to guarantee the safety of both passengers and employees on urban rail networks, particularly against threats like firearms, explosives, and other weapons (Luxton and Marinov, 2020). This strategy aims to give employees a safe working environment while empowering them to properly address possible dangers.

In order to guarantee accessibility and comfort for all users, support facilities and assistive equipment for disabled passengers in urban rail stations have gained importance in recent years. This emphasis is in line with both the law and the changing demands of passengers for inclusive transportation systems. For those with disabilities and limited mobility, accessible city space, infrastructure, and public transportation enhance inclusivity and quality of life (Warchoł-Jakubowska et al., 2024). Examples of accessible amenities that improve the security, comfort, and autonomy of passengers with disabilities include designated waiting areas for passengers with disabilities, accessible restrooms and toilets (Lianto et al., 2021), and visual and audio signage for passengers with disabilities.

The extensive strategy needed to improve the perception of safety quality in urban rail systems is highlighted in this assessment of the research. According to studies, creating a safe environment that reassures passengers is mostly dependent on the physical infrastructure, which includes safety devices, signaling systems, and station architecture. In order to successfully manage safety risks and minimize accidents, modern stations must have characteristics including emergency response equipment, barrier-free platforms, and clear signs (Global Railway Review, 2023). Weapon detection systems and frequent safety drills are among the security measures that URT operators use to address perceived and real crime dangers. These measures increase passengers' perception of security and system trust (U.S.DOT, 2023). By encouraging autonomous travel for passengers with disabilities and avoiding crowding in specified places, accessible infrastructure—such as tactile pathways and priority seating—directly contributes to a safer transit environment. Passengers' opinions about the general safety of train services are improved by such actions, which also lessen the likelihood of accidents. Dedicated waiting areas, accessible restrooms, and tactile guide devices are examples of inclusive accessibility measures that further demonstrate a growing dedication to providing equitable service to all passenger groups. These amenities foster trust and encourage a more inclusive urban transit experience by guaranteeing that disabled passengers may independently navigate and use the train system (United Nations Development Programme, 2010).

In summary, improving the perception of safety quality in urban rail systems necessitates a thorough integration of accessible services, staff readiness, and infrastructure. In order to maintain a safe and inclusive urban rail system, this analysis emphasizes the significance of ongoing investments in both human and physical resources. An integrated strategy comprising knowledgeable staff and strong infrastructure is necessary to guarantee continued safety, boost passenger confidence, and support sustainable urban expansion in places like Bangkok, where urban rail transportation is crucial to public mobility.

Conceptual Framework

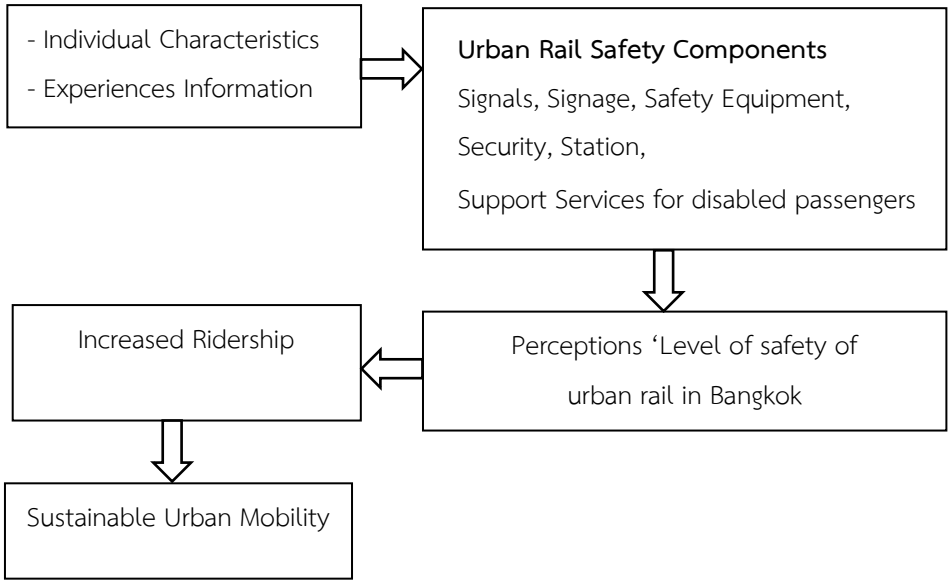

Figure 1 Research Conceptual Framework

Methodology

Research Tool

The nature of this study is descriptive. Descriptive research uses questionnaires to directly obtain original data from respondents. By using the survey method to distribute questionnaires, the primary data was gathered. Additionally, a cross-sectional

study using a quantitative technique was conducted from November to December 2023. The questionnaire was meticulously created after taking into account all the study's aspects. On the other hand, secondary data was gathered from a variety of scholarly sources, including reports, websites, research articles, and academic articles. Cronbach's alpha coefficient (Cronbach, 1951) was used as a reliability research tool. Its computed value was higher than 0.70, or 0.98, and had a discriminatory power value between 0.40 and 0.9. According to Ferguson (1981), a discriminatory power value of 0.20 or above is deemed adequate. A summary of safety perceptions is given by the descriptive design. Cronbach's alpha coefficient (Cronbach, 1951) was used as a reliability research tool. Its computed value was higher than 0.70, or 0.98, and had a discriminatory power value between 0.40 and 0.9. According to Ferguson (1981), a discriminatory power value of 0.20 or above is deemed adequate. Bangkok was the study area.

Population and Sample

The target population comprised passengers using urban rail systems in Bangkok, including BTS, MRT, and ARL services. With an anticipated 5,494,932 residents in 2023, it is the most developed city in the state (Ministry of Interior, 2023). The sample size was determined using Krejcie and Morgan's (1970) formula, yielding a required sample of 384 respondents at a 95% confidence level. A total of 394 valid responses were collected for this study.

Data Collection

Data were collected through a cross-sectional survey conducted between November and December 2023. The questionnaires were distributed both online and at rail stations during peak and off-peak hours to ensure diverse representation of passenger experiences. There are three sections in the questionnaire set. The first was the participants' demographic data, passenger safety perception questions, disabled passengers, equipment, signages, signals, and train stations. Every response was guaranteed privacy and secrecy.

Data Analysis

The collected data were analyzed using descriptive. Descriptive statistics, including mean, standard deviation, and percentage, were used to summarize passenger perceptions of safety.

Results

The study surveyed 394 urban rail passengers in Bangkok, Table 1 shows that most respondents are female (61.3%) and are dominant in the age group of 21–25 years (36.0%), and 26–30 years (20.7%). Following occupational, the student/pupil and the work at work are similar for both occupational (36.7%). Lastly, participants mainly have an income level of 15,000–25,000 Baht per month (46.7%) followed by below 15,000 baht per month (37.3%), and 25,001–35,000 baht/month (15.3%), and above 35,000 baht/month (0.7%).

Table 1: The Demographic Data of participants in percentage

Demographic Information		Percentage
Gender	Male	38.7
	Female	61.3
Age	Below 20 years	13.3
	21-25 year	36.0
	26-30 year	20.7
	31-40 year	15.3
	Above 40 years	14.7
Occupational	Student/pupil	36.7
	Private company	36.7
	Government or private agency	6.7
	General Employment	8.7
	Self employ	11.3
Income	Below 15,000 baht/month	37.3
	15,000-25,000 baht/month	46.7
	25001-35,000 baht/month	15.3
	Above 35,000 baht/month	0.7

Table 2 illustrates the distribution of usage among the three urban rail types (BTS, MRT, ARL) is evenly split, with each accounting equal (33.3%) of the users. Next, the time

of usage, the majority of rail users (50.7%), utilize the system between 06.00 -11.59 hours, indicating high demand during the morning hours, likely for work or school commutes. The percentage of URT users, 25.3%, use URT in the evening, from 18.00 – 24.00 hours, which may include leisure or return trips from work, while 24.0% use URT during 12.00 – 17.59 hours, representing midday and afternoon travel. The frequency of URT' usage. The frequency of URT usage shows a declining trend as the number of trips increases. The passengers' usage frequency, the most is 1-2/week, 3-4/week, 5-6/week and more than 6 times/week, with 34.7%, 27.3%, 21.3%, and 16.7%, respectively. Most users ride less than 3 times per week, though a smaller core of frequent users suggests that URT is essential for daily mobility for some. This insight could help in planning for demand management, optimizing service schedules, and addressing peak-hour capacity issues.

Table 2: The passenger experience data of participants

Experiences information		Percentage
Urban Rail types	BTS	33.3
	MRT	33.3
	ARL	33.3
The time usages	06.00 - 11.59 hours	50.7
	12.00 - 17.59 hours	24.0
	18.00 - 24.00 hours	25.3
Frequency	1 - 2 times/week	34.7
	3 - 4 times/week	27.3
	5 - 6 times/week	21.3
	More than 6 times/week	16.7
	Total	100

Objective 1: To assess the passenger perceptions' level of safety of urban rail in Bangkok

In order to address the study's goals, an assessment of passenger safety perception of Bangkok's urban rail system and its environs was assessed. The researcher presents the following Table 3 through Table 8 with the safety level measures with the

station, signals, signages, equipment, security, and support device for passengers with disabilities.

Table 3 shows the summary of railway station attributes. It has a high rating at 3.53, with cleanliness and ambiance rated highly (4.34 and 4.13), with users generally perceiving stations to be well maintained, clean, and comfortable. Following space adequacy and safety features, however, receive moderate ratings, at 3.48 and 2.96, respectively. The service availability is another area of moderate satisfaction, with a lower rating of 2.70.

Table 3: Mean, standard deviation (S.D.), and level of safety of urban rail service at railways stations.

Railways station	$\overline{x}$	S.D.	Perceptions 'Level
Cleanliness; the building is airy, clean, and tidy.	4.37	0.71	High
Sufficient space for using the service	3.48	1.07	Moderate
The station has platform screen doors to prevent passengers from falling off the tracks.	2.96	1.65	Moderate
There are service points to provide advice and sufficient information.	2.70	1.37	Moderate
The ambience, such as the interior of the station and buildings, has appropriate lighting and temperature.	4.13	0.73	High
Total	3.53		High

Table 4 for railway signals reveals that the automatic warning and emergency announcement systems have a lower rating of 4.15, while the announcement prior to train movement and obstacle detection at train doors have a very high rating of 4.6. However, railway signals have a good overall safety rating of 4.45.

Table 4: Mean, standard deviation (S.D.), and level of safety and trust of urban rail service of railway signals.

Railway signals	$\bar{x}$	S.D.	Perceptions 'Level
There are always announcements before the train enters and leaves the station.	4.60	0.60	Very High
There is an automatic warning system and an emergency announcement system.	4.15	0.76	High
The train doors have an obstacle detection system to prevent passengers from getting stuck between the doors.	4.60	0.66	Very High
Total	4.45		High

The railway signages in Table 5 have a very high rating of 4.53 for sign and direction clarity, a high rating of 4.17 for service instructions and warning signs, and a high rating of 4.09 for emergency equipment symbols and prohibitions. Then, a high rating of 4.26 for overall safety of signs.

Table 5: Mean, standard deviation (S.D.), and level of safety and trust of urban rail service of railway signages.

Railway Signages	$\bar{x}$	S.D.	Perceptions 'Level
The signs and directions are clear.	4.53	0.61	Very High
There are signs with instructions for using the service or warnings as a common guideline.	4.17	0.86	High
There are clear symbols, signs, prohibitions, and instructions for using emergency equipment.	4.09	0.86	High
Total	4.26		High

Table 6: Mean, standard deviation (S.D.), and level of safety and trust of urban rail service of railway safety equipment.

Railway Safety Equipment	$\bar{x}$	S.D.	Perceptions 'Level
In case of emergency, there is a lever inside the train to open the passenger door.	4.17	0.70	High
CCTV cameras have been installed covering the station area.	4.53	0.62	Very High
Emergency stop buttons have been installed on the trains.	3.75	0.88	High
Fire prevention and suppression equipment has been installed covering the station area.	4.17	0.70	High
There is a communication device with the train controller to report emergencies on the train.	4.10	0.82	High
Total	4.14		High

Data on railway safety equipment is shown in Table 6 as follows: passengers give Bangkok's urban rail system's safety equipment a high rating of 4.14 overall, demonstrating their strong belief in its efficacy. The highest grade (4.53) went to CCTV cameras, indicating how crucial they are to maintaining station security. Other types of equipment, such as communication devices, fire prevention systems, and emergency levers, received consistently high scores (4.10–4.17), emphasizing their importance in disaster preparedness. However, train emergency stops buttons received a little lower grade (3.75), indicating that this section could use some work. All things considered; the results show that the safety features of the system offer a strong basis for passenger safety while offering potential for improvement.

Railway security is covered in Table 7, which reveals that while the availability of security guards for enabling is assessed as high (4.29), the luggage checks for weapons and explosives are rated as modest (2.79). The final grade of 3.54 is still quite high.

Table 7: Mean, standard deviation (S.D.), and level of safety and trust of urban rail service of railway security.

Railway security	$\bar{x}$	S.D.	Perceptions 'Level
Security guards at the station are always ready to assist and provide assistance.	4.29	0.70	High
Officers strictly check the luggage of passengers to prevent violence such as guns, bombs or other weapons.	2.79	1.31	Moderate
Total	3.54		High

According to Table 8, the seats reserved for passengers with disabilities have the highest rating (4.20). After that, elevators with braille or voice assistance receive a high rating of 4.02, while elevators with mobility issues receive a high score of 3.77. Given the low rating of 2.36 for the handicapped passenger restrooms and a fair rating of 3.11 for the special waiting space, the overall rating of 3.49 for the services provided to disabled passengers at railway stations is considered moderate.

Table 8: Mean, standard deviation (S.D.), and level of safety and trust of urban rail service of support services for disabled passengers.

Services for disabled passengers	$\bar{x}$	S.D.	Perceptions 'Level
There is an elevator inside the station for people with leg or walking disabilities.	3.77	0.86	High
Inside the station there is a special waiting area for people with disabilities.	3.11	1.06	Moderate
There are toilets specifically for the disabled within the station.	2.36	1.33	Low
Inside the station, there are seats specifically for people with disabilities.	4.20	0.83	High

Services for disabled passengers	$\overline{x}$	S.D.	Perceptions 'Level
Inside the elevator there is Braille, or speech, for the visually impaired.	4.02	0.87	High
Total	3.49		Moderate

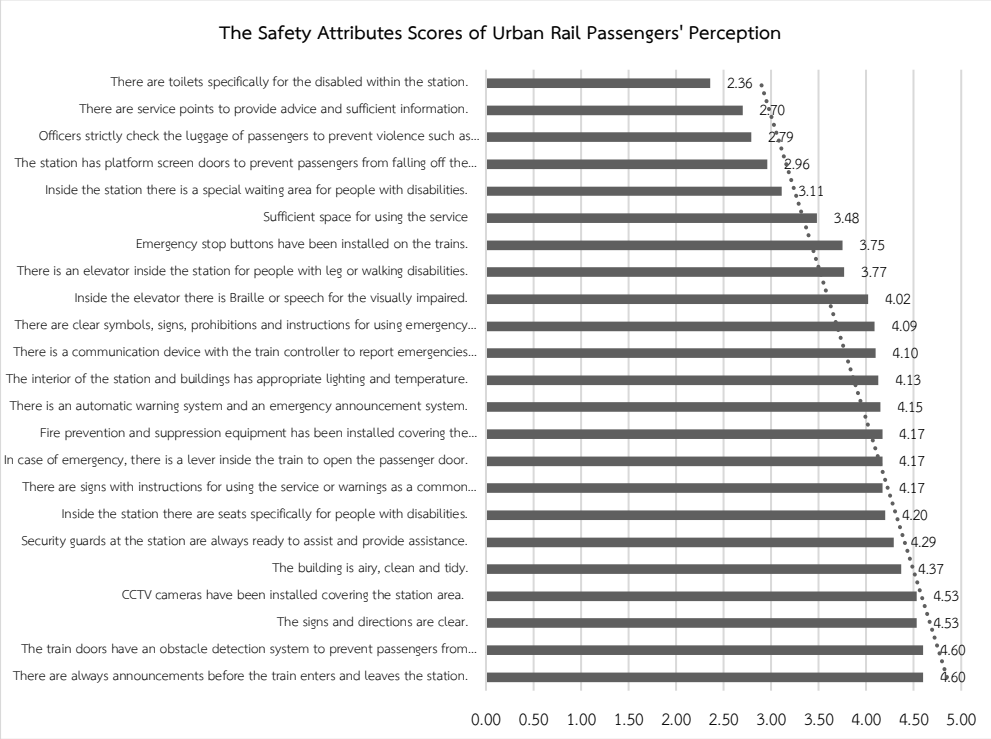

Figure 2 The Safety Attributes Scores of Urban Rail Passengers' Perception

Objective 2: To identify strength and weakness in safety operation and management within urban rail system, focusing on critical factors influencing passenger satisfaction and confidence.

The figure 2 presented various of the urban rail transportation system's strength, especially with regard to safety and passenger communication. In addition to using cutting-edge door detection technology to avoid passenger entrapment, the system is excellent at providing timely notifications prior to trains arriving and departing (4.60).

Passengers also feel more guided and secure overall because of the thorough CCTV surveillance of station areas (4.53) and the obvious signage and directions (4.53). Additionally, the spotless and well-ventilated station amenities (4.37) point to an emphasis on the experience and comfort of passengers. These qualities show a strong dedication to educating, protecting, and meeting the requirements of users of the transit system. In contrast, the information also highlights various attributes of possible areas for enhancing the accessibility and security characteristics of the urban rail transit system.

While, the urban rail system in Bangkok reveals several weaknesses in safety operation and management that impact passenger satisfaction and confidence. Insufficient space, poor platform safety features (2.96), and a lack of service points (2.70) were identified as important shortcomings in the station facilities, which got moderate scores (3.53). Low satisfaction with luggage checks (2.79), which undermines passenger faith in crime prevention, was one of the security measures' concerning features. These characteristics obtain relatively low scores, suggesting that greater accessibility measures are needed, even if the system offers certain accommodations for passengers with disabilities, such as a separate waiting place (3.11) and restrooms for individuals with disabilities (2.36) (Figure 2).

Figure 3 The Safety Attributes Scores of Urban Rail Passengers' Perception

In urban rail networks, inclusivity and operational effectiveness have significant effects on passengers' perceptions of safety in additional to infrastructure quality. In order to ensure that all users, including those with disabilities, can comfortably and freely traverse public transportation networks, accessibilities are essential to building trust and advancing equity. Passenger trust as well as satisfaction may be greatly increased by combining global best practices with locally developed solutions that are suited to the particular requirements of Bangkok's urban rail users. This will help create a transit environment that is safer, more inclusive, and more effective (Figure 3).

Discussion

The safety signals attribute received the highest score of all the initial signals, with a high rating of 4.45, indicating a "high" level of passenger satisfaction. Well-maintained signals that effectively meet safety requirements, as shown by this score, enhance the overall operational safety of the railway system. Clear and consistent signaling ensures efficient train management and reduces the risk of accidents. Rules regarding the Centralized Traffic Control system regulate the signaling system for trains

to safely operate by following the standards of the Department of Rail Transport (Department of Rail Transport, 2023). The State Railway of Thailand uses a Fixed Blocked train control system for operating its trains, specifically designed for Thailand. Various colored electric trains utilize different train control systems, with red trains using ETCS, and high-speed trains of the State Railway of Thailand use GSM-R (Noranarttakun, 2022).

The good rating implies that travelers believe the signaling systems are dependable, which may be the result of regular maintenance and updates. To guarantee that signal systems stay at the forefront of safety requirements, however, frequent evaluations and technological advancements should continue (Abedsoltan et al., 2024).

The mean score for signage was 4.26, which is considered "high." For newcomers and non-native speakers who depend on signs to navigate stations, effective signage is essential for passenger orientation (Chang et al., 2018). The high ranking suggests that the signs are easy to see, clear, and visible. Regular audits should be carried out to make sure that signs are updated to reflect any changes in station layouts or service information, and that they are still readable and visible in all lighting circumstances, in order to preserve and further enhance this area.

The safety equipment category scored 4.14, also classified as "high." This includes features such as emergency stop buttons, fire suppression equipment, and emergency communication devices. The high rating underscores that passengers feel secure due to the presence of these safety features. Both analogue and CCTV cameras enable railway stations to identify places such as tunnels, escalators, and platforms. However, the system's essential component is the human behind the screens, which raises the possibility of human error. In actuality, though, more cameras in these locations result in a loss of the monitors' capacity to provide a real-time overview of occurrences. In actuality, CCTV serves mostly as evidence in accidents; as such, the method relies more on previous event records than on real-time event detection (Alawad et al., 2020). Enhancing training programs for staff to assist passengers in emergencies could also boost confidence in safety protocols (Padovano et al., 2024).

Passenger security in urban rail systems plays a pivotal role in shaping safety perceptions. A high satisfaction score of 3.54 highlights passenger appreciation while indicating room for improvement. Security measures, such as luggage checks and visible

security personnel, effectively enhance safety confidence. In order to fulfill the responsibility of examining safety, BTS Skytrain designates officers to do operational system inspections in order to carry out the duty of assessing the safety of the Skytrain system and preventing, addressing, and eliminating any threats that could jeopardize it. However, please alert the personnel right once if a passenger comes across any questionable individuals or objects (BTS, n.d.). Examples from the London Underground show that the main causes of anxiety were discovered to be overcrowding, loud noises, traveling late at night, and observing the antisocial behavior of other passengers, considering the degree of concern about anticipated future risks pertaining to adverse situations where passengers' safety needs may become visible (Kim & Gustafson-Pearce, 2016). Strandh analyzed attacks on rail-bound traffic in general from 1970 to 2013, and of the 1,122 attacks that have since been found, 22% have been specifically targeted at stations, for a total of approximately 200 attacks worldwide (Strandh 2017). Terminal stations are unfortunately not distinguished from other targets by the additional data provided by experts who solely concentrate on vehicle bomb attacks against transportation infrastructure (Shvetsov et al. 2019).

The rail station facilities scored an average of 3.53, also classified as high. This category encompasses general station amenities and conditions, which are critical to the passenger experience. The moderate rating may indicate that stations lack essential amenities or that their cleanliness and maintenance need improvement. To enhance this area, it is recommended to conduct regular facility inspections and focus on improving passenger comfort, such as by adding seating, lighting, and climate control features. Strategically located service desks staffed with multilingual personnel and equipped with digital information systems have been shown to significantly increase. To make the transportation system safer for everyone and moving closer to a future free of catastrophic injuries and fatalities related to transportation, DOT will offer language support services to individuals with limited English proficiency (LEP) (U.S.DOT, 2023). Preventing passengers from accessing the tracks is crucial for contemporary urban railroad transit. The "safety first" philosophy required that the platform be kept apart from the train lines as a precaution for the passengers' safety. As a result, many train stations across the world have barrier (screen) security systems installed. However,

stringent rules are also in place to ensure the passengers' comfort. On-time trains and seamless passenger exchange at stops should be features of automated transportation (Tomov and Dimitrova, 2024).

The moderately satisfactory rating of 3.49 for support services for disabled passengers in urban train systems indicates that there is still much need for improvement in accessibility measures. According to this score, there is a need for improved amenities, including elevators, designated waiting places, and accessible restrooms. Additionally, staff members should receive training on how to help customers with disabilities. Thus, it includes Glinsukon's (2018) study on the needs of disabled passengers in Bangkok's public rail accessibility services, which concluded that the relevant agencies should address the issue of having staff members who can communicate with the deaf and blind using Braille or sign language. Everyone should be able to utilize the ticket booths, ticket storage, and money exchange with ease, and there should be large, conspicuous signs for the disabled. Although the decision to enact disability legislation to ensure public agencies and businesses provide equal access to all individuals rests with each province, most do not have such legislation. This is because there is no federal disability act with enforceable physical access standards, such as the Americans with Disabilities Act of 1990 (ADA) in the United States (Whaley et al., 2024).

Conclusion

This study evaluated passenger perceptions of safety in Bangkok's urban rail systems, analyzing six dimensions: stations, signals, signage, safety equipment, security, and services for disabled passengers. Overall, passenger satisfaction with the service was high, particularly in critical areas such as railway signals, signage, and safety equipment. The urban rail system demonstrates strong operational safety, with high ratings for signals, signage, and safety equipment, showcasing its foundational commitment to passenger safety. However, moderate scores for security, station facilities, and support services for disabled passengers highlight areas for improvement. Enhancing security through increased personnel presence during peak hours and advanced surveillance systems can mitigate risks and ensure passenger confidence. Regular maintenance audits of station facilities, along with improvements such as additional seating, better lighting,

and climate controls, could significantly increase passenger comfort and convenience. For disabled passengers, upgrading accessibility features, such as dedicated waiting areas, and providing ongoing staff training are critical steps toward fostering inclusivity and equity in public transit. Addressing these gaps aligns with best practices in urban rail management and emphasizes a balanced focus on safety, comfort, and accessibility to meet diverse passenger needs comprehensively. The highest scores were attributed to station announcements and door detection systems, emphasizing the rail system's strong focus on operational safety. However, services for disabled passengers, station facilities, and security measures exhibited lower scores, with the availability of disabled-accessible toilets, sufficient information centers, and violence prevention measures identified as key deficiencies.

The findings underscore the rail system's operational efficiency but highlight gaps in accessibility and inclusivity. Addressing these issues could significantly enhance the passenger experience, foster inclusivity, and boost ridership. The study recommends targeted improvements, such as increasing security personnel and integrating advanced surveillance systems, periodic maintenance and upgrades to station facilities, and implementing ADA-compliant infrastructure for disabled passengers. These measures align with international best practices and would improve the quality of urban transportation systems. Limitations of the study, including its reliance on passenger surveys and the lack of comparative analysis with other global systems, restrict the generalizability of the findings.

Implications

1. Policy Implications

Upgrading urban rail infrastructure should be a top priority for policymakers in order to comply with global safety and accessibility standards. Building passenger trust requires clear regulations that promote diversity, such as requiring ADA-compliant features, providing funding for infrastructure upgrades, and enforcing stronger security measures. To guarantee uniform safety and service quality over all rail networks, policies should also promote cooperation between public and private operators.

2. Practical Implications

By upgrading station amenities like lighting, seating, and climate control, rail operators can close gaps in passenger safety and comfort. Enhancing passenger confidence in security measures requires implementing cutting-edge surveillance systems, strengthening luggage checks, and making security officers more visible. In order to enhance service inclusivity, practical measures should also include providing accessible amenities for passengers with disabilities, such as audio-enabled and Braille elevators, ADA-compliant restrooms, and designated waiting areas, along with specific staff training.

3. Further Research

Future research should explore longitudinal studies to assess how passenger perceptions of safety evolve after implementing recommended improvements. Comparative studies between Bangkok's urban rail system and those in other cities or countries can provide valuable benchmarks for improving safety and accessibility. Additionally, further research could focus on emerging technologies, such as AI-enabled surveillance and predictive maintenance systems, to evaluate their potential in enhancing operational safety and efficiency.

Reference

Abedsoltan, H. & Abedsoltan, A. (2024). Future of process safety: Insights, approaches, and potential developments. *Process Safety and Environmental Protection*, *185*(2024), 684-7077. https://doi.org/10.1016/j.psep.2024.03.034

Alawad, H., Kaewunruen, S. & An, M. (2020). A deep learning approach towards railway safety risk assessment. *IEEE Access*, *8*, 102811-102832. https://doi.org/10.1109/ACCESS.2020.2997946

Chai, N., Zhou, W. & Hu, X. (2022). Safety evaluation of urban rail transit operation considering uncertainty and risk preference: A case study in China. *Transport Policy*, *125*, 267-288. https://doi.org/10.1016/j.tranpol.2022.05.002

Chang, X. Y., Ikeda, Y., Tsujimura, S. & Sakamoto, K. (2018). Examining the Provision of Railway Transit Information to Foreign Visitors in the Tokyo Metropolitan Area and

Strategies for Improvement. *Transportation Research Record*, *2672*(8), 546-556. https://doi.org/10.1177/0361198118790839

Cornet, S., Buisson, C., Ramond, F., Bouvarel, P. & Rodriguez, J. (2019). Methods for quantitative assessment of passenger flow influence on train dwell time in dense traffic areas. *Transportation Research Part C: Emerging Technologies*, *106*, 345-359. https://doi.org/10.1016/j.trc.2019.05.008

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of test. *Psychomerika, 16*(3), 297-334.

Department of Rail Transport. (2023). *Centralized Traffic Control Standard for Mainline Train. [Online].* https://www.shorturl.asia/Dn1a8

Ferreira, A. F., Leite, A. D., de Freitas Pereira, L., de Jesus Neves, J. M., de Oliveira Pinheiro, M. G. & Chang, S. J. (2021). Wheelchair accessibility of urban rail systems: Some preliminary findings of a global overview. *IATSS Research*, *45*(3), 326-335. https://doi.org/10.1016/j.iatssr.2021.01.003

Ferguson, G. A. (1981). *Statistical Analysis in Psychology and Education.* (5th ed). Tokyam Mc Graw – Hill Book Company.

Glinsukon, T. (2018). The disabled passengers' needs accessibility services of public rail transport. *Proceedings of the RSU Research conference 2018, Thailand,* 374-385. https://doi.org/10.14458/RSU.res.2018.56

Global Railway Review. (2023). *Improving station safety & reducing incidents on platforms. [Online].* https://www.globalrailwayreview.com/article/26441/improving-station-safety/

Hu, X., & Xu, L. (2022). How Guidance Signage Design Influences Passengers' Wayfinding Performance in Metro Stations: Case Study of a Virtual Reality xperiment. *Transportation Research Record, 2677*, 1118 - 1129. https://doi.org/10.1177/03611981221103591

Ibrahim, A.N.H.; Borhan, M.N.; Osman, M.H.; Mat Yazid, M.R.; Md. Rohani, M. (2022). The Influence of Service Quality on User's Perceived Satisfaction with Light Rail Transit Service in Klang Valley, Malaysia. *Mathematics*, *10*(13), 2213. https:// doi.org/10.3390/math10132213

Jing, Z., & Bai, W. (2020). Sign Optimization Model for Rail Transit: A Big Data Approach. *IEEE Access*, *8*, 81660-81673.

Kim, J., & Gustafson-Pearce, O. (2016). Passengers' anxiety about using the London Underground. *Proceedings of the 2016 IEEE International Conference on Intelligent Rail Transportation (ICIRT), United Kingdom*, 165-169. https://doi.org/10.1109/ICIRT38252.2016

Kong, Q., Li, N. & Li, P. (2024). Literature Review on Age-Friendly Design of Urban Rail Transit way finding Signage in the Context of Digital Economy. *Proceedings of the 2024 IEEE 7th International Conference on Electronic Information and Communication Technology (ICEICT)*, *China,* 1193-1196.

Krejcie, R. V. & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607–610.

Lianto, F., Supriyatna, E. & Budiyanto, F. (2021). Wheelchair-Accessible Toilet at Gambir Station. Proceedings of the *International Conference on Economics, Business, Social, and Humanities (ICEBSH 2021), Malaysia,* 299-304. https://doi.org/10.2991/assehr.k.210805.048

Luxton, A., & Marinov, M. (2020). Terrorist threat mitigation strategies for the railways. *Sustainability*, *12*(8), 3408. https://doi.org/10.3390/su12083408

Man, Li., Xin, Min, Zhou., Jinxin, Liu., Weikai, Ma. & Xiwei, Li. (2022). Topological Modeling and Analysis of Urban Rail Transit Safety Risk Relationship. *Journal of Intelligent Management Decision*, *1*, 108-117. http://dx.doi.org/10.56578/jimd010204

Ministry of Interior. (2022). *Population Statistics 2022.* [Online]. https://stat.bora.dopa.go.th/stat/statnew/statyear/#/TableTemplate/Area/statpop

Noranarttakun, R. (2022). Railway Signaling System. *The National Defence College of Thailand Journal, 64(2),* 54-64.

Ouyang, K. M. & Liu, S. F. (2021). A Simulation Method for Rail Transit Sign Optimization. *International Journal of Simulation Modelling, 20*(4), 742-753. https://doi.org/10.2507/IJSIMM20-4-CO16

Padovano, A., Longo, F., Manca, L. & Grugni, R. (2024). Improving safety management in railway stations through a simulation-based digital twin approach. *Computers & Industrial Engineering*, *187*, 109839. https://doi.org/10.1016/j.cie.2023.109839

Shvetsov A. V., Sharov V. A., Kozyrev V. A., Shvetsova S. V., Balalaev A. S., Shvetsov M. A., et al., (2019). Trends of Modern Terrorism in the Metro Systems of the World. *European Journal for Security Research*, *4*(1), 149-156. https://doi.org/10.1007/s41125-018-0037-9

Strandh V. (2017). Exploring vulnerabilities in preparedness - rail bound traffic and terrorist attacks. Journal of Transportation Security, 10, 45-62. https://doi.org/10.1007/s12198-017-0178-5

Sundling, C., & Ceccato, V. (2022). The impact of rail-based stations on passengers' safety perceptions. A systematic review of international evidence. *Transportation research part F: traffic psychology and behaviour*, *86*, 99-120. ttps://doi.org/10.1016/j.trf.2022.02.011.

Taecharungroj, V. (2022). An analysis of tripadvisor reviews of 127 urban rail transit networks worldwide. *Travel Behaviour and Society*, *26*, 193-205. https://doi.org/10.1016/j.tbs.2021.10.007.

Tomov, S., & Dimitrova, E. (2024). Station Passenger Barrier Systems and Their Impact on Metro Transport Services. *Engineering Proceedings*, *70*(1), 56. https://doi.org/10.3390/engproc2024070056.

U.S. Department of Transportation. (2023). *Surface Operations Security Overview. [Online].* https://www.transit.dot.gov/sites/fta.dot.gov/files/2023-11/Session-23-TSA-Surface-Operations-Security-Overview_0.pdf.

United Nations Development Programme. (2016). *Sustainable Urbanization Strategy. [Online].* https://www.undp.org/publications/sustainable-urbanization-strategy.

United Nations Development Programme. (2010). *A review of international best practice in accessible public transportation for person with disabilities.* [Online]. https://www.undp.org/sites/g/files/zskgke326/files/migration/my/PWD-transport-publication.pdf.

Warchoł-Jakubowska, A., Szwoch, I., Szczeciński, P., Krejtz, I., & Krejtz, K. (2024). Accessible Public Transport: A Case Study of Warsaw. *Transforming Media Accessibility in Europe: Digital Media. Education and City Space Accessibility Contexts*, 21. http://dx.doi.org/10.1007/978-3-031-60049-4_2.

Whaley, B. A., Martinis, J. G., Pagano, G. F., Barthol, S., Senzer, J., Williamson, P. R. & Blanck, P. D. (2024). The Americans with Disabilities Act and Equal Access to Public Spaces. *Laws*, *13*(1), 5. https://doi.org/10.3390/laws13010005.

Wu, H. W., Zhen, J. & Zhang, J. (2020). Urban rail transit operation safety evaluation based on an improved CRITIC method and cloud model. *Journal of Rail Transport Planning & Management*, *16*, 100206. https://doi.org/10.1016/j.jrtpm.2020.100206.