DOCTORAL DISSERTATION

博 士 論 文

A STUDY OF THE PEDESTRIAN ENVIRONMENT AND PASSENGER PERCEPTION OF ACCESS TO MASS RAPID TRANSIT STATIONS: A CASE STUDY OF ELEVATED STATIONS IN BANGKOK

大量高速輸送機関の駅へのアクセスにおける歩行者環境と歩行者の認識に関する研究：バンコクにおける高架鉄道駅の事例

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by

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ABSTRACT

Bangkok's rapid transit system began operating in 1999, but the city has grown quickly; traffic congestion remains. Increased car use causes traffic congestion. Bangkok's traffic problems have many complicated causes. Urban planning that is not appropriate and the lack of cooperation between the government and mass transit systems that do not operate according to effective plans, or minor causes such as the time management of traffic lights that do not correspond to the overall traffic of the whole city, In the past decade, various government initiatives have tried to tackle traffic problems by extending roads, including traffic lane expansion plans, interchanges, and overpasses. Most pedestrian environment initiatives focused on eliminating businesses from the pedestrian area, but not on safety or the environment. The difficulties in the pedestrian environment have not been fully resolved and continue to accrue.

This research focuses on Bangkok's pedestrian and Transit environments. This research focuses on pedestrian paths linking Bangkok's main public transit systems and how passengers feel about pedestrians to describe the environment that arises from how each variable is connected to one another. This research aims to build a framework that can lead to research objectives being fulfilled by a questionnaire survey regarding travel behavior and attitude toward public transit, private cars, and pedestrian surroundings. Physical survey inquiry will be incorporated in the observation survey, which will disclose urban visibility and street and pedestrian connections.

Based on the most significant data from each aim, the conclusion would be expressed both simply, such that even passengers feel marginally satisfied towards pedestrians, and physically, such that the Bangkok pedestrian environment connecting to stations has to be enhanced in many ways. For the plan, every station must improve quickly At Station of the Siam, the presence of trees has the largest impact on passenger enjoyment; this should be a key goal in any short-term plan. Within 800 meters, most buildings are government and university, with strong fences around pedestrian areas. Most pedestrian patterns around walking places aren't pedestrian-friendly. The public sector must establish a design center with masterplan oversight power.

Regarding the study methodology, this study would be applied to other stations both current operation and future station which are under construction. The data from both passenger side and pedestrian physical side would be apply for improving the design guideline or back up data for urban policy planner.

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CHAPTER 1
INTRODUCTION

1.1 RESEARCH BACKGROUND

Attaining sustainable mobility is a major challenge, especially for developing countries that are forced to cope with transport-related environmental challenges brought on by the growing trend of automotive ownership and use. However, achieving sustainable mobility is a worthy goal that must be pursued. Therefore, Cities that expand vertically and have a compact urban form (Compact Urban Form) use urban space cost-effectively. There is a high density and mix of land use. There is a transportation system and public services that are comprehensive. Urban residents tend to travel on foot, by bicycle and on public transport. healthy Reduce pollution, stimulate and add value. Stimulate the economy at the district level preserving the natural areas around the city. The present day offers many kinds of means of transport and ways how to move fast even at a long distance in the global world. Fascination by this previously unknown possibility - to travel all over the world in a relatively short time - often diverts attention from the most natural and also the healthiest modes of transport. Walking indeed is the first and basic transport mode (Schmeidler, 2010).

Present day, many cities are working to encourage people to leave their car at home, through public policy, clever urban design, and the provision of alternative transport modes. This is where the concept of a ‘walkable city’ comes in – one where the pedestrian is prioritized, and where multiple destinations are linked and easily accessible by pathways (Winkless, 2021). Short start or end journeys are an essential part of the daily commute. Bus, rail and metro services often cover the main part of trips to and from work, but people still need to first walk, drive or use another way to get to and from the nearest station or stop. (EEA, 2020). A pleasant atmosphere for pedestrians may also contribute to a pleasant atmosphere in a city. Freiburg, located in the southwest of Germany, is an excellent example of a city that has invested in this strategy. In the 1960s, the administration of the city made the decision that they intended to concentrate on environmentally friendly modes of transportation. That meant imposing restrictions on the flow of automobile traffic and making investments in both active and mass transit; the effects of these decisions were felt across the whole city. In modern times, Freiburg has developed a great deal in terms of bicycle and pedestrian infrastructure. Seventy percent of individuals live within 500 meters of a tram station, which is an extremely high percentage (Winkless, 2021).

Since 1977 up till the present day, Bangkok has had development plans, and the city now has a total of 12 development plans (BMA, 2020). The development directions that appear in each Bangkok plan are in line with the problems in each period. with a goal of how

you want to see Bangkok Most of the 8 Bangkok Development Plans are not very different. cover story Land and town planning, traffic, drainage, wastewater disposal, solid waste, education, public health, environment, community development, and social welfare. Since the first plan, all plans have focused on building and connecting roads, including building expressways or expressways for private cars, and expanding routes and increasing the number of buses until the 4th Plan has started to include the construction of electric trams in traffic congestion areas and navigating the waterways as for the sixth plan, the issue of increasing the transport network for both roads and waterways is to be used as a travel option. The 20-year long-term plan is the first to talk about cycling. Convenient and safe pedestrian walkways with the vision plan is Bangkok city has a mass transit system and a comprehensive, economical and convenient alternative transportation comfortable, streamlined traffic and there are many options both by boat, bicycle and walkway. The concept of this vision plan is mentioned about 1. Bangkok There are various public transport systems comprehensive, easily accessible not far from the house 2. Bicycle lanes and pedestrian walkways are of sufficient width and allowing people to travel comfortably 3. Both road traffic and water traffic are flexible, not crowded (BMA, 2013). More specifically, the issue of pedestrian quality has just appeared in the 20-year Bangkok Development Plan (2013-2032). 'Convenience Green City', a subcategory of mass transit systems, which is convenient, cost-effective, streamlined traffic and has options by laying down the policy that "Bangkok citizens can travel by boat, bicycle, and pedestrians easily and safely", although this is not a direct mention of the improvement of the quality of the pavement. But it was the first time that the Bangkok Development Plan included pavements in the plan. After not having a pedestrian issue for 36 years. However, the problems of these development plans found that most of the projects assessed to be successful are short-term projects and it an increase in the number of things that already exist and there are many things that cannot be accomplished.

There have been very few studies done on Bangkok's pedestrian walkways. And as of late, Bangkok has been paying more attention to the issue of pedestrian crossings. As a result, there is a dearth of information concerning pedestrian walkways that may be incorporated into an operational strategy.

1.2 STATEMENT OF PROBLEM

The capital city of Thailand, Bangkok, is continuously expanding, although its overall layout will not change for quite some time. With the city's growth reaching that of a megalopolis, it is home to more over 10 million people, which accounts for one sixth of the total population of the country. It is not unusual for there to be a large number of people and a lot of traffic in Bangkok. At present, Bangkok is expanding the economy. Both the industrial

sector, the agricultural sector and the service sector (tourism) contribute to the rapid growth of the city. By 2020, the trend of road and road transport is expected to increase to more than 3 million people-trips per day (the whole country), the average travel speed in the Bangkok metropolitan area is expected to drop to just 13.64 kilometers per hour. Access to the business district will take up to 2 hours, which will affect the traffic volume in the future, especially in the areas around Bangkok Metropolitan Region and on the main roads that link between regions of the country.

Even though Bangkok's mass rapid transit system began operations in 1999, the city has experienced fast development throughout that time; the problem of traffic congestion has not been resolved. The use of automobiles continues to increase, which contributes to an increase in traffic congestion. There are a multitude of different and complex factors that contribute to Bangkok's traffic issues. Whether it is urban planning that is not in accordance with the appropriateness and the lack of cooperation between the government and mass transit systems that do not operate according to effective plans, or whether it is more minor causes such as the time management of traffic lights that do not correspond to the overall traffic of the whole city, urban planning that is not in accordance with the appropriateness and the lack of cooperation between the government and mass transit systems that do not operate according to effective plans are to blame.

Recent of decade year, there are many government’s projects that have been trying to solve the traffic problem but however, most of the project are focus expanding the road which includes traffic lane expansion plan new construction and the construction of interchanges and overpasses etc. In the case of initiatives pertaining to the pedestrian environment, the majority of the projects were centered on removing merchants from the pedestrian area, but they did not concern themselves with enhancing either safety or the environment. As a result, the problems that exist in the environment that pedestrians inhabit have not yet been remedied in full and continue to accumulate up to the present day.

In relation to the issue at hand, this study posed three primary questions: what people in Bangkok think about pedestrian access to mass rapid transit stations; what the quality of pedestrian access to stations is like; and what kind of relationship there is between the user's side and the physical side. The conclusion that should be drawn from these three questions should provide an answer to the final issue, which is why people don't want to walk. To be more explicit, the following three questions have been formulated in this research;

1. *What are the perceptions of passengers in Bangkok's mass rapid transit stations regarding the pedestrian environment?*

A study on pedestrian along with mass rapid transit station light green line mentioned

about obstacles that cause walking inconvenience and in line with the preference of pedestrians to improve sidewalks are (1) Lack of equipment and facilities for pedestrians and disabled people (2) Safety from crime (3) Continuation of sidewalk, pedestrian crossing, obstacles to walking and driving on sidewalk (Boonon, 2020). However, this study did not investigate in term of respondent's factor. The majority of individuals in the neighborhood have a tendency to stroll within a walking distance of 500 meters from stations, however this varies depending on the distance and the pedestrian quality (Sangsila, 2012). Incorporating walkable elements into transport planning decisions has been gaining increased attention in recent years, shady walkways have more chances to enable the residents to walk further (Sukpattanacharoen, 2021).

2. *How is pedestrian environment physical connecting to mass rapid transit station?*

A pedestrian environmental evaluation is an indicative approach for assessing pedestrian quality. It may be used as a criteria to check and characterize the current condition of the pavement, and the score can reflect whether or not an area is suitable for walking. Walkability is a measure of how friendly an area is to walking; walkability supports community health, safety, livability, and reduced car dependence. Walk Score also measures pedestrian friendliness by analyzing population density and road metrics such as block length and intersection density (Score, 2022)

3. *What is relationship between passenger's perception and pedestrian environment.*

Experiences in the physical environment awaken different perceptions in different people and enable the formation of an environmental image in people's minds during and after use (Orkun Alptekin, 2019). The primary and fundamental reality of physical order is realm of perceptual experience (J. A. Leighton, 1910). Numerous studies have been conducted on the topic of the physical environment and perception in an effort to comprehend the phenomena concerning the location and the user, and therefore to enhance and determine the influence between the factors for instant, effects of open versus closed physical environment on employee perception and attitude, This experiment undertakes to determine the effects of a closed (versus an open) physical office environment on worker attitude, perception, and interpersonal relations. A closed environment provides for privacy but isolates employees; while an increased interruption (Cangelos, 1988). A study in Adult Intensive Care Units suggested that the physical environment can be important for patient comfort, patient safety, patient privacy, family integration with patient care, and staff working condition in adult intensive care units (ICUs) (Rashid, 2007). Concerning the site, there is a paucity of understanding regarding the link between pedestrian and user perception in the studies that have been done.

1.3 AIM AND RESEARCH OBJECTIVES

The main objective of this research is to understand the attitude, perception and satisfaction of passenger who mainly travel by mass rapid transit system following 6 objectives.

1) To investigate the Pedestrian Environment with Regards to the perception and attitude of Passengers Regarding Mass Rapid Transit Stations.
2) To investigate the degree to which passengers are content with the quality of pedestrian connections to interchanges between mass rapid transit stations in a variety of Bangkok metropolitan zones.
3) To investigate of urban spatial patterns and street connection.
4) To investigate and analyze the pedestrian environment using the 7Cs as indications.
5) To conduct an investigation on the relevance of the correlation between pedestrian behavior, passenger perception, and the pedestrian environment in Bangkok.

Study material of this research is pedestrian environment along with mass rapid transit stations in Bangkok. This research focuses on the study of pedestrian walkways connecting Bangkok's main public transport systems, and the investigation of how passenger's feel about pedestrians as a means of describing the phenomenon of the environment that emerges from the investigation of how each variable is related to one another. The purpose of this research is to establish an appropriate framework that can lead to the purpose of research objectives being answered by a questionnaire survey that asks about travel behavior and attitude toward public transit, private cars, and pedestrian environments is what makes up a study of passengers' perceptions and attitudes towards certain modes of transportation. While the observation survey will reveal about the response of investigate of physical survey, which is include urban visibility and street and pedestrian connection, the investigation of the physical survey will be included.

1.4 SCOPE AND LIMITATIONS

The research has attempted to give a practical lesson to promote walking as a sustainable mode of transportation in the interest of boosting major public transportation in developing countries. The case study was chosen solely and specifically in accordance with the following primary criteria:

- Stations of the mass rapid transit system that are currently active and have the largest number of passengers in the system. The purpose of the station would be to serve as an interchange station, and it would essentially be situated at the core of urban zone in order to facilitate growth.
- The sites of the stations would vary depending on the urban conditions, including economic, demographic, and facility factors, among others. In order to examine the similarities and differences, as well as the key patterns, of the pedestrian environments seen in various metropolitan settings, the comparison will be conducted.
- The theoretical and actual walkable catchment areas within five minutes' (400 meters) or ten minutes' (800 meters) walking distance of a location are commonly compared during a walkable catchment study. In the event that the destination is a station for mass rapid transit, the catchment analysis will be performed within a radius of either 800 meters or ten minutes of walking distance from the station.
- Population of this research is passengers who travel by mass rapid transit stations. The number of respondents is calculated based on the number of passengers that pass through each station on a single day and then dividing those numbers into proportions using the ratio order.

With reference to the aforementioned objectives of the research, the mass rapid transit stations that were chosen for the case study are BTS skytrain stations, which are part of an elevated mass rapid transit system. Following this, an empirical research study on passenger's views and attitudes towards walking to the station was initiated. Due to the limit of time and resource, the data collection in term of passenger and attitude was collected and divided into two analysis; 1) Nonprobability sampling, which involves selecting replies from a whole pool of those who were polled in order to do research on the overall image of the pedestrian connections between all of mass rapid transit stations, 2) The research method known as purposeful sampling focuses on persons who transit through interchange stations. As a component of the physical environment of the pedestrian, a case study was conducted using interchange stations, which are placed in a variety of urban conditions. After that, the results of the survey of pedestrians and passengers were employed for the correlation analysis in the final aim.

Therefore, this research scope on pedestrian environment within 800 meters from station focusing on main street. In terms of the aim and objectives, a more detailed explanation can be found following;

Objective 1:	All mass rapid transit station (Nonprobability sampling).
Objective 2:	All of Interchange stations.
Objective 3-5:	Interchange stations in different urban zones.

1.5 OUTLINE OF DISSERTATION

There are a total of 11 chapters and appendices in this dissertation consists of,

In Chapter 1, present the background of what is the primary concern of the current scenario and why it is important to examine the pedestrian environment.

In Chapter 2, a literature review of pedestrian environment studies is discussed, along with how to evaluate the pedestrian environment, as well as the study of the connectivity and visibility of urban and street spaces by space syntax theory, and finally, a review of correlation analysis is presented in order to comprehend the statistical analysis that is used to evaluate the data.

In Chapter 3, provides an overview of the study framework, the hypotheses, the data collection, the variables, and the models that were utilized throughout this dissertation.

In Chapter 4, provides further information on the case study area and other issues that are relevant to it.

In Chapter 5, investigation on the impact of the pedestrian environment on the way passengers experience mass rapid transport stations. To investigate the attitudes of passengers toward various modes of transportation as well as the problems faced by pedestrians at the elevated mass rapid transit station as a whole.

In Chapter 6, research into the perspectives of passengers, with a particular emphasis on interchange stations and walking indications.

In Chapter 7, research on urban visibility and street connection, with a particular emphasis on Central Business District (CBD) locations, conducted with the goal of better comprehending urban features and patterns of street connectivity.

In Chapter 8, research comparing the street and pedestrian connectivity of mass rapid

transit stations to that of three other metropolitan locations with significantly different circumstances and analyze the pedestrian environment by making use of walking indicators to gain an understanding of the level of quality currently present in the circumstances faced by pedestrians.

In Chapter 9, Find out the correlation between passenger perception satisfaction score and pedestrian environment quality to understand how relationship between two different variables.

In Chapter 10, Reviewing the rule and policy implementation which are currently applied in Bangkok.

In Chapter 11, This chapter draws a conclusion to the significant results and makes recommendations about crucial implications and contributions that might help guide the planning. In addition to this, it hypothesizes the potential avenues for additional study that, if pursued, might strengthen the credibility of the findings of the previous research.

CHAPTER 2
LITERATURE REVIEW

2.1 REVIEW RELATED PAPERS AND CLARIFY ORIGINALITY AND NOVELTY OF THIS RESEARCH

The field of pedestrian related to mass rapid transit studies has been the subject of a great deal of research and writing, particularly in Asia. Build environment and pedestrian behavior at rail rapid transit stations in Bangkok found that the existence and length of pathways impacted the departing direction of people (Craig Townsend, 2010). In Jakarta, Its Impact Senayan district's MRT is sufficient to provide pedestrian comfort, although there are still shortfalls that need to be considered to support pedestrian comfort, especially during rainy weather, so the finding of "canopy seating" is expected to be taken into consideration (Trisno Rudy, 2019). In Singapore, there is a study aims include determining what factors influence riders' decisions to walk instead of use rail transit and creating a system for evaluating pedestrian safety around MRT stations (MRT). The model coefficients are used to suggest an equation for the equivalent walking distance, which indicates the relative impact of these variables on the overall walking effort. The keyword of this study found that equivalent walking distance may be used as a measure of the effectiveness of pedestrian infrastructure, as it reflects the additional effort necessary to navigate around obstructions (Piotr Olszewski, 2005). As well as another study in Singapore, the probability of walking is introduced to demonstrate the permissible walking distance to a public transportation terminal, and a walking distance of 800 meters is applied for reaching public transportation after a 15-minute walk (Sony Sulaksono WIBOWO, 2005). In China, there was an Analyze the motion of pedestrian groups statistically, including their walking velocity, acceleration, trajectory variations, and group proxemics between individuals and pairs. The case study in subway station. The data indicate that the social group has a substantially greater percentage of members on non-working days than on working days (Pengfei Zhao, 2016). There is a study which is related to Geographical Context, the case study in Kuala Lumpur. This main finding was the central city sections were mostly commercial, whereas the outlying city portions were largely residential, however, the result of this study had not focus on pedestrian accessibility to station as the aims of study (Thaqif, et al., 2019). The comparison analysis in term of pedestrian accessibility on micro scale level was studied in 2016. This study suggests that when assessing accessibility to all destinations in the city, the influence of less-than-optimal linkages from transportation to the pedestrian network, a local assessment, may be observed. (Eggermond, et al., 2015)

From the literature review above there is no research which have been studied on pedestrian environment itself access to mass rapid transit station and also studied of

relationship between building environments. According to an original research paper Gill & Dolan (2015) mentioned about Originality and the PhD, there are some criteria from researcher below:

- New information that has not before been shared.
- Adding to previously original work - Conducting original research despite the fact that it has been specified by someone else (supervisor).
- Inventive procedures, observations, methods, or outcomes.
- Demonstrating uniqueness by testing someone else's ideas.
- New empirical work - Synthesizing previous work - Using known material but interpreting it differently.
- Using previously learned content in novel circumstances.
- Using known material in a new area/field - Introducing fresh evidence on an existing subject.
- Introducing cross-disciplinary interpretations or techniques.
- Investigating new topics in a field - Contributing to knowledge in novel ways. (Dolan, et al., 2015)

In Bangkok, pedestrian environment research or dissertation has been conducted, however the area of connect to mass rapid transit station has not been elaborated upon in terms of user experience, urban street connectivity, and empirical study of existing areas. Therefore, this research is an empirical study aims to explore variables and the phenomenon of variables to bring the results to explain the occurrence of pedestrian phenomenon between pedestrian environment and specific on building environment surround walking to station withing 800 meters. Determine as an original research paper in term of New knowledge that has not previously presented

- New empirical work
- Applying known material in a new area or field
- Exploring new areas in a discipline

2.2 AN OVERVIEW OF PERCEPTION, ATTITUDE, AND SATISFACTIONS

In order to have a better understanding of what people's thoughts are regarding the study variables, this is an essential component of the research survey that has to be carried out. However, in order to have a complete comprehension, the meaning of each term should be explained in detail.

Meaning of “Perception” could be explained in various ways such as (a) a belief or opinion, often held by many people and based on how things seem, (b) the quality of being

aware of things through the physical senses, especially sight, (c) someone's ability to notice and understand things that are not obvious to other people, an awareness of things through the physical senses (Cambridge Dictionary, 2022). Perception questions differ from other types of survey questions—behavioral, knowledge, attitudinal, or demographic—in that questions that measure perception ask respondents to provide information on how they perceive such matters as the effectiveness of variables. (Lavrakas, 2022). While the keyword of "Attitude" means (a) a feeling or opinion about something or someone, or a way of behaving that is caused by situation, (b) a feeling or opinion about something, especially when this shows in your behaviour. (Cambridge Dictionary, 2022). Attitude throughout the research survey can be explain for more in-depth, qualitative interviews, especially to examine attitudes toward presumed consent as a term. And "Satisfactions" means (a) a pleasant feeling that you get when you receive something you wanted, or when you have done something, you wanted to do, (b) a way of dealing with a complaint or problem that makes the person who complained feel happy. (Cambridge Dictionary, 2022). As a result, in order to create the survey questionnaire, three keywords may be stated like they are in Table 2.1

Table 2.1 Keywords summary of perception, attitude, and satisfactions

Keyword	**Definition in research**
Satisfaction	Pleasant feelings
Perception	Sensory awareness, especially sight
Attitude	Situational thinking

2.3 URBAN SPATIAL, STREET CONNECTIVITY AND PEDESTRIAN ENVIRONMENT PHYSICAL

Urban analytics combines spatial analysis, statistics, computer science, and urban planning to understand and shape city futures. While it promises better policymaking insights, concerns exist around its epistemological scope and impacts on privacy, ethics, and social control (Geoff Boeing, 2021). This research will study Urban spatial by using space syntax analysis, is a set of techniques for analyzing spatial layouts and human activity patterns in buildings and urban areas. It is also a set of theories linking space and society. Theories of the relations between spatial and social patterns are established to explore whether and how space is internalized into socio-economic processes through which the built environment is created. This has been done in two ways. Firstly, theories can be used to look for commonalities in the pattern of models across functions and cultures. One example is the theory of the generic city. Secondly, theories can use space syntax tools to explore what happens to spatial patterns if objects in space are deployed and shaped in different ways. (UCL, 2018)

In term of street connectivity, Liveable neighbourhoods have a street network which promotes walking and cycling around the local area. Street connectivity describes how well-connected streets are to each other and is typically measured as the density of intersections in a given area (Observation, 2022). Street connectivity, can also defined as how well streets connect to one and other and the density of intersections, is positively associated with active transportation in adults (Graham Mecredy, 2011). There are many streets network types which could be explain about the street pattern and grid. Prior to the late 19th and early 20th century, a grid street pattern was relatively uncommon. The conventional street grid is mostly the outcome of the streetcar suburbs that emerged in the early part of the 20th century. It conferred optimal accessibility and the use of available space. The diffusion of the automobile was a driver in the shift of the street network towards a more curvilinear pattern. This implied a reduction in the level of connectivity as well as the density of land use. This was part of a paradox where while the automobile was becoming the dominant support of urban mobility, it was also increasingly associated with local disturbances. Planners responded by developing cul-de-sac suburban patterns with the goal to reduce and even eliminate through movements on a large number of residential streets and having them taking place on main arterials. By the 1950s, the conventional cul-de-sac pattern became prevalent in suburban developments. Although this pattern minimizes non-local circulation, it also generates more movements and energy consumption (Marshall, 2010). Street network type Connectivity relates to the availability and directness of travel routes used to move through a network from an origin to a destination. Common approaches to the measurement and assessment of connectivity include:

1) identifying the spacing between streets (with a tight grid formation resulting in higher connectivity).

2) assessing the amount of intersections with connecting streets that provide four or more routes choices (as opposed to t-intersections and dead-ends)

3) comparing the network distance to the Euclidean distance (a network distance that is only marginally above Euclidean distance indicates a very direct route along the network). High connectivity improves accessibility by providing a more direct route and shortening the required travel distance. Neighborhoods with low connectivity might contain numerous large block sizes and fewer intersections. (Lukar E Thornton, 2011)

Pedestrian environment assessment related to walkable and how lively of urban planning which is refer to walkability concept. “Walkability” has been probably brought to the debate by Chris Bradshaw in 1993. Following property tax raise in Ottawa (1992) in connection to road infrastructure improvements, landowners and local shop owners argued that most people in their neighborhood walked in their daily trips instead of driving. Because

they walked instead of driving, they had less need for the road infrastructure expansion and therefore should not pay extra tax. From a conceptual point of view, walkability was then defined as a “quality of place” which had 4 basic characteristics:

> A "foot-friendly" man-made, physical micro-environment: wide. leveled sidewalks, small intersections, narrow streets, lots of litter containers, good lighting, and an absence of obstructions.
>
> A full range of useful, active destinations within walking distance: shops, services, employment, professional offices, recreation, libraries, etc.
>
> A natural environment that moderates the extremes of weather- wind, rain, sunlight – while providing the refreshment of the absence of man's overuse. It has no excessive noise, air pollution, or the dirt, stains, and grime of motor traffic.
>
> A local culture that is social and diverse. This increases contact between people and the conditions for social and economic commerce. (Bradshaw, 1993)

The walkability of a community has been conceptualized as “the extent to which characteristics of the built environment and land use may or may not be conductive to residents in the area walking for either leisure, exercise or recreation, to access services, or to travel to work”, or in simpler terms, “the extent to which the built environment is walking friendly” (Steve Abley, 2011). This research is based on the second definition, which means that we need to figure out what makes a place "walking friendly." This question was looked at in the work done by Transport for London, where the concerns and needs of pedestrians were put into 5 main categories. These things have been called the "5Cs," and they have been thought about in terms of the idea of walkability. Here, the five "Cs" are explained one after the other:

> Connected: How well the pedestrian network links to key trip starts and ends, as well as how well the different routes on the network link to each other.
>
> Convivial: How much people, the built and natural environment, and other people on the road make walking a pleasant activity.
>
> Conspicuous: How well walking routes and public spaces make pedestrians feel safe and welcome, based on how clear and readable the signs and information are.
>
> Comfortable: The degree to which walking is made easy for people with different skills and abilities.
>
> Convenient: The degree to which walking is possible and can compete with other ways to get around in terms of time and money saved (time, money and space).
>
> In the scope of this research, the above definitions have been changed to match what

the dictionary says and two more dimensions have been added: coexistence and commitment.

Coexistence: It has been said that motorized vehicles, especially automobiles, are a big reason why fewer people walk in cities. Their effect on how people feel about walking is felt in different ways.

Commitment: A lot of the built environment is the result of decisions made by policymakers and planning rules. Also, a lot of what happens because of how people use the built environment has to do with how people in the community act and think. (Steve Abley, 2011).

Walking is frequently seen as a "lost" means of transportation in modern times. Other forms of transportation, including the use of private motor vehicles, have been the subject of much research over the course of the past few decades and are highly measurable. Due to the fact that walking is an easy way to get around and doesn't require much in the way of specialized infrastructure, it has fallen behind other modes of transportation in terms of research, and there have been very few analytical techniques developed to assist practitioners in enhancing the provision for walking as a mode of transportation (Alasdair Turner, 2014).

2.4 CORRELATION ANALYSIS

Correlation in the widest meaning is a measure of a connection between variables. In correlated data, the change in the magnitude of 1 variable is connected with a change in the magnitude of another variable, either in the same (positive correlation) or in the opposite (negative correlation) direction. Most typically, the term correlation is employed in the context of a linear connection between 2 continuous variables and stated as Pearson product-moment correlation. Both correlation coefficients are scaled such that they range from –1 to +1, where 0 indicates that there is no linear or monotonic association, and the relationship gets stronger and ultimately approaches a straight line (Pearson correlation) or a constantly increasing or decreasing curve (Spearman correlation) as the coefficient approaches an absolute value of 1. (P. Schober, 2018) In research, correlation analysis is a statistical technique that measures the linear relationship between two variables and computes their association. Simply defined, correlation analysis determines the amount of change in one variable as a result of the change in the other variable. A high correlation indicates a strong association between the variables, whereas a low correlation indicates a weak relationship. (QuestionPro, 2018)

There may be a positive correlation, a negative correlation, or none at all between two variables. Examining the appearance of each of these three categories:

- Positive correlation: When two variables are positively correlated, they move in the same direction. When one variable increases, the other variable increases proportionately, and vice versa.
- Negative correlation: When two variables have a negative correlation, this indicates that they move in opposing directions. If one variable rises, the other variable will fall, and vice versa.
- Weak or zero correlation: When one variable has no influence on the other, there is no correlation.

Figure 2.1 illustrates the diagrams of variable correlation.

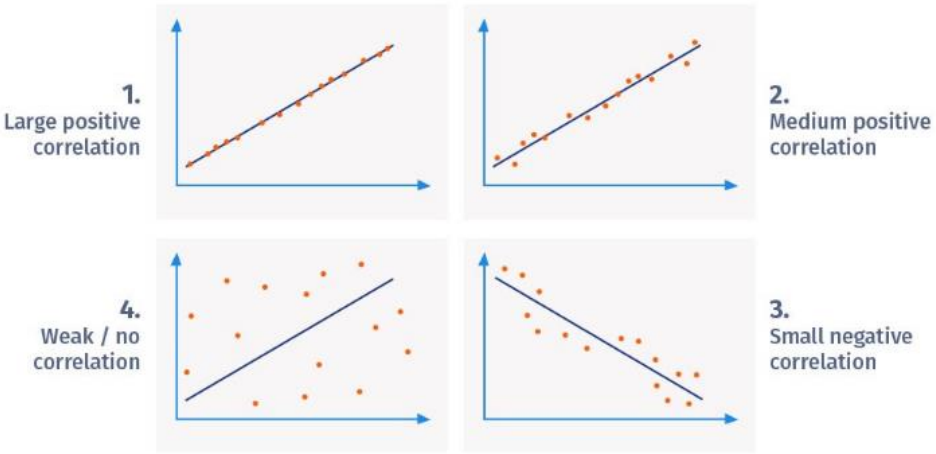


Figure 2. 1 Correlation analysis type

CHAPTER 3
RESEARCH METHODOLOGY

3.1 QUESTIONNAIRE DESIGN SURVEY

Regarding to objective 1, This section is quantitative research which is the process of collecting and analyzing numerical data. It can be used to find patterns and averages, make predictions, test causal relationships, and generalize results to wider populations; therefore, questionnaire design survey was use as a tool to collect data. To understand how the passenger's satisfaction and perception of the pedestrian environment connects to BTS Station in Bangkok, an online questionnaire survey was conducted for this study. The sample size was finite population by determining the sample size by the Yamane's formula method for sample size calculation to determine the sample size from a given population. The formula shows below.

$$n = \frac{N}{1 + Ne^2}$$

Where n = Sample size
N = Population size
e = Level of precision or Sampling of Error which is ±5 percent

This research designs the questionnaire survey divided into 5 parts consists of Demographics, Travel Behavior, Pedestrian Perception (access to the station), Sensibility, and Point of view. The survey question shows in table 3.1

Table 3.1 The Survey data categorized

Section	Content		Scoring
Part 1: Demographics	1	Age	Single Answer Variations
	2	Gender	Single Answer Variations
	3	Occupation	Single Answer Variations
	4	Current Address (Zone and District)	Single Answer Variations and text entry
	5	Number of Family member	Single Answer Variations
	6	Number of own cars	Single Answer Variations
Part 2; Travel Behavior	7	Purpose to use BTS station	Multiple Answer Variations
	8	Transfer to other public transportation	Multiple Answer Variations
	9	Frequency to get to the stations before COVID 19	Single Answer Variations
	10	Frequency to get to the stations after COVID 19	Single Answer Variations

Section	Content		Scoring
	11	Transportation mode choice to get to the station	Multiple Answer Variations
	12	Time travel to station (Overall)	Single Answer Variations
	13	Time travel to station (walking)	Single Answer Variations
	14	The opinion about pedestrian obstacle	Multiple Answer Variations
	15	The attitude of Private car	Variations Likert
	16	The attitude of Mass Rapid Transit	Variations Likert
	17	The attitude of Walking and Pedestrian Environment	Variations Likert
Part 3; Pedestrian Perception (access to the station)	18	Network and connectivity	Variations Likert
	19	Sidewalk available (width)	Variations Likert
	20	Amenities	Variations Likert
	21	Presence of Trees	Variations Likert
	22	Climate protection	Variations Likert
	23	Lighting	Variations Likert
	24	Fence and walled buildings	Variations Likert
	25	Building shops/ No obstacle	Variations Likert
	26	street enclosure	Variations Likert
	27	Conflicts	Variations Likert
	28	sidewalk Buffer (width)	Variations Likert
	29	Maintenance of sidewalk	Variations Likert
	30	Cleanliness	Variations Likert
	31	Universal design	Variations Likert
Part 4; Sensibility	32	Safety	Single Answer Variations
	33	Overall Satisfaction	Single Answer Variations
Part 5; Point of view	34	Pedestrian elements to improvement	Multiple Answer Variations and text

3.2 OBSERVATION DESIGN SURVEY

Regarding the second aim, the quality of the pedestrian environment, the purpose of this research is to discover the characteristics and the current state of the environment in which people walk. The evaluation is based on the IAAPE framework, and the score is derived from the 7Cs indicator, which takes into account 13 different aspects of the situation. These components, on a more granular basis, are connected to the accessibility and attractiveness of the site.

This empirical research applies an analytical framework that begins with the collection of primary data such as an assessment of the pedestrian environment obtained from observation of an existing area.

3.3 ANALYTICAL METHODOLOGY

This study used three different approaches to data collecting and analysis, which is referred to as numerous different techniques. Detailed explanations of the data collecting, and analysis methods are provided in this section.

1) The first objective is to collect information on the users' perspectives by means of an online questionnaire survey. The questionnaire survey will concentrate on the population of passengers who travel by Elevated Mass Rapid transit stations, which will serve as the basis for the case studies. After that, the response will be generated into an analysis in each area by utilizing SPSS analysis, which comprises of descriptive analysis, crosstabulation analysis, and correlation analysis, in order to determine the relationship between variables that pertain to the pedestrian environment.
2) The second objective part 1 is to collect information from the physical site survey. This part divided into 2 sections, the first part collect data from secondary data which were consists of existing building, street and pedestrian environment. After that, run the analysis by making use of depth map software while utilizing AutoCAD to produce the data. The objective is to identify the characteristics of the building and street connectivity surrounding the station accessibility, as well as the urban visible space. In terms of the urban viewable area, this part will be focused on the CBD area, which is the inner-city core and has a large number of high-rise buildings.
3) The second part of the second objective is to collect information directly from an observation survey of pedestrians who are accessing the station. The collection of data is carried out with the use of data sheets that are based on the 7c indicator's (Chapter 2). In addition to this, photography is also utilized as a primary component in the scoring process.
4) 4) The response to the questionnaire survey from the previous customer's level of satisfaction based on the 7c pedestrian environment indicators would be to determine the connection of the pedestrian environment score, which would be the outcome in objective 3.
5) The laws, regulations, and policies that are currently being put into effect will be scrutinized in order to ascertain the bottleneck and provide a recommendation based on the findings of the study.

   Figure 3.1 shows research analytical methodology

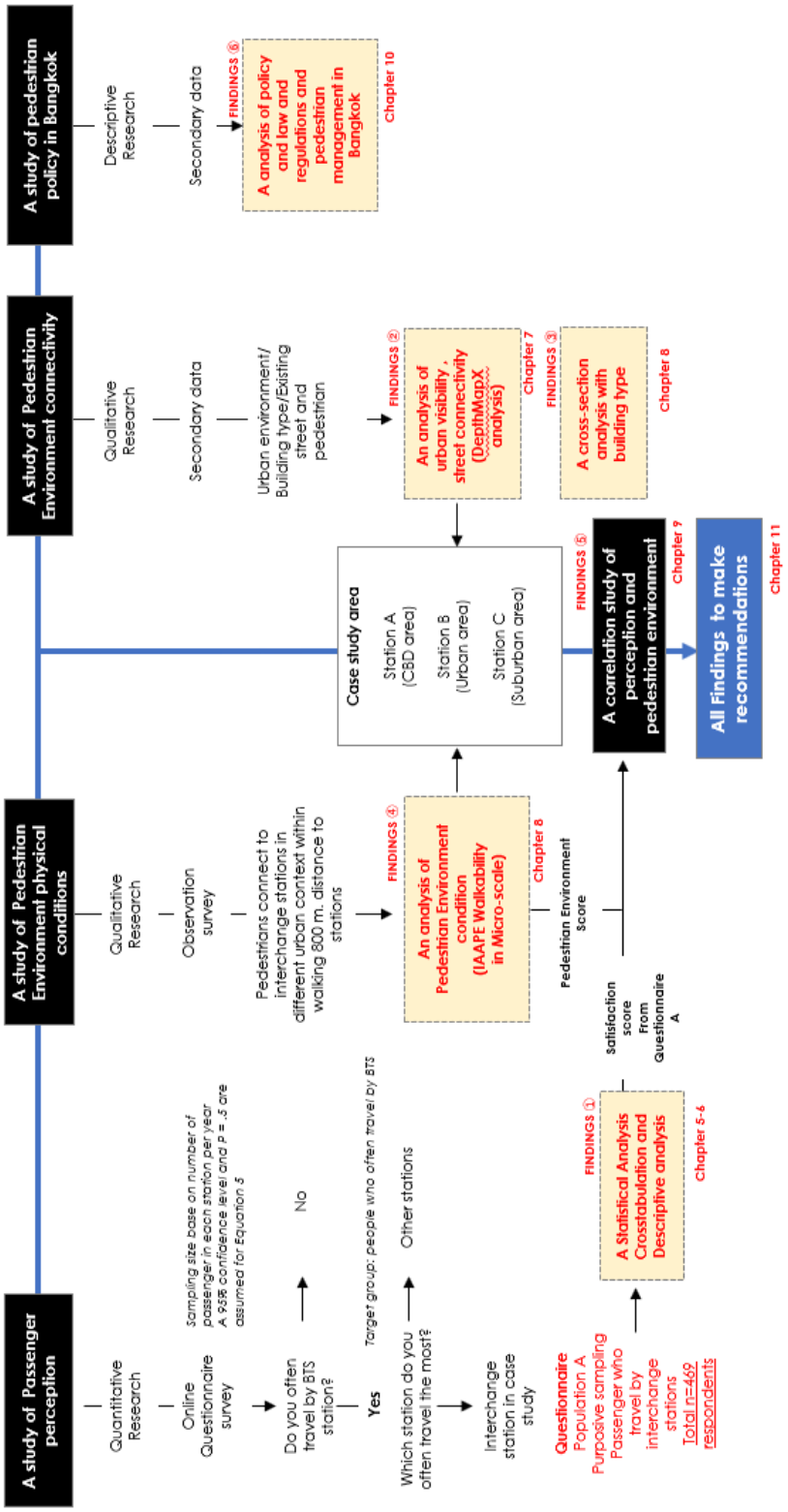


Figure 3. 1 Research analytical methodology

3.4 Technical terms and Definition in this research

In order to ensure that the reader has a complete comprehension of the information presented in this research, this part will provide an explanation of each term and its respective definition.

- Pedestrian: physical sidewalk, foot path, or walking route with or without the clearly by eyesight, yet people are nevertheless able to walk along these paths. This portion does not include any road at all.
- Pedestrian environment: According to the 7c indications, the environment that the pedestrian is in surrounds them.
- Station: Elevation station which is mean BTS stations.
- Passenger: User who often travel by BTS stations
- Interchange station: stations which can transfer to other Mass rapid transit line, in this research referred to 6 stations consists of 1) Siam station, 2) Asok station 3)Mochit station 4)Sala deang station 5)Phaya Thai station 6) Bangwa station.
- Central Business District (CBD): the highest development area, in this research divided into 2 parts 1) questionnaire survey referred to Siam station, Asok station, Sala Deang station 2) Observation survey referred to Siam station
- Urban area: undergoing to develop to business area, basically this area is combined between many activities of building, in this research divided into 2 parts 1) questionnaire survey referred to Mochit station and Phaya Thai stati 2) Observation survey referred to Mochit station.
- Suburban area or Westest outer ring road: This area is mostly made up of residential areas, and there are just a few high-rise buildings and business areas here. In this research mentioned to Bangwa station.

CHAPTER 4
STUDY AREA CHARACTERISTICS

Due to the conditions of the capital city, which suffers from traffic congestion and urban congestion, Bangkok, a capital city of Thailand, was chosen as the location for this research project's case study. In this chapter, provide information that is pertinent to the case study, beginning with urban characteristics and on through transportation system, mass rapid transit and station characteristic, as well as the existing pedestrian environment.

4.1 URBAN DEVELOPMENT IN BANGKOK

Bangkok serves as the country's economic, transportation, and educational hubs, all of which contribute to the city's growth. As a result, it grew to be the world's most populous metropolis (The most primate city on earth). Bangkok's urban development model in the past focus on "Suburbanization" mainly starting around the year 1907, when the city began to develop. There is not much expansion during this period. It will be located in the inner-city area of Bangkok. Later in the year 1957 until spreading to the surrounding suburbs both the north, south, east, and west until in the year 1987, when people began to migrate to the suburbs causing the suburban area to expand. Meanwhile, the urban area, which was the former center, began to deteriorate until 1997 due to the arrival of the mass transit system has caused more people to move back to the inner-city areas along with the expansion into the suburbs, it continues to exist.

Regarding Bangkok Information Center, an overview of the urban development found that in 1967 there was a community area (Urbanized Area) about 143.42 square kilometers. The city had expanded to the south to metropolitan regions and from a periodic study of aerial photographs in the following years, including the years 1986 and 1995 and 2000, it was found that the area urbanization had expanded very rapidly, amounting to 347.39, 585.54 and 672.339 square kilometers, respectively. The direction of urban expansion has covered various provinces in the perimeter and on the east and north side of the former city center and the transformation from agricultural land to residential, commercial and industrial areas to serve the communities surrounding the aforementioned areas (BMA, 2021).

Reviews of Bangkok urban spatial structure found that the city is stated both polycentric and monocentric (Narongsak Kittisan, 2014). Bangkok has expanded the area according to the nature of the use of the area that has been continuously expanded. In the first phase of the city expansion, it remained within the boundary of the area that was Bangkok. Subsequently, it was expanded to neighboring provinces according to the urban growth characteristics of the metropolis (Tunkchontip, 2018).

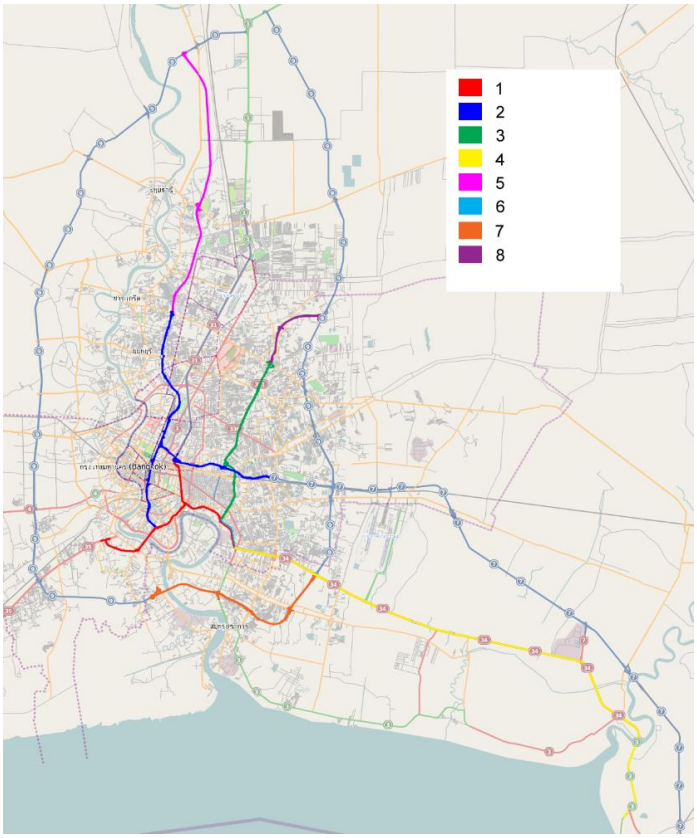
4.2 TRANSPORTATION SYSTEM IN BANGKOK

At the moment, the majority of Bangkok's transportation relies on roads since, in comparison to other systems, they provide the easiest access to the city's neighborhoods. Most travelers rely on their own automobiles when they are on the road. The percentage of people who drive their own automobiles is 53%, whereas the percentage of people who take public transportation is just 47%.

The following is a description of each kind of transportation that may be used on roads;

- **Road and expressway network**

An important main network project of transportation in Bangkok and surrounding areas. There are important roads about 4,700 kilometers, with main roads that are the routes in and out of the city in different directions. Figure 4.1 shows an overview map of Thailand's expressway system in Bangkok Metropolitan area.



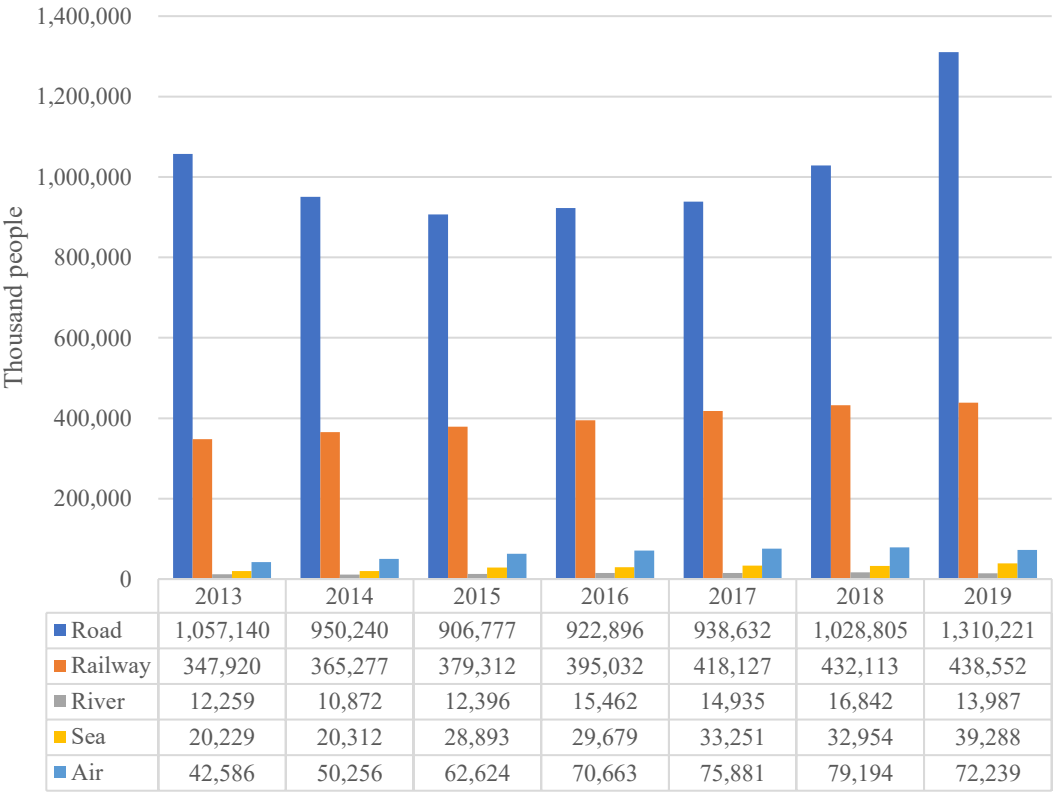
Source: OpenStreetMap image

(1 First Stage Expressway System (officially known as Chalerm Maha Nakhon Expressway) 2 Second Stage Expressway System (Si Rat Expressway) 3 Ramindra – At Narong Expressway (Chalong Rat Expressway) 4 Bang Na Expressway (Burapha Withi Expressway) 5 Bang Pa-in – Pak Kret Expressway (Udon Ratthaya Expressway) 6 Third Stage Expressway System, S1 section 7 Bang Phli – Suk Sawat Expressway 8 Ramindra – Outer Ring Road Expressway)

Figure 4.1 Overview map of Thailand's expressway system

- **Public transport network**

According to data from Digital Government Development Agency (DGA), domestic public transport classified by mode of transportation, consisting of road, rail, river, sea, and air. Number of passengers traveling by public transportation from 2013 – 2019 found that more than twice as many journeys are taken through road as were taken via rail. Every year, the number of people who travel by train increases. Nevertheless, the proportion was two and a half times lower when compared to the typical amount of car journeys taken during a span of seven years. Figure 4.2 shows the number of travels categorized by public transportation type.



	2013	2014	2015	2016	2017	2018	2019
Road	1,057,140	950,240	906,777	922,896	938,632	1,028,805	1,310,221
Railway	347,920	365,277	379,312	395,032	418,127	432,113	438,552
River	12,259	10,872	12,396	15,462	14,935	16,842	13,987
Sea	20,229	20,312	28,893	29,679	33,251	32,954	39,288
Air	42,586	50,256	62,624	70,663	75,881	79,194	72,239

Source: DGA, 2020

Figure 4.2 Number of travels categorized by public transportation type

Considering Public transportation on road, there are 4 types of land transport services as follows:

1) Bus, operated by Bangkok Mass Transit Authority (BMTA)
2) Suburban Railway, operated by State Railway of Thailand (SRT)
3) Mass Rapid Transit, operated by BTS
4) Metropolitan Rapid Transit, operated by Mass Rapid Transit Authority of Thailand (MRTA)

Due to the high concentration of activities and the immigrant workers to the metropolitan region causing problems in the transportation network system that cannot support the rapid growth and population growth as well as requirements of the approximately 18 million individuals that travel each day. The conversion of huge agricultural plots to urban land use without sufficient planning has caused Bangkok's road area to fall below the average for cities with accessible transit (Bangkok has approximately 10 percent of the road area, the entire city area while in Tokyo with 23 percent of road space, and New York City has an area of 38 percent). In addition, the majority of individuals continue to have a requirement for personal automobiles. The greatest of modes of public transportation share their routes with private automobile traffic. Only three percent of the entire amount of travel is comprised of trips taken on public transportation by rail. Therefore, the network is not yet fully operational, therefore, there is no integrated management planning with other forms of transportation. (BMA, 2021).

4.3 MASS RAPID TRANSIT SYSTEM IN BANGKOK

The Mass Rapid Transit Master Plan in Bangkok Metropolitan Region, or M-Map, is the latest version in a series of Thai government plans for the development of an urban rail transit network serving the Greater Bangkok area. It was drafted under the care of the Office of Transport and Traffic Policy and Planning (OTP) of the Ministry of Transport. Mass Rapid Transit Network is a rail transport system in urban areas in Bangkok and its vicinities. It was opened for the first time in 1999 on the BTS Skytrain Sukhumvit Line (Mo Chit Station - On Nut Station) and the BTS Silom Line (National Stadium Station - Saphan Taksin Station). At present, there are a total of 8 lines, 137 stations in service, covering a distance of more than 210.25 kilometers. The current operation line is shown in Table 1.

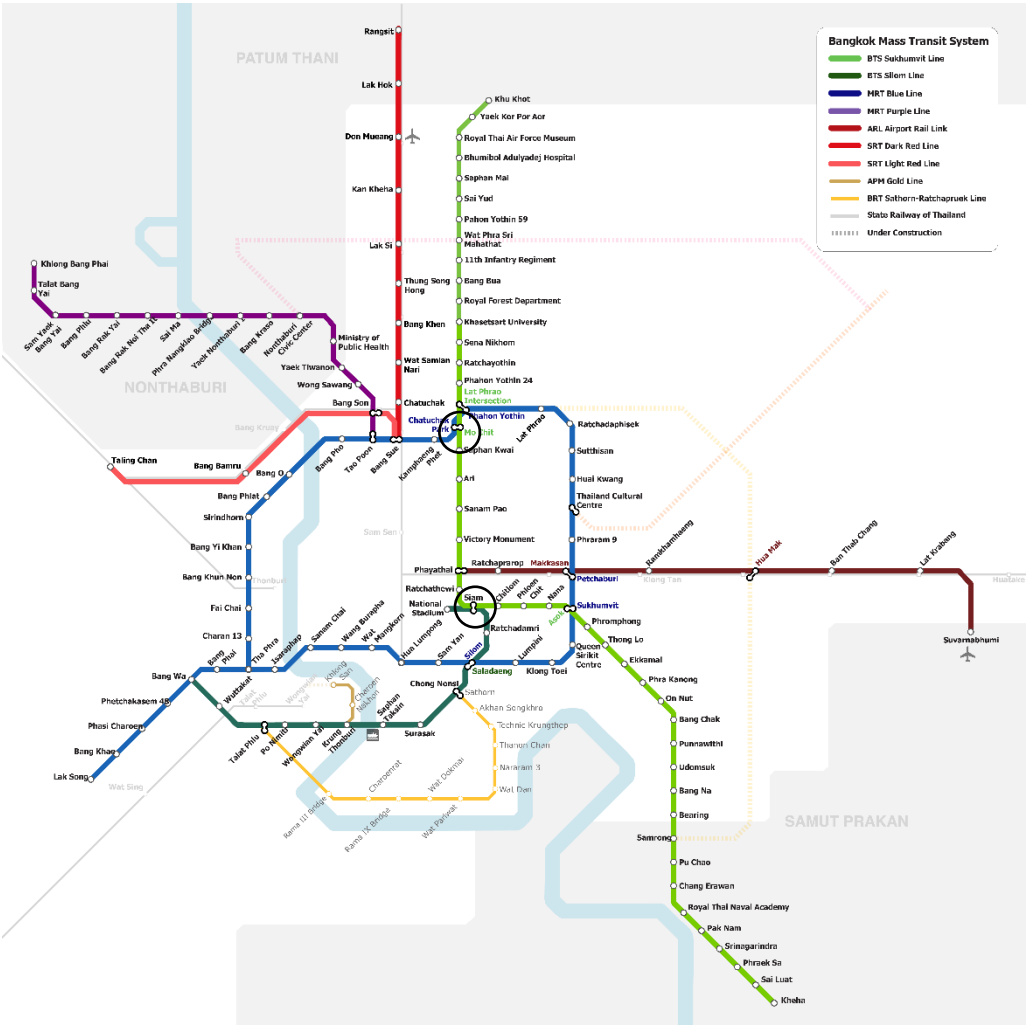
Table 4.1 Mass rapid transit current operation

Line		Number of stations	Distance	First operation year
BTS	Light Green line (Sukhumvit Line)	47	53.58	1999
BTS	Dark Green Line (Silom Line)	14	14.67	1999
APM	Gold Line	3	1.8	2020
MRT	Blue Line	38	47	2004
MRT	Purple Line	16	23.6	2016
APL	Airport Rail Link	8	28.6	2010
SRT	Dark Red Line	10	26	2021
SRT	Light Red Line	4	15	2021
Total		**137**	**210.25**	

Since 1994, there have been many revisions of the master design for the mass rapid transportation system. The most recent version of the master plan is referred to as the second phase of the mass transit network (M-MAP 2), and it focuses on the development of secondary

routes to support the expansion of the city and feed passengers to the main routes of Bangkok. In total, there are 7 versions of the master plan, and the most recent one is called M-MAP 2.

Figure 4.3 illustrates the current mass rapid transit map, which includes 137 stations. There are 13 interchange stations spread over several line and urban zoning areas. This research chose three interchange stations to examine the pedestrian environment. The selection criteria include considering operating years of more than 5 years and locations in various urban conditions. As a result, the case study includes Siam station in the CBD, Mochit station in the urban zone, and Bangwa station in the West Outer Ring zone or suburban zone.



◯ **Case study area (Interchange station)**

Figure 4.3 Mass rapid transit Map (2021)

CHAPTER 5
A STUDY OF PEDESTRIAN ENVIRONMENT TOWARDS TO PASSENGER PERCEPTION OF MASS RAPID TRANSIT STATION: CASE STUDY BTS STATIONS IN BANGKOK

5.1 BACKGROUND

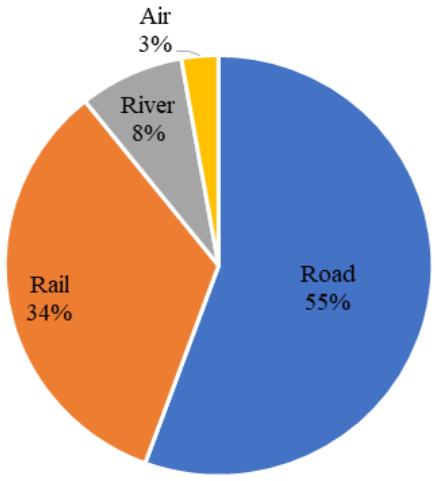


Figure 5.1 Percentage of travel mode in Bangkok (2019)

Bangkok is the capital and economic center of Thailand with a densely populated city with over 5 million registered residents and non-registered and commuter populations with over 3 million. Due to population density, Bangkok has a population density of up to 5,625 people per square kilometer and is growing steadily (National Statistical Office, 2020). According to Bangkok passenger data in 2019, the number of people traveling on the road is more than 60 million with ratio of more than 55% compared to all modes of transport (Figure 5.1). Besides the increase in car registrations in Bangkok in 2016, over 350,000 vehicles compared to the previous year. However, in the last decade, Bangkok has not had more road space. As mentioned above, Bangkok is experiencing problems, both in terms of population density and the increased number of road trips, as well as increased car consumption.

To resolve urban congestion, the Thai government asked for cooperation with the German government to develop a common public transport network. Subsequently, Cabinet adopted a resolution approving the study, recommending and supporting the formulation of a master plan on an ongoing basis since 1994 with the following sequence of development of the master plan. The Mass Rapid Transit network in Bangkok and adjoining areas became the first Mass Rapid Transit System in Thailand. However, with the passage of time and the irregularity of the road, consequently, the original master plan was revised. In 2018, Japan International Cooperation Agency (JICA) has supported the development of current Mass Rapid Transit Master Plan and actual implementation of various Routes. Cooperation between Thailand and Japan continued the development of phase 2 of the blueprint which is called “20-Year Mass Rapid Transit Master Plan for Bangkok Metropolitan Region (M-Map) (2010-2029). This blueprint will focus on the development of secondary routes to support the expansion of the city and feed passengers to the main routes of Bangkok (JICA, 2019)

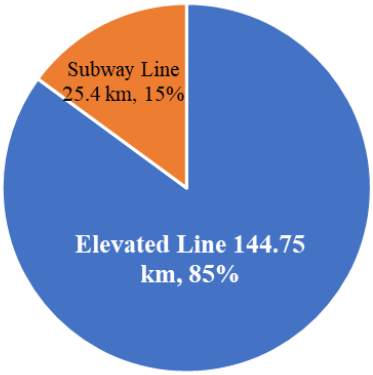


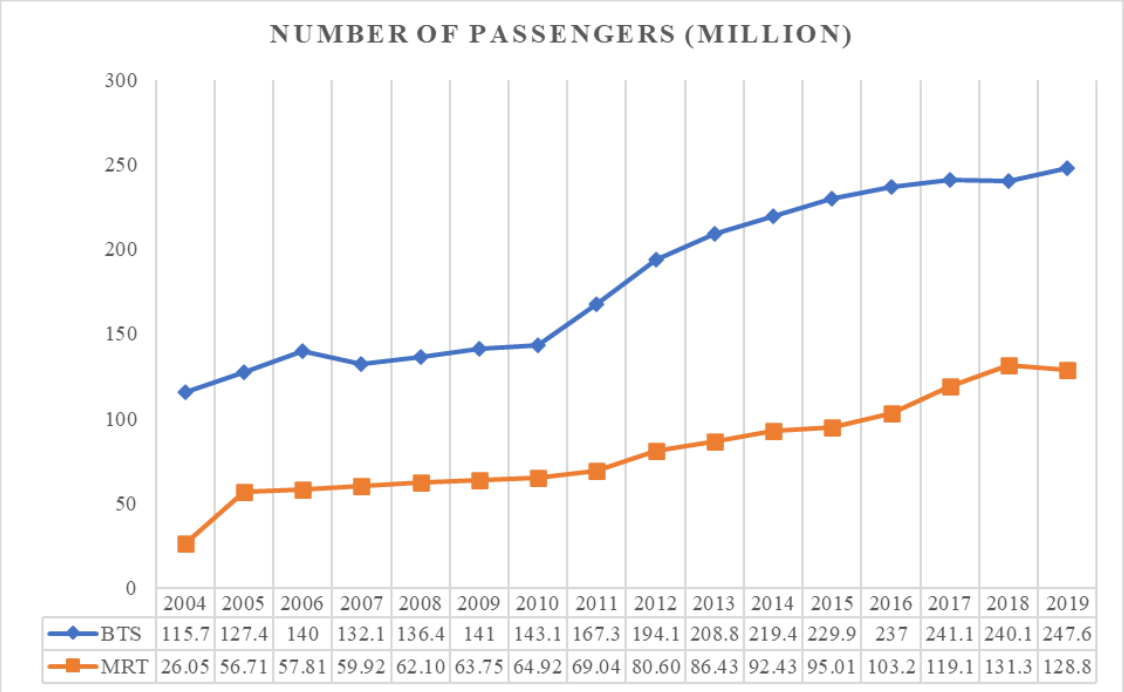
Figure 5.2 Percentage of Distance between Elevated and Subway Line

In 2021, there are 6 lines in service with 124 stations covering over 170 kilometers, including Bangkok Mass Transit System (BTS Skytrain) 60 stations, Metropolitan Rapid Transit (MRT) 53 stations, Suvarnabhumi Airport Rail Link 8 stations and Secondary Mass Transit System Project 3 stations. Table-1 shows Current operation of Mass Rapid Transit stations in Bangkok Metropolitan. Considering the structure of the Railway station found that the distance of Elevated stations are 85%, whereas the Subway stations are only 15% (Figure 5.2)

Table 5.1 Current operation of Mass Rapid Transit stations in Bangkok Metropolitan

Line	Terminal Station	Number of stations	Structure	Distance (km)
BTS Skytrain (BTS)				
Sukhumvit Line	Khu Khot - Kheha	47	Elevated	53.58
Silom Line	National Stadium – Bang Wa	14	Elevated	14.67
Secondary Mass Transit System				
Gold Line	Krungthonburi – Khlong San	3	Elevated	1.80
Metropolitan Rapid Transit (MRT)				
Blue Line				
	Hua Lamphong Station – Bang Sue	18	Subway	20.00
	Hua Lamphong Station – Lak Song	4	Subway	5.40
		7	Elevated	10.50
	Bang Sue Station – Tha Phra	9	Elevated	12.00
Purple Line	Khlong Bang Phai – Tao Poon	16	Elevated	23.60
Airport Rail Link				
	Suvarnabhumi - Phayathai	8	Elevated	28.60
Total		124*		170.15
*The total of station number is included interchange station **not include SRT Line				

Figure 5.3 shows data of the number of passengers from ministry of transport. It was found that since 2004, the number of passengers travelling on BTS stations has continued to grow from 115 million trips in 2004 to 247 million in 2019, representing 132 million trips. As well, MRT passenger traffic also increased from 26 million trips in 2004 to 128 million, reaching 102 million trips in 2019 (Transport, 2019). Compared to the average proportion, it was found that 2.22 times more commuters with BTS than MRT systems, which is the main system of Mass Rapid Transit System, which will be used as a case study.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BTS	115.7	127.4	140	132.1	136.4	141	143.1	167.3	194.1	208.8	219.4	229.9	237	241.1	240.1	247.6
MRT	26.05	56.71	57.81	59.92	62.10	63.75	64.92	69.04	80.60	86.43	92.43	95.01	103.2	119.1	131.3	128.8

Figure 5.3 Number of passengers between BTS and MRT

The characteristic of BTS stations regards to the viaduct placed on a single pole which are generally built in an island in the middle of the road. This elevated walkway is approximately 9 meters wide and is approximately 12 meters high from the ground. The reason for choosing this construction system because the method is quick to install and avoids the impact on congested city traffic. The typical of station design to evade underground and above-ground utilities and maintain the condition of road traffic as much as possible. Generally designed to have a single column structure. The station is located on an island in the middle of the road (Figure 5.4) (BTS, 2019).

According to a measurement of urban quality in urban structures, good city standards should have at least 20-25 percent road surface per city area. The road area also includes the entire portion of the road, which includes traffic surfaces and pedestrians. However, Bangkok

has a total area the urban area of more than 1,569 square kilometers. It has only 7.21% of total road space, and in 7.21%, only 1.44% that are pedestrian walkway (Adisak Kanthamuanglee, 2019).

As mentioned above, most of the structure of the Mass Rapid Transit station is elevated, occupying traffic surfaces on less widely spaced roads. It causes congestion and cannot extend the traffic surface. What happened was an elevated building that covers the area of the road, as well as the entrance to the station which used a limited pedestrian zone, and some stations the pedestrian environment are not conducive to travel such as other vehicle on the footpath and narrow space and building environment are not enhance etc. (Figure 5.5).

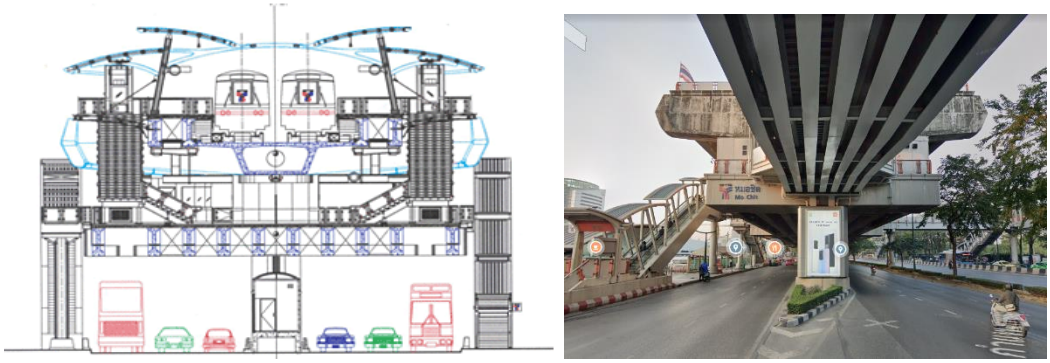


Figure 5.4 Typical Elevated Station (BTS Station)

Figure 5.5 Pedestrian Environment access to BTS stations

This issue has resulted in problems with urban expansion, such as increased congestion and a decline in the quality of life for city dwellers. Therefore, it is important to expand the complete rail network, such as Mass Rapid Transit; pedestrian access to stations is of the utmost significance; and the premium should be placed on environmentally friendly modes of transportation, such as walking. Access to public transportation, which is based on "Good, and Quality of Pedestrian" may motivate people to travel by public transportation, which is the starting point for sustainable urban development and transportation. This is the starting point for sustainable urban development and transportation.

The investigation of people's reactions to their surroundings and how they move

through space are going to be the most important aspects of this research project. Environmental perception is directly tied to the introduction of environmental consciousness, and this relationship implies that the higher the level of awareness, the higher the quality of interaction that exists between man and environment. There is a great deal of individual and collective subjectivity that gets in the way of perception and the process of being aware. The observation and cognitive processes that result in interactive behavior, as well as the judgment and anticipation of how environmental events will unfold, stand out in the context of the environment.

As a result, the major purpose of this research is to conduct an investigation of the pedestrian environment as part of an evaluation of passenger attitudes regarding walking to BTS stations and public transportation in general. The behavior and perception of walking was the primary focus of this research. The bulk of the research is on the perspective of the Passenger with regard to the aspects of the Environment in an effort to comprehend the barrier that prevents access to the Mass Rapid Transit station in Bangkok Metropolitan. There are three hypotheses that point in different directions: 1) A passenger utilizing the Mass Rapid Transit station will give priority to private car as the primary mode of transportation, 2) The pedestrian environment will be significantly different by the perceived difference between age groups, and 3) The passenger will perceive the pedestrian environment negatively. The findings will lead to a better knowledge of the perspectives of passengers, which will serve as a method of guiding the crucial sequence of pedestrian development in the interest of fostering greater user access to stations.

5.2 METHODOLOGY

For the purpose of this study, both quantitative and qualitative research methodologies were utilized by way of an online survey comprised of questionnaires. Previous study on the pedestrian environment in Bangkok served as the basis for the development of the questions. The population consisted primarily of pedestrian passengers who used BTS stations. In order to accomplish the purpose of this research, the questionnaires were structured into three primary portions, which are as follows: 1) Information on the population's demographics, 2) Patterns of travel, and 3) responses to the pedestrian environment. After that, the data were processed with the use of a statistical analysis program, and the investigation was finished up with descriptive statistics, standard deviation analysis, and cross tabulation research to determine the association between the many individual elements.

5.3 FINDINGS AND DISCUSSION

The gathering of information began in September of the next year and involved a total of 601 respondents. The analysis was broken down into three distinct sections.

- Demographics

In general, the majority of respondents (38.6 percent) were between the ages of 24 and 30; more than half were women (67.1 percent)); and the occupation was corporate employee (46.3 percent).

Table 5.2 The Demographics Factor of Respondents

N=601		Frequency	Percent
Age	<18 y	26	4.3
	18-23 y	66	11
	24-30 y	232	38.6
	31-40 y	143	23.8
	41-50	75	12.5
	51-60 y	32	5.3
	>60	27	4.5
Gender	Male	198	32.9
	Female	403	67.1
Occupation	Employee	278	46.3
	Public Servant	61	10.1
	Self-employed	122	20.3
	Student	130	21.6
	Other	10	1.7

- Travel Behavior

The total investigation on the respondents' travel patterns was broken down into three primary categories: 1) the reason for the trip, 2) the transfer from the station, and 3) the mode of travel to the station The majority of respondents needed to transfer to other Mass Rapid Transit stations (33.1 percent); the respondents' preferred mode of transportation to get to the station was public transportation (31.5 percent); and this survey discovered that the percentage of people who walked was slightly higher than the usage of private cars. As a result, the primary reason to take the BTS was to get to work, which accounted for 33,2 percent of all trips taken on the system.

Table 5.3 Travel Behavior

Purpose to travel	Work	33.20%
	Visit family / friends	29.80%
	Go shopping	29.00%
	Others	7.90%
Transfer from station	Transfer to other Mass Transit. (BTS/MRT)	33.10%
	Transfer to bus	23.70%
	Transfer to semi-public transportation (Taxi, Motorbike taxi)	22.00%
	Able to walk between the station and the destination.	21.20%
Travel Mode to station	Private car	12.50%
	Public transportation	31.50%
	Walking	15.90%
	Bicycle	2.80%
	Motorcycle	7.80%
	Taxi, motor bike taxi	20.40%
	Grab	4.80%
	Others	4.20%

An examination of respondents' travel patterns in terms of their trip purposes and their ages revealed that their top travel goals included travelling to work, visiting friends and family, going shopping, and participating in other activities.

Going to work; the majority of them are between the ages of 24 and 30, accounting for 46.40 percent, 31 to 40 years old accounting for 29.70 percent, and 41 to 50 years old accounting for 11.60 percent, respectively. Those who were there to see friends and family ranged in age from 18 to 23 years old (15.50 percent), followed by those who were 31 to 40 years old (22.90 percent), and then those who were 24 to 30 years old (40.20 percent). When it came to shopping, the majority of customers were between the ages of 24 and 30 (35.20 percent), 31 and 40 (28.00 percent), and 41 and 50 (15.50 percent), respectively. And other activities, the majority of respondents fell in the age range of 0 to 23 years old, and the activities were educational in nature.

In a similar vein, this research indicated that individuals between the ages of 24 and 30 were able to walk from the station to their destination, as well as transition to semi-public transportation such as taxis, motorbike taxis, buses, and mass rapid transit systems after leaving the station.

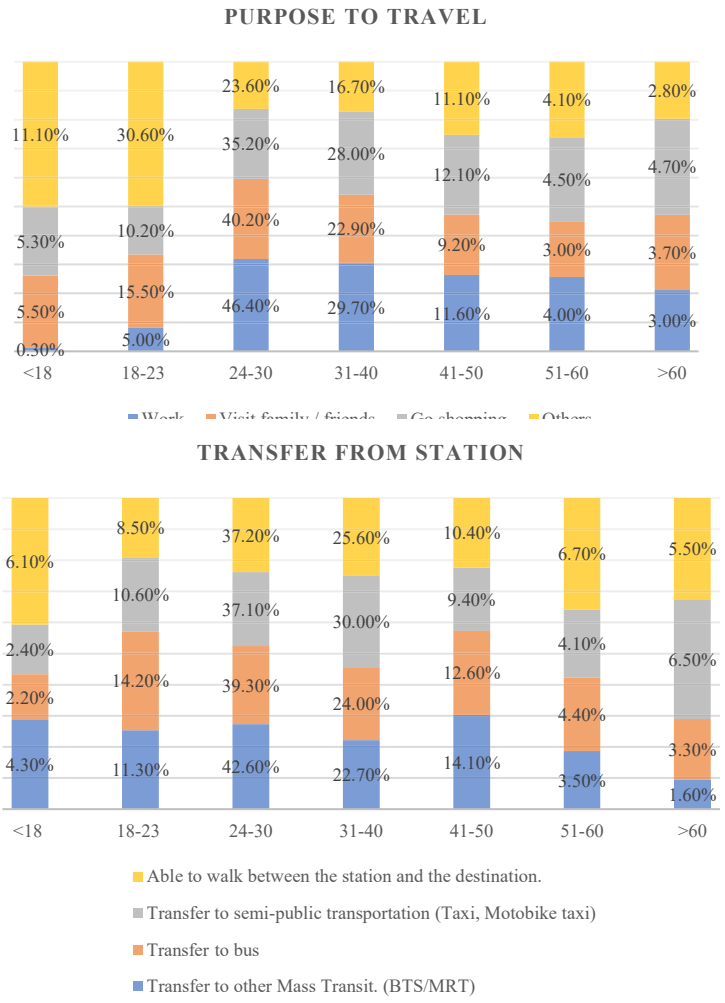


Figure 5.6 Analysis of travel behaviors by age group

Table 5.4 presents the results of an analysis of travel behaviors that were conducted within the context of the section on transportation to the station. The results showed that the majority of individuals traveled to the station using public transportation (31.5 percent), followed by taxis and motor-taxis (20.40 percent) and walking (15.90 percent) respectively. The category of transportation that saw the fewest cyclists was the bicycle (2.80 percent). An investigation of the relationship between age range and mode of transportation to the station revealed that this was true across all forms of travel. The majority of passengers fall within the age bracket of 24 to 40 years old. In the meantime, it was discovered that the senior passengers with ages greater than sixty years old had arrived at the station via GRAB.

Table 5.4 Transportation Mode choice

Mode choice	Responses	
	N	Percent
Public transportation	323	31.50
Taxi, motor bike taxi	209	20.40
Walking	163	15.90
Private car	128	12.50
Motorcycle	80	7.80
Grab	49	4.80
Others	43	4.20
Bicycle	29	2.80

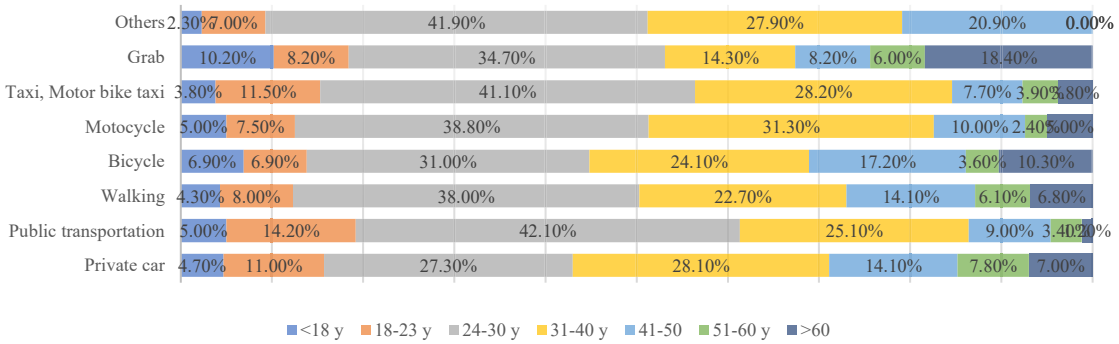


Figure 5.7 Analysis of Travel Mode to Station by age group

- Perception

Compare walking, driving a private automobile, and using a rapid transit system based on the results of a poll that asked passengers about their perceptions and attitudes towards various modes of transportation. The research questions were broken down into four basic categories: the principal form of transportation (option 1), convenience (option 2), cost-effectiveness (option 3), and safety (option 4) and timeliness (option 5). The evaluation scale consists of four distinct levels, which are as follows: strongly agree (3.5-4.0), agree (2.50-3.49), disagree (1.50-2.49), and strongly disagree (1.00-1.49). The MEAN statistical analysis served as the foundation for this investigation's grounds for explanation. The findings demonstrated that the vast majority of respondents were in agreement on practically all aspects of driving a private automobile, which has a higher average than taking public transportation, with the exception of timeliness. During this period, the Cost-effectiveness component of the survey revealed that Mass Rapid Transit got the lowest average score.

In the Walking study, the majority of respondents were against it, mostly for the reasons of convenience and safety, with an average score of just 1.80 and an average score of 1.83 respectively.

The results of an age-based attitude survey on walking are presented in Figure 5.8. The findings revealed that a sizable proportion of people of all ages were opposed to walking being selected as the principal means of transportation. However, the majority of them offer a great deal of help in terms of cost-effectiveness.

Table 5.5 Attitude toward Transportation

Passenger's Attitude	Private Car		Mass Rapid Transit		Walking	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
1) The primary travel mode choice	3.12	0.79	3.08	0.58	1.97	0.68
2) Convenience	3.36	0.67	3.19	0.61	1.80	0.63
3) Cost-effectiveness	2.91	0.81	2.69	0.85	2.72	0.92
4) Safety	3.35	0.62	3.21	0.60	1.83	0.69
5) Punctuality	2.64	0.91	3.21	0.69	2.09	0.77

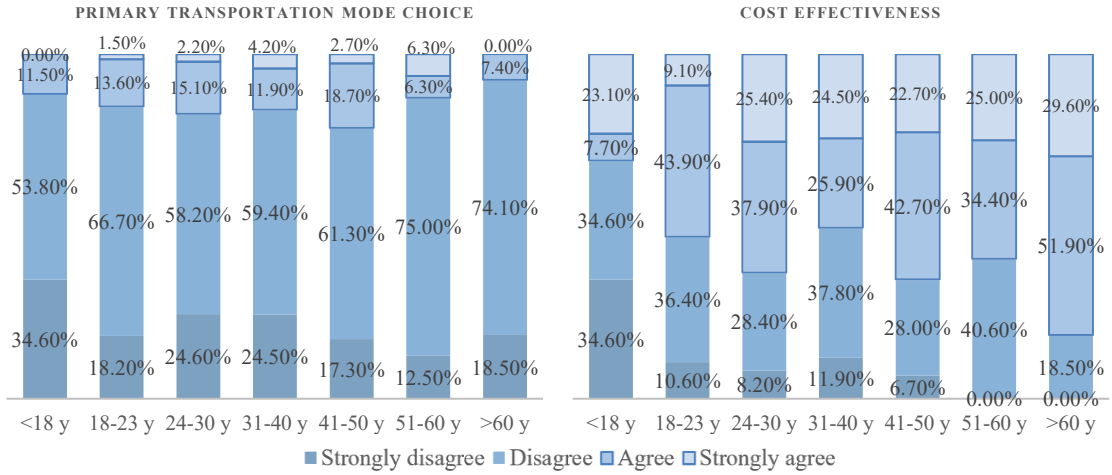


Figure 5.8 Attitude and Perception toward walking

According to the results of the study of the pedestrian environment, the three most prevalent issues are broken pavement and uneven surfaces (15.10 percent), a lack of shade provided by trees (13.00 percent), and a dusty sidewalk (12.10 percent). Other cars driving on pedestrians, walkways that were too small, and flooding made for around 11 percent of the total (Table 5.6). In addition, a number of respondents mentioned that the distance between the destination and the station is rather far, and that it takes a considerable amount of time to walk there.

Table 5. 6 Perception to Pedestrian Environment

Obstacles		Responses	Percent
1	Rough pavement, uneven surfaces.	346	15.10%
2	No shading of trees	297	13.00%
3	Sidewalks are dirty	277	12.10%
4	The pedestrian route is shared with other vehicles.	264	11.50%
5	The sidewalk is narrow.	260	11.40%
6	Flooding	257	11.20%
7	Obstacle on sidewalk	228	10.00%
8	No facilities	218	9.50%
9	A beggar or a homeless person living on the sidewalk	110	4.80%
10	Others	29	1.30%

One-way ANOVA is a method that can be used to compare the procedures of two samples, and the significance level for testing the hypothesis is set at 0.05. The Analysis of Variance between Perception toward Pedestrian Environment and age group is evaluated by using this method. The significance level for this test is 0.05.

According to Table 5.7, the findings of the respondents of various age groups regarding pedestrian perceptions found that there were three aspects of the pedestrian environment that showed significant differences at the 0.05 level. These aspects include the fact that the pedestrian route is shared with other vehicles (0.008), that there is no shading from trees (0.035) or roofs, and that there is flooding (0.000).

Table 5.7 Analysis of Variance between Perception toward Pedestrian Environment and age group

		df	Mean Square	F	Sig.
Rough pavement, uneven surfaces	Between Groups	6	0.133	0.540	0.778
	Within Groups	594	0.246		
The pedestrian route is shared with other vehicles	Between Groups	6	0.714	2.952	0.008*
	Within Groups	594	0.242		
Sidewalks are dirty	Between Groups	6	0.434	1.758	0.105
	Within Groups	594	0.247		
The sidewalk is narrow	Between Groups	6	0.121	0.490	0.816
	Within Groups	594	0.247		
Obstacle on sidewalk	Between Groups	6	0.187	0.792	0.576
	Within Groups	594	0.236		
No facilities	Between Groups	6	0.306	1.325	0.244
	Within Groups	594	0.231		
No shading of trees or roof	Between Groups	6	0.565	2.284	0.035*
	Within Groups	594	0.247		
Flooding	Between Groups	6	1.487	6.391	0.000*
	Within Groups	594	0.233		
A beggar or a homeless person living on the sidewalk	Between Groups	6	0.214	1.433	0.200
	Within Groups	594	0.149		
Others	Between Groups	6	0.121	2.681	0.014
	Within Groups	594	0.045		

The mean difference is significant at the 0.05 level.

5.4 Conclusion

In the following three categories, this study offers a response to the study's underlying assumption:

1) Passengers using the Mass Rapid Transit station will give priority to private car as the primary mode of transportation.

The findings of the survey mirror the perspective of passengers, who, for the most part, choose to travel by private automobile rather than by public transportation or on foot. This preference is driven mostly by concerns over comfort and safety. Although the government has made efforts to promote public transportation as a primary mode of travel, such efforts have not proven fruitful. To be more specific, the creation of a master plan for rail transportation linking Bangkok to suburban and metropolitan centers in the surrounding areas. However, due to conditions that are physically restrictive to the expansion of the area and the lack of integration of areas to promote public transportation, such as the development of pedestrian paths in connection with stations or areas that promote an atmosphere conducive to walking, including traffic control or restriction, etc., the area cannot be expanded.

2) The pedestrian environment elements will be significantly different by the perceived difference between age groups.

There are a variety of different pedestrian elements that have the potential to influence the viewpoints of people of diverse ages. Some examples of these factors are the presence of other vehicles on footpaths, a lack of shade trees, and floods. It is essential to take into mind the demographic tale of differences between age groups when designing or improving the environment for pedestrians. As a direct result of this, these physical elements of the region need to be taken into consideration in extensive physical studies of the area in order to improve the pedestrian path so that it is more appropriate for a wider age range.

3) The passenger will perceive the pedestrian environment negatively

The assessment of the pedestrian environment that accesses the station revealed a rough footpath, the absence of trees that provide shade, and uncleanliness are barriers that impact the view of going in a direction that is unfavorable. This agrees with the findings of the study on the typical walker's perceptions of convenience and safety, despite the fact that the majority of respondents hold the opposite view. Therefore, the pedestrian environment is of great importance and must be created in conjunction with improvements in the utilization of the area surrounding the station in order to encourage walking and contribute to the continued support of the mass transport system.

The study of perception for pedestrians may have found that the pedestrian

environment that connects to Mass Rapid Transit stations has many problems and barriers that make walking difficult. In particular, the perception and attitude of pedestrians in different age groups differ significantly from one another. As a result, the general consensus among pedestrians is unfavorable, particularly with regard to the convenience and safety of the area. This is mirrored in the commonly held belief that driving one's own automobile is preferable to relying on public transportation or walking as a mode of mobility. The findings of this study have the potential to provide a response to the question posed in the goal, which is how the user perceives the pedestrian environment features that impact access to the station.

In order to have a complete understanding of the walkability to the Mass Rapid Transit Station in Bangkok, the subsequent research should lead to the subsequent research in terms of the relationship between perception and physical urban planning on the pedestrian connection to the stations. This will allow for a complete comprehension of the walkability to the station.

CHAPTER 6
RELATIONSHIP OF PASSENGER SATISFACTION AND PEDESTRIAN ENVIRONMENT ACCESS TO MASS RAPID TRANSIT STATION IN DIFFERENT URBAN ZONING: CASE STUDY INTERCHANGE STATIONS IN BANGKOK

6.1 BACKGROUND

The mass rapid transit network is a rail mass transit system in Bangkok and its vicinities. It began operation in 1999 with the BTS Sukhumvit line and the BTS Silom line. At present, there are eight lines and 137 stations in service covering more than 210.25 kilometers. The current mass rapid transit plan is aimed at establishing a public transport society to support the region's sustainable development and to enhance accessibility.

However, Bangkok still has severe traffic congestion, with the number of personal vehicles increasing considerably, and limited walking in pedestrian areas. The number of registered personal vehicles from 2010–2020 increased significantly between 2010–2013, before declining in 2014 and steadily rising until the COVID-19 pandemic in 2020. Overall, the number of personal cars increased by approximately 350,000 vehicles per year (Transport, 2019). According to the Department of Public Works, the Department is responsible for a pedestrian area in Bangkok approximately 6.25 square kilometers. Moreover, the central unit that oversees the construction and maintenance of roads and sidewalks is the Construction and Reconstruction Office (Department of Public Work, 2018). The construction and restoration office interview indicates that certain pedestrian areas are regularly repaired. But the sidewalks are heavily used, including motorcycles and parked cars, along with "abuses" such as hawkers and stalls, and many are old and require renovation. Moreover, the sidewalks require utilities repairs that leave uncovered holes, causing repeat repairs to the same spot. Currently, the pedestrian still has many barriers that make walking difficult, such as obstacles, safety against crime, pedestrian crossings, other vehicles driving in the pedestrian areas, and narrow pathways (Boonon, 2020). Therefore, Walking can be beneficial for all sectors of society, trade, and business, environment and health and safety of residents. Walking is also a universal way of transport, and for many people, the only possible transportation. Therefore, the best part of the pedestrian environment would encourage people to walk and make the urban city more sustainable.

Mass rapid transit is the primary mode of transportation for reducing traffic congestion in downtown Bangkok, but the number of private cars has continued to grow over the past year. This may indicate that the mass rapid transit system has not been reduced traffic congestion. If the environment can be to help people walk, it can build the urban and lively environment and convince people to shift from private car trips to public transportation.

Consequently, pedestrian access to the station would be an essential consideration that encourages greater use of mass rapid transit and make the city more walkable and sustainable.

The issue of pedestrians in Bangkok is multidimensional. Walking is a primary transport without pollution and may reflect the quality of urban life in the city. The communities have a good pedestrian environment to support gatherings and social life. Therefore, user perception may indicate satisfaction. However, safety and the pedestrian environment do not support walkability access to the station, which is the main source of public transportation.

This study seeks to comprehend passenger satisfaction towards pedestrian access to the mass rapid transit station in each urban zone in Bangkok in order to 1) identify the relationship between passenger satisfaction and pedestrian environment between each urban zone in Bangkok; and 2) evaluate the variables of passenger satisfaction mean with the pedestrian environment using walking indicators.

The assumptions are that 1) the perception of the pedestrian environment in each city area will be completely different. Particularly in the CBD zone, passenger satisfaction expects to be significantly higher than in other areas. And 2) that the differences between the personal variables will result in a different perception of the pedestrian environment. This study's outcome could lead people to understand the satisfaction of walking to a mass rapid station in different urban- zones in Bangkok. Moreover, to understand the physical encirclements formed through the perception and feelings of the passengers, which can improve the pedestrian path that is suitable for everyone of all ages in every zone of Bangkok, therefore, supporting sustainable transport going forward.

6.2 LITERATURE REVIEW

6.2.1 AN OVERVIEW OF PEDESTRIAN STUDY IN BANGKOK AND OTHER CITIES

Research on the pedestrian in Bangkok includes Level-Of-Service standards for pedestrian facilities comparing the level of service standard with the United States (Tanaboriboon Yordphol, 1989). The study on pedestrian trip length with types of pedestrian destinations (Townsend Craig, 2009). Determining an influencing area affecting walking speed on the footpath (Tipakornkiat, 2012). Other research examines the urban physical environment and pedestrian quantity (TWINPRAWAT, 2018). Concerning the five research articles above, the variables are relevant to distance, Level-Of-Service perception of pedestrians, and the relationship between urban land use and pedestrain. Another study investigated pedestrian satisfaction in urban environments under transit-oriented development (TOD). This study, which analyzed three areas of mass rapid transit stations in Bangkok, asked the respondents to evaluate the influence of site on the level of distance they

were willing to walk under different street conditions (Pawinee IAMTRAKUL, 2011). However, a study of pedestrians' connection to mass rapid transit has yet to study the perception of the pedestrian. Furthermore, users' satisfaction through the pedestrian connection to the station has yet to be examined through a comprehensive survey. One study of walking in Bangkok, called "The Good walk Thailand," is a project being conducted at the Urban Design and Development Center Chulalongkorn University (UddC, 2014). and supported by the Health Promotion Foundation (Thai Health Promotion Foundation). The project's aim is to promote daily walking of people in urban areas. This study found five significant problems affecting walking in Bangkok: lack of shade and cover, dark corridors, insufficient lighting, dirty sidewalks with solid waste, and bumpy and uneven pavement. And an academic research study about the physical aspects and convenience of walking along the BTS Green Line (Silom-Line) was based on questionnaires on pedestrian satisfaction. However, the limitation of this research was that the data provided by respondents were not diverse because most respondents were students. Furthermore, the overall problem of the pedestrian in Bangkok is unfriendly pedestrian such as the physics of pavement is not supported for walking, and the walking environment is not comfortable for people and especially in the safe environment.

However, there are many studies about pedestrians in other countries. VPS (2003) studied pedestrian behaviors at various urban crosswalks in urban boulevards in Michigan, USA. This study found that midblock crosswalks for pedestrians, and vegetation and concrete barriers influenced the decision to cross for a significant number of pedestrians surveyed (Sisiopiku V.P, 2003). Campbell (2003) reviewed pedestrian safety in the United States and abroad, such as Australia, Canada, the Netherlands, Sweden, and the United Kingdom. The significant findings related to pedestrians showed that improved nighttime lighting can enhance pedestrian safety in certain situations; providing raised medians on multi-lane roads can also substantially reduce pedestrian crash risk and help pedestrians cross the street; sidewalks and walkways enhance pedestrian safety and mobility and are critical components of a pedestrian transportation network in urban and suburban areas; and rural roads should also have shoulders for pedestrian travel.

6.2.2 AN OVERVIEW OF PEDESTRIAN ENVIRONMENT, PERCEPTIONS, AND SATISFACTION

Present-day, walking is sustainable transportation and the primary transportation mode for many. The development of a better environment for pedestrians can make more people start walking. Moreover, walking can improve the quality of life for all people (Schmeidler, 2010). Various studies have measured pedestrian environment indicators by investigating the physical condition of pavement and walking barriers. Karel (2010) stated

that obstructions preventing walking can be divided into three general areas: 1) social environment, 2) physical environment, and 3) travelling distance and needed time. The pedestrian safety index (PSI) model was studied in one street in Singapore, with 24 indicators reviewed from the twenty developed guidelines in various countries (Asadi-Shekari, 2015). The primary focus of this model is physical observation. Most research on the pedestrian environment is related to the concept of walking ability that has been classified. Most research on the pedestrian environment is related to the walkability concept, which was classified under factors such as connected, convivial, conspicuous, comfortable, convenient, coexistence, and commitment. Nevertheless, the users' perception of pedestrian infrastructure in developing nations is being increasingly studied and sometimes translated into designing the walking environment (Bhaduri, 2019).

6.3 SURVEY METHODOLOGY

Bangkok area divisions result from economic growth, infrastructure, land prices, and development into future investments. Consequently, no specific area is dedicated to one type because it depends on economic activities. This study divided the entire urban zoning base of the economic and main route structure linked to the center of Bangkok into four urban zones: 1) Central Business District Zone (CBD), areas with the most social and economic activity, 2) Urban zone, a densely populated neighborhood with a wide variety of economic and social activities, 3) East Outer Ring Road, an area that can connect to travel into the city quickly and connects to the provinces in the eastern part of Thailand, and 4) West Outer Ring Road, this area connects to the five provinces around Bangkok.

Table 6.1 Detail of interchange stations in Bangkok

Station Name	Mass Rapid Transit Network	Zoning	Operating Year
Siam	Sukhumvit Line to Silom Line	Central Business District	1999
Asok	Sukhumvit Line to Blue Line	Central Business District	1999
Mo Chit	Sukhumvit Line to Blue Line	Urban	1999
Phaya Thai	Sukhumvit Line to Airport Rail Link	Urban	1999
Sala Daeng	Sukhumvit Line to Blue Line	Central Business District	1999
Bang Wa	Sukhumvit to Blue Line	West Outer Ring Road	2013

Regarding urban zoning, the interchange of BTS stations that are the research areas

are located in three urban zones: CBD zone, Urban zone, and West Outer Ring Road zone (Table 6.1). This case study focuses on elevated interchange stations (TerraBKK, 2014).

These stations are located in commercial centers or residential areas. Cities typically plan for land use around interchange stations for development areas. The case study selection criteria was stations in operation for more than five years. A total of six stations me the criteria: A) Siam station, B) Asok station, C) Mo Chit station, D) Phaya Thai Station, E) Sala Daeng station, and F) Bang Wa station (Figure 6.1).

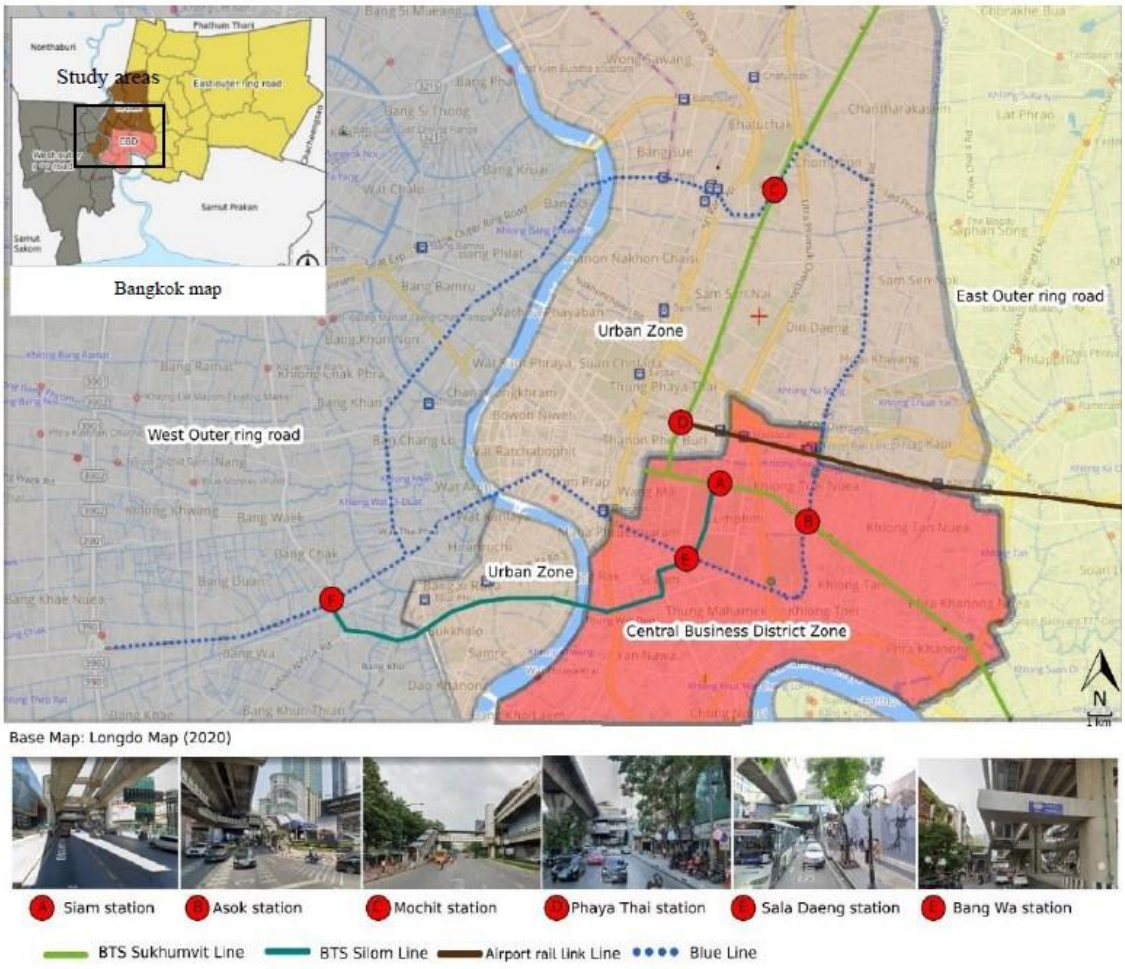


Figure 6.1 The location of BTS interchange

For the purpose of this study, an online questionnaire survey was carried out in order to gain an understanding of the connection between the BTS Station in Bangkok and the level of happiness and perspective that passengers have regarding the pedestrian environment. The sample size was determined to be a representative subset of a finite population using Yamane's formula, which may be found below;

$$n = \frac{N}{1 + Ne^2}$$

Where n = Sample size
N = Population size
e = Level of precision or Sampling of Error which is ±5 percent

The size of the sample was determined by looking at the total number of people who fall into the target demographic and use interchange stations. According to the most recent information available, there were around 94,000,000 passengers in the year 2016. Therefore, the minimum sample size to be collected was 400 samples. The questionnaire was divided into three parts: 1) demographic data, 2) travel behavior, and 3) satisfaction and perception of pedestrian environment. The satisfaction part was designed based on pedestrian accessibility and attractiveness indicators, which have an analysis scale in a microscale at street level to find passenger satisfaction through a set of walkability dimensions that form the 7Cs layout consisting of 1) connectivity 2) convenience, 3) comfort, 4) conviviality, 5) conspicuous, 6) coexistence, and 7) commitment.

Table 6.2 Pedestrian Environment indicator 7Cs layout

Key concern	Definition	Elementary viewpoint
Connectivity	The extent to which the pedestrian environment is linked; interfaced; joined; attached; networked.	Network and connectivity
Convenience	The extent to which the pedestrian environment is appropriate; useful; proper; suitable; timesaving.	Sidewalk availability (width)
Comfort	The extent to which the pedestrian environment is easy; pleasant; protected; relaxed; sheltered; untroubled.	Amenities
		Presence of trees
		Pedestrian canopy
		Lighting
Conviviality	The extent to which the pedestrian environment is entertaining; lively; pleasant; sociable.	Fence and walled buildings
		Building shops/ No obstacle
Conspicuous	The extent to which the pedestrian environment is obvious; clear; scribble; distinct; perceptible.	Street enclosure
Coexistence	The extent to which the pedestrian and other transport modes can exist at the same time and place with order and peace.	Conflicts
		Sidewalk buffer (width)
Commitment	The extent to which there exists engagement, liability, and responsibility towards the pedestrian environment.	Maintenance of sidewalk
		Cleanliness

The population of this study is passengers traveling to and from the BTS stations where the case studies are located. The data were gathered through an online questionnaire

by Google Form. The ratio of the sample corresponds with the number of passengers per station. The type of sampling was determined by purposive sampling. The characteristics of the selected group were consistent with the research objectives that were referred to the case study stations. Figure 6.2 shows the sample of respondent's selection Methodology Diagram, which had two sets of questionnaires appropriate for the target group of that survey. This survey used Set A, which focused on satisfaction with pedestrian elements. Moreover, Table 6.3 shows the sampling size of the questionnaire survey, which was related to passenger trips.

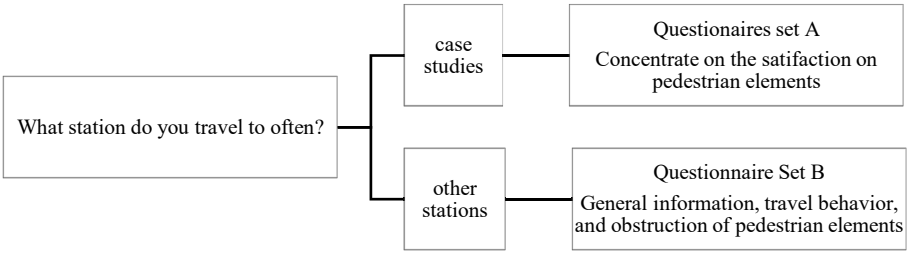


Figure 6.2 Sample of respondent's selection Methodology Diagram

To evaluate satisfaction, the rating used Likert 5 point scale (5 = Very Satisfied, 4 = Satisfied, 3= Slightly Satisfied, 2= Dissatisfied, 1= Very Dissatisfied). Based on the assessment of the pedestrian environment indicators of micro-scale walkability by TRIMIS (Transport Research and Innovation Monitoring and Information System), the questions asked about satisfaction with 13 elements (Table-3) comprising 1) pedestrian network continuity, 2) sidewalk available, 3) amenities, 4) presence of tree, 5) Pedestrian canopy, 6) lighting, 7) fence and walled buildings, 8) no obstacle, 9) path enclosure, 10) conflicts, 11) sidewalk buffer width, 12) maintenance of sidewalk, and 13) cleanliness.

The analysis relied primarily on cross-tabulation-analysis and narrative analysis to investigate the objective and assumption.

Table 6.3 The sampling size of the questionnaire survey

Station	Passenger trips per year (2016)	Ratio	Sampling (Minimum)	Total Respondents
Siam	23,563,874	25%	100	117
Asok	19,475,356	21%	82	83
Mo Chit	16,076,588	17%	68	88
Phaya Thai	16,004,290	17%	68	70
Sala Daeng	12,340,499	13%	52	53
Bang Wa	7,251,844	8%	31	58
Total	94,712,451	100%	400	469

Source: BTS (2016)

6.4 FINDINGS

6.4.1 DEMOGRAPHIC CHARACTERISTIC OF RESPONDENTS

The survey was distributed and collected in September 2020, with 469 respondents from six stations. The overall descriptive analysis of all respondents indicated that most respondents were between the ages of 24 and 30, women and working as employees. Over half of those were not living in the 800-meter radius from a station. Table 6.4 shows that in CBD, most respondents' occupations were similar for Urban and West Outer Ring Road zone but for West Outer Ring Road most respondents were students (48.3%). In CBD, family members were two people and more than three people, similar to Urban zone and West Outer Ring Road. Most families had two members and most respondents had at least one private car. In CBD, most respondents had at least one car, but in the Urban zone and West Outer Ring Road, only some people do not own cars.

The statistics for responders are presented in table 6.5, organized by urban zone. The dwelling site was more than 800 meters away from the station in all of the urban regions, notably in the suburbs (62.1 percent). Families typically consisted of two people, while some households in urban areas had up to three people.

In terms of the number of privately owned automobiles, respondents who reside in the CBD zone have at least one vehicle (40.7%), whereas respondents who live in the Urban region have at least one vehicle (36.9%). (39.2 percent). However, in the West Outer Ring Road zone, the vast majority of responders do not possess their own cars (34.5 percent).

The analysis may demonstrate that even respondents who lived in the CBD area have their own vehicle more so than in other areas. It shows that even within the CBD area, which is the center of primary transportation such as mass rapid transit, people still have private cars.

Table 6.4 Descriptive Analysis of Respondents

Station Name	SIAM	ASOK	MO CHIT	PHAYA THAI	SALA DAENG	BANG WA
Sample size	**117**	**83**	**88**	**70**	**53**	**58**
Zoning	**CBD**	**CBD**	**Urban**	**Urban**	**Urban**	**WOR**
Age						
<18 y	4.3%	2.4%	2.3%	1.4%	18.9%	10.3%
18-23 y	19.7%	9.6%	3.4%	14.3%	9.4%	22.4%
24-30 y	48.7%	42.2%	35.2%	54.3%	34.0%	41.4%
31-40 y	19.7%	31.3%	33.0%	24.3%	17.0%	15.5%
41-50	7.7%	12.0%	12.5%	5.7%	15.1%	8.6%
51-60 y	0.0%	1.2%	13.6%	0.0%	3.8%	1.7%
>60	0.0%	1.2%	0.0%	0.0%	1.9%	0.0%
Gender						
Male	21.4%	22.9%	31.8%	34.3%	32.1%	24.1%
Female	78.6%	77.1%	68.2%	65.7%	67.9%	75.9%
Occupation						
Employee	39.3%	62.7%	51.1%	50.0%	47.2%	41.4%
Public Servant	9.4%	4.8%	15.9%	5.7%	9.4%	1.7%
Self-employed	20.5%	19.3%	23.9%	12.9%	11.3%	8.6%
Student	30.8%	13.3%	9.1%	31.4%	32.1%	48.3%
Residential Location from the station						
500 m	13.7%	19.3%	11.4%	15.7%	22.6%	12.1%
800 m	24.8%	33.7%	33.0%	28.6%	22.6%	25.9%
other	61.5%	47.0%	55.7%	55.7%	54.7%	62.1%
Number of Family						
1 member	18.8%	10.8%	15.9%	17.1%	9.4%	8.6%
2 members	27.4%	39.8%	33.0%	54.3%	30.2%	36.2%
3 members	19.7%	24.1%	19.3%	12.9%	20.8%	19.0%
>3 members	34.2%	25.3%	31.8%	15.7%	39.6%	36.2%
Number of Own vehicles						
1 vehicle	39.3%	42.2%	42.0%	34.3%	41.5%	29.3%
2 to 3 vehicles	31.6%	25.3%	23.9%	15.7%	37.7%	31.0%
>3 vehicles	8.5%	2.4%	8.0%	2.9%	1.9%	5.2%
no vehicle	20.5%	30.1%	26.1%	47.1%	18.9%	34.5%

Note: WOR means West outer ring road , Lowest to highest

Table 6.5 Descriptive Analysis Categorized by Urban Zone

Zoning	CBD	Urban	WOR
Residential Location from the station			
500 m	16.5%	16.5%	12.1%
800 m	29.2%	28.0%	25.9%
other	54.2%	55.3%	62.1%
Number of Family			
1 member	14.8%	14.1%	55.7%
2 members	33.6%	39.1%	0.0%
3 members	21.9%	17.6%	17.1%
>3 members	29.7%	29.0%	54.3%
Number of Own vehicles			
1 vehicle	40.7%	39.2%	29.3%
2 to 3 vehicles	28.4%	25.7%	31.0%
>3 vehicles	5.4%	4.2%	5.2%
no vehicle	25.3%	30.7%	34.5%

Note: WOR means West outer ring road , Lowest to highest

6.4.2 Travel Behavior Analysis

1) Travel time to the station

Table 6.6 shows the details from the survey of travel time to the station categorized by urban zoning. In the CBD, zone travel was within 500 meters, about 10–30 minutes (24.1%), within 800 meters, about 30 minutes to an hour (39.1%), and beyond 800 meters, more than 1 hour to reach the station (82.4%). In the Urban, zone travel was within 500 meters, less than 5 minutes (38.5%), within 800 meters, 30 minutes to an hour (38.2%), and beyond 800 meters, more than 1 hour to reach the station (94.7%). Travel time to the West Outer Ring Road zone was within 500 meters, 15–30 minutes (23.8%), within 800 meters, 30 minutes to 1 hour, and beyond 800 meters, most respondents more than 1 hour to reach the station (100%).

All areas outside the 800 meters radius of the station could reach the station in more than one hour. However, focusing on the CBD zone within a 500-meter radius of the station, the result was that only 16.7%. of people would reach the station within 5 minutes. Meanwhile, the Urban area within a 500-meter radius might reach the station in 5 minutes more than the CBD zone by 38.5%. Moreover, no respondents could reach the station in less than 5 minutes in the West Outer Ring Road zone.

Table 6.6 Travel Time to the Station Categorized by Urban Zoning

Station Zoning	< 5 mins	5-10 mins	10-15 mins	15-30 mins	30 mins - 1hour	> 1hour
CBD_500 m	16.7%	12.5%	24.1%	24.1%	8.7%	0.0%
CBD_800 m	16.7%	25.0%	10.3%	37.9%	39.1%	17.6%
CBD_other	66.7%	62.5%	65.5%	37.9%	52.2%	82.4%
URBAN_500 m	38.5%	22.2%	11.5%	19.0%	10.3%	5.3%
URBAN_800 m	23.1%	29.6%	34.6%	25.9%	38.2%	0.0%
URBAN_other	38.5%	48.1%	53.8%	55.2%	51.5%	94.7%
West Outer Ring Road_500 m	0.0%	8.3%	12.5%	23.8%	0.0%	0.0%
West Outer Ring Road_800 m	28.6%	41.7%	12.5%	19.0%	42.9%	0.0%
West Outer Ring Road_other	71.4%	50.0%	75.0%	57.1%	57.1%	100.0%

Highest percentage score

Figure 6.3 shows the overall commuting time to the station by zoning area, which was categorized into three zones. The graph demonstrates that most respondents took 15–30 minutes to get to the stations in each zone. The Urban zone took 30 minutes to 1 hour, with the highest score (32.0%), while the CBD zone and the Urban zone for over 1 hour each had the same percentage (9.0%). Focusing on the trend line, the CBD and Urban zones were similar commuting timelines, ascending travel times tend to be higher. Meanwhile, the West Outer Ring Road is tending in the opposite direction.

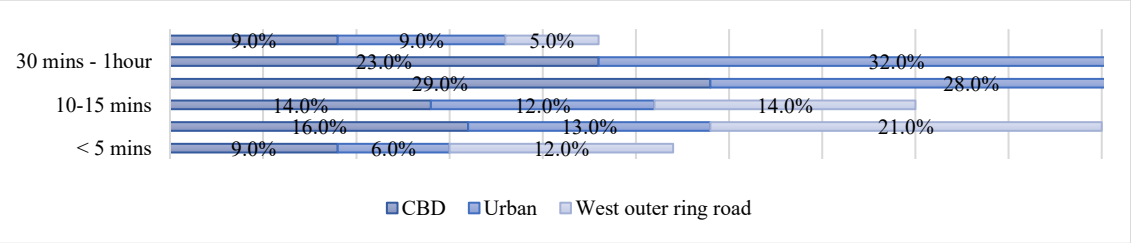


Figure 6.3 Commuting Time to the Station by Zoning

2) Travel mode to the station

Figure 6.4, which shows the analysis of travel mode choice to the station, shows that in all areas most people's first mode of choice for transportation travel is public transportation: CBD zone 31.6%, Urban zone 38.1%, and West Outer Ring Road zone 45.1%. In comparison, semi-public transportation such as taxi and motorbike taxi were the second mode choice and then private car. Walking, however, showed a smaller proportion: CBD zone 13.9%, Urban zone 11.9%, and West Outer Ring Road zone 4.9%. Travel by bicycle was found to be the least proportioned at 1.2%– 2.9%. When analyzing spatial areas, the CBD

zone had the lowest public transport relative to other areas and the percentage of walking was the highest.

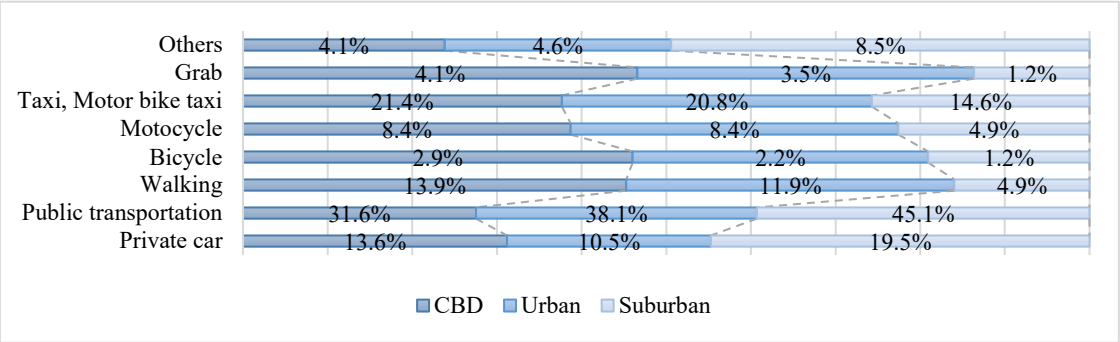


Figure 6.4 Travel mode choices to station

6.4.3 PASSENGER SATISFACTION TO PEDESTRIAN ENVIRONMENT

Overall, analyzing the satisfaction of pedestrian access to the station using ratings from 4.50 to 5 (Very Satisfied), 3.50 to 4.49 (Satisfied), 2.50 to 3.49 (Slightly Satisfied), 1.50 to 2.49 (Dissatisfied), and 1.00 to 1.49 (Very Dissatisfied).

As a direct consequence of this, passengers expressed dissatisfaction with several aspects of the indicators (2.74 - 3.33). The indication that showed the highest level of dissatisfaction was conflict (2.74), whereas the indicator that showed the highest level of satisfaction was continuity of the pedestrian network (3.33). (Figure 6.5).

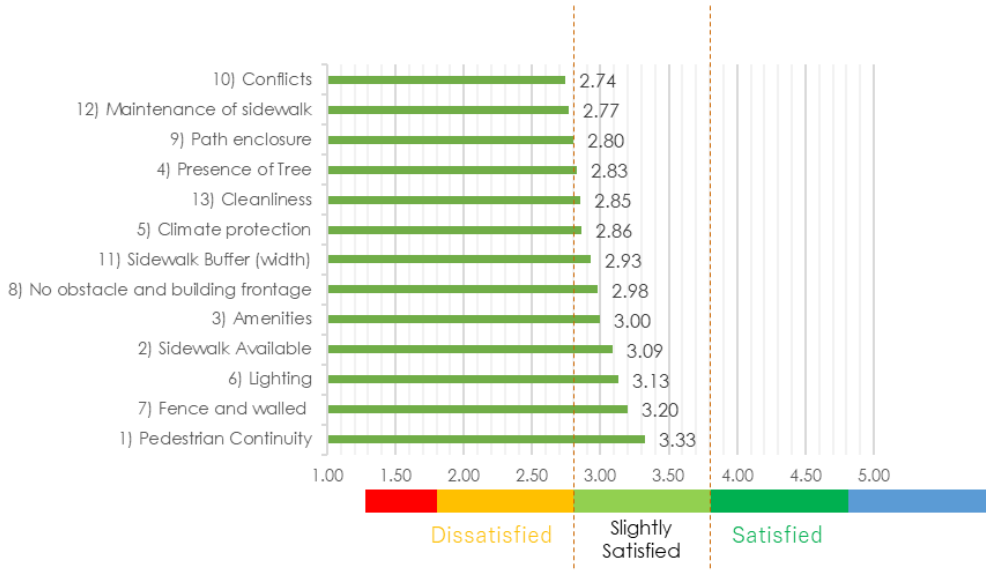


Figure 6.5 Overall satisfaction toward pedestrian elements

Table 6.7 shows the mean and standard deviation scores for individual stations. The analysis found that the satisfaction rating for each station was slightly different, within the slightly satisfied range (2.8–3.0). Most indicators' mean scores were slightly satisfied,

excluding dissatisfaction to conflict at the station in the West Outer Ring Road zone (2.3). The satisfaction in the environment in the greater or lesser satisfaction scores in CBD and Urban zones were more significant than the West Outer Ring Road Zone, except for connectivity. Sidewalk available and cleanliness had slightly more satisfaction scores in the city center area. Even in CBD and Urban zones, the analysis shows a score of satisfaction of less than 3 for presence of a tree, path enclosure, conflicts, maintenance sidewalks, and cleanliness. Meanwhile, in the West Outer Ring Road zone, the scores for pedestrian continuity, sidewalk availability, fence and walled, and cleanliness are higher than in another zone. It has been observed that in all Urban zones, the top scores are pedestrian continuity and fence and walled. The pedestrian element with the lowest score was the sidewalk maintenance, which was the same level in both the CBD zone and Urban zone but in the West Outer Ring Road zone was conflicted.

Table 6.7 Satisfaction of Mean and Standard Deviation

Station Code	**SIAM**		**ASOK**		**PHAYA THAI**		**MO CHIT**		**SALA DAENG**		**BANG WA**	
Zoning	**CBD**		**CBD**		**Urban**		**Urban**		**Urban**		**WOR**	
Indicators	Mean	S. D	Mean	S. D	Mean	S. D	Mean	S. D	Mean	S. D	Mean	S. D
1) Pedestrian Continuity	3.2	*0.7*	3.4	*0.7*	3.1	*0.8*	3.5	*0.6*	3.2	*0.8*	3.5	*0.8*
2) Sidewalk Available	3.0	*0.8*	3.1	*0.8*	2.8	*1.0*	3.3	*0.7*	3.0	*1.1*	3.2	*0.9*
3) Amenities	2.9	*0.8*	3.1	*0.9*	3.0	*0.9*	3.0	*0.7*	2.9	*1.1*	3.0	*0.8*
4) Presence of Tree	2.7	*1.0*	2.9	*0.8*	2.9	*1.0*	2.9	*0.7*	2.7	*1.0*	2.6	*0.8*
5) Climate protection	3.0	*1.1*	2.9	*0.8*	2.7	*1.0*	2.9	*0.8*	2.8	*1.0*	2.5	*0.7*
6) Lighting	3.2	*1.0*	3.1	*0.9*	2.9	*1.0*	3.3	*0.7*	3.0	*1.0*	3.0	*0.8*
7) Fence and walled	3.2	*1.0*	3.3	*0.9*	2.8	*1.0*	3.2	*0.6*	3.1	*1.0*	3.2	*0.8*
8) No obstacle	3.0	*0.9*	3.0	*0.9*	2.7	*1.0*	3.0	*0.8*	2.8	*1.0*	3.0	*0.9*
9) Path enclosure	2.8	*0.8*	2.8	*0.8*	2.7	*0.9*	2.8	*0.6*	2.6	*1.0*	2.7	*0.9*
10) Conflicts	2.9	*1.1*	2.7	*0.9*	2.5	*1.2*	2.7	*1.0*	2.8	*1.0*	2.3	*1.1*
11) Sidewalk Buffer (width)	2.9	*0.8*	3.0	*0.8*	2.8	*1.0*	3.0	*0.7*	2.8	*0.9*	2.8	*0.8*
12) Maintenance of sidewalk	2.8	*0.9*	2.8	*0.9*	2.6	*1.1*	2.8	*0.8*	2.6	*1.0*	2.8	*1.0*
13) Cleanliness	2.9	*0.9*	2.8	*0.7*	2.7	*1.2*	2.8	*0.8*	2.6	*1.0*	2.9	*1.1*
Average	3.0		3.0		2.8		3.0		2.8		2.9	

Satisfied Slightly atisfied Dissatisfied

Note: 4.50 - 5 (Very Satisfied) 3.50 - 4.49 (Satisfied) 2.50 - 3.49 (Slightly Satisfied) 1.50 - 2.49 (Dissatisfied) 1.00 - 1.49 (Very Dissatisfied), WOR = West outer ring road

The coefficient of variation (CV) in statistics is significantly vital for comprehending comparisons of findings from multiple variables or tests that have different measurements or values, as seen in the following example. There is a measure of the variation in a sample data set represented by this statistic, which is expressed as a percentage of the mean of the data set. The following is how it is calculated: It is the relationship between a sample standard deviation and the sample mean. The sample mean is equal to the sample standard deviation.

Coefficient of Variation (CV) can be calculated using the formula shown below.

$$\mathbf{CV = (SD/\bar{x}) * 100}$$

Where CV = Coefficient of Variation
SD = Standard Deviation
$\bar{x}$ = Mean

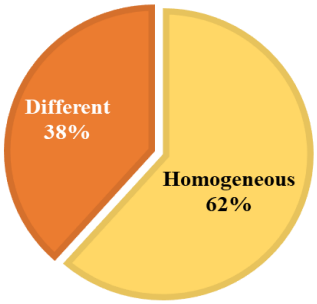
To compare the distribution data sets with different units in order to determine significance between each station. This study refers to the statistic indicator being measured as a percentage (if multiplied by 100%). It is statistically accepted that if the coefficient of variation can be explained below;

- Less than 10%, so the data distribution level is considered Insignificant.
- From 10% to 20%, Moderate.
- Greater than 20% and less than or equal to 33% is Significant. If the coefficient of variation is not more than 33%, then the population is considered Homogeneous.
- If it's more than 33%, it's Different.

Table 6.8 Coefficient of Variation

Station Code	SIAM	ASOK	PHAYA THAI	MOCHIT	SALA DAENG	BANGWA
Zoning	CBD	CBD	Urban	Urban	Urban	WOR
1 Pedestrian Continuity	22 %	21 %	26 %	17 %	25 %	23 %
2 Sidewalk Available	27 %	26 %	36 %	21 %	37 %	28 %
3 Amenities	28 %	29 %	30 %	23 %	38 %	27 %
4 Presence of Tree	37 %	28 %	34 %	24 %	37 %	31 %
5 Climate protection	37 %	28 %	37 %	28 %	36 %	28 %
6 Lighting	31 %	29 %	34 %	21 %	33 %	27 %
7 Fence and walled	31 %	27 %	36 %	19 %	32 %	25 %
8 No obstacle	30 %	30 %	37 %	27 %	36 %	30 %
9 Path enclosure	29 %	29 %	33 %	21 %	38 %	33 %
10 Conflicts	38 %	33 %	48 %	37 %	36 %	48 %
11 Sidewalk Buffer (width)	28 %	27 %	36 %	23 %	32 %	29 %
12 Maintenance of sidewalk	32 %	32 %	42 %	29 %	38 %	36 %
13 Cleanliness	31 %	25 %	44 %	29 %	38 %	38 %

Homogeneous Different



The data sets for significant level distribution are shown in Table-9. This table will be regarded significant (less than 33%) and different (more than 33 percent). The total coefficient of variation was determined to be substantial, which means that 62% of the population is regarded homogenous, whereas 38% of the population is regarded different (Figure 6.6).

Figure 6.6 Coefficient of Variation

Conversely, when each station was evaluated, the results revealed that the majority of the coefficient of variation was regarded as homogenous in central business districts and WOR. Meanwhile, in urban locations such as Phaya Thai station and Sala Daeng station, it was determined that there were differences, which meant the answers of respondents were in a large number of different and not considered homogeneous. As a consequence of the findings, it can be concluded that the pedestrian environment in urban areas should be considered in terms of standard deviation satisfaction.

This analysis may indicate no exact average different score for the pedestrian environment, even in developed areas of CBD (Table 6.9).

Table 6.9 Pedestrian Environment Satisfaction with Urban Zones

No	CBD		URBAN		West Outer Ring Road	
	Indicators	Mean	Indicators	Mean	Indicators	Mean
1	Pedestrian continuity	3.34	Pedestrian continuity	3.3	Pedestrian continuity	3.53
2	Fence and walled	3.32	Fence and walled	3.11	Fence and walled	3.26
3	Lighting	3.21	Lighting	3.09	Sidewalk available	3.22
4	Sidewalk available	3.08	Sidewalk available	3.09	Lighting	3.03
5	No obstacle	3.05	Amenities	3	Amenities	3.02
6	Amenities	3	No obstacle	2.91	No obstacle	3
7	Sidewalk buffer (width)	2.98	Sidewalk buffer (width)	2.91	Cleanliness	2.95
8	Pedestrian canopy	2.98	Presence of Tree	2.85	Maintenance of sidewalk	2.88
9	Cleanliness	2.92	Pedestrian canopy	2.83	Sidewalk buffer (width)	2.84
10	Path enclosure	2.88	Cleanliness	2.74	Path enclosure	2.79
11	Presence of tree	2.86	Path enclosure	2.73	Presence of tree	2.69
12	Conflicts	2.86	Conflicts	2.72	Pedestrian canopy	2.55
13	Maintenance of sidewalk	2.8	Maintenance of sidewalk	2.71	Conflicts	2.38

Note: 4.50 - 5 (Very Satisfied), 3.50 - 4.49 (Satisfied), 2.50 - 3.49 (Slightly Satisfied), 1.50 - 2.49 (Dissatisfied), 1.00 - 1.49 (Very Dissatisfied)

6.4.4 ANALYSIS OF INDIVIDUAL VARIABLE TOWARDS PEDESTRIAN ENVIRONMENT

- Personal variables

Pedestrian satisfaction was analyzed by comparing personal variables, dividing the analysis into three primary variables: age, gender, and residential location of the station indicated in Figure 6.7. The results found that across the variables compared across age ranges, all ages were slightly satisfied. Respondents in the under-18 age group had the highest satisfaction score (3.1), whereas those aged 50 to 60 had the lowest satisfaction score (2.6).

When analyzing pedestrian elements, it was found that in the over-60s age group, the least satisfaction score was for Pedestrian canopy (2.0) but slightly satisfied with pedestrian continuity (3.4). At the same time, working-age groups aged 24 to 40 gave less satisfaction to the presence of trees, path enclosures, and conflicts but slight satisfied with no obstacle (3.3), fence and walled (3.6), and lighting (3.4). Gender comparisons revealed that both males and females were slightly satisfied, as males were less satisfied with conflicts (2.6) while females had less satisfied with conflicts (2.6) and path enclosure (2.6). But for pedestrian continuity, both males and females had the highest mean score with 3.3 and 3.4, respectively. Comparisons between the distances between the locations to the station revealed that all respondents were slightly satisfied. Those within a pedestrian radius within 500 meters of the station were the least satisfied with maintenance of sidewalk (2.8), sidewalk buffer (2.8), and path enclosure (2.8) but slightly satisfied the most with pedestrian continuity (3.5). Those who lived within 800 meters had less satisfied with path enclosure (2.8) but slightly satisfied the most with pedestrian continuity (3.3). And those who lived other zones had less satisfied with conflicts (2.6) but slightly satisfied the most with pedestrian continuity (3.3).

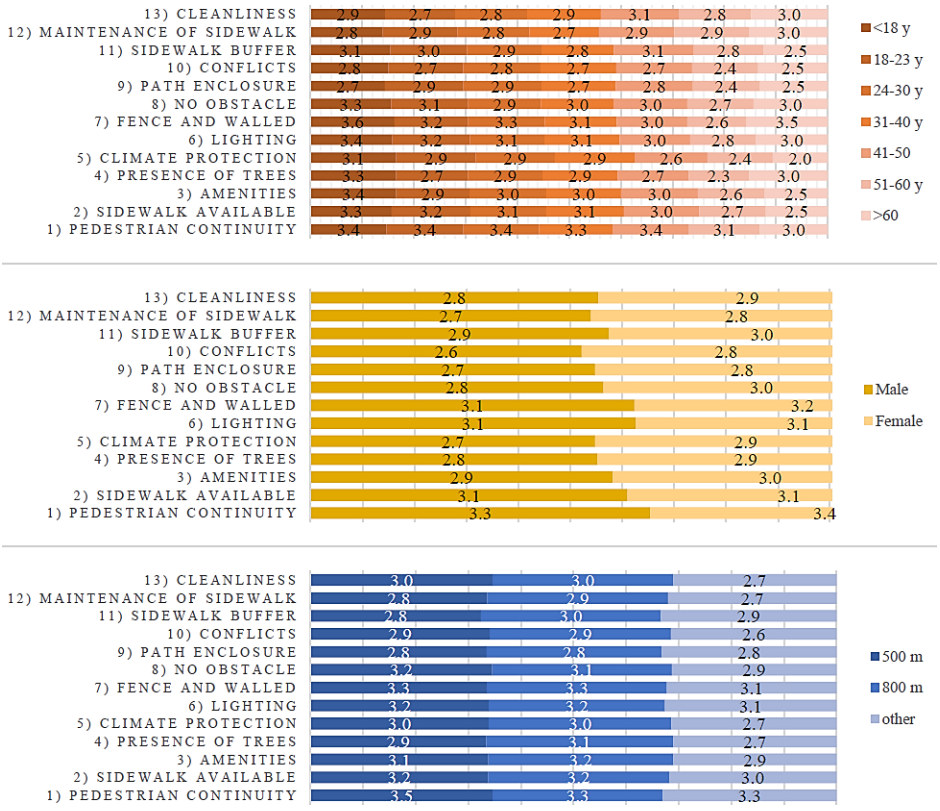


Figure 6.7 Mean Satisfaction by Age, Gender and Location from the stations

- The relationship of passengers with pedestrian satisfaction

This analysis demonstrated the relationship between three variables: age, gender, and location from the station with satisfied pedestrian environment overall in every Urban zone by cross-tabulation analysis, and percentages and totals are based on responses. The results found that respondents of any age group in the CBD area were slightly satisfied, but respondents aged 51 to 60 were the most dissatisfied (69.2%). Regarding gender, the ratio was quite similar. Male was slightly satisfied than female (47.3%, 43.5%) but female was dissatisfied more than male (21.3%, 19.4%). Regarding distance from the station, most respondents were slightly satisfied, especially the percentage of respondents who live 500 meters from the station, which was highest (46.1%) (Figure 6.8).

In the Urban zone, the outcome revealed that most respondents were slightly satisfied across all age groups. People over the age of 60 had the highest percentage (61.54%). Regarding gender, male was slightly satisfied than female (47.3%, 43.5%). In the case of distance from the station, most respondents were slightly satisfied and within 800 meters from the station, the highest percentage (48.4%) (Figure 6.9). On West Outer Ring Road, no respondents were more than 60 years of age. Most respondents were slightly satisfied, except those between 50 and 60 years of age who were very dissatisfied (69.2%). In gender, male

was slightly satisfied more than female (48.3%, 36.5%). Regarding distance from the station within 500 meters, respondents were satisfied (36.2%), while 800 meters and others were slightly satisfied (44.1%, 39.9%) (Figure 6.10).

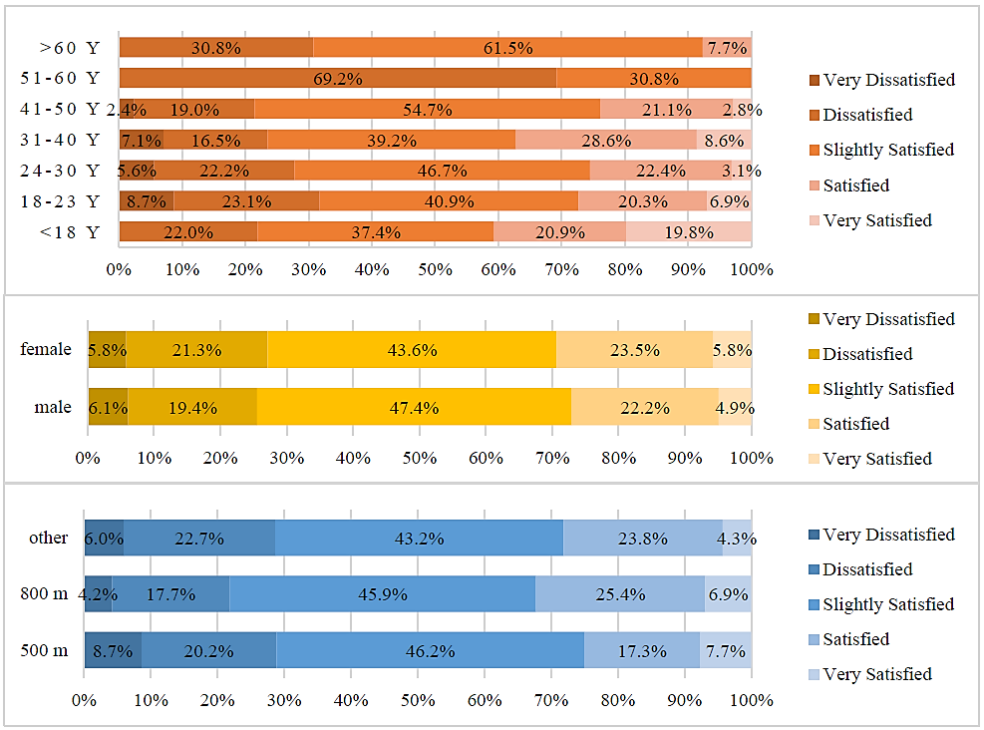


Figure 6.8 Relationship between Age, Gender, Location with Satisfaction in CBD Zone

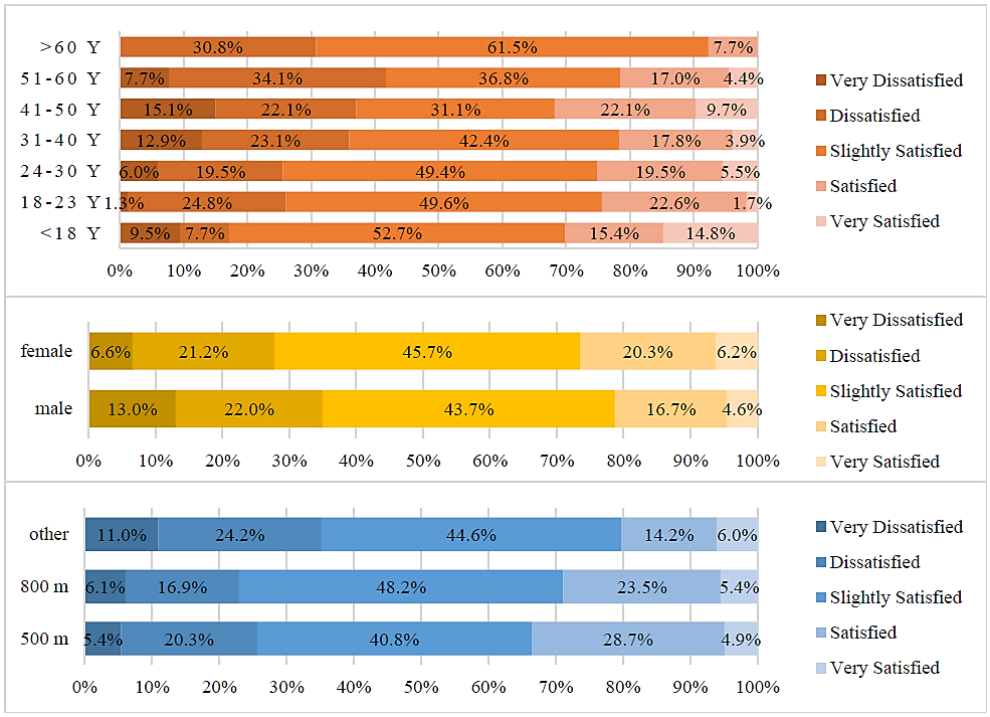


Figure 6.9 Relationship between Age, Gender, Location with Satisfaction in Urban Zone

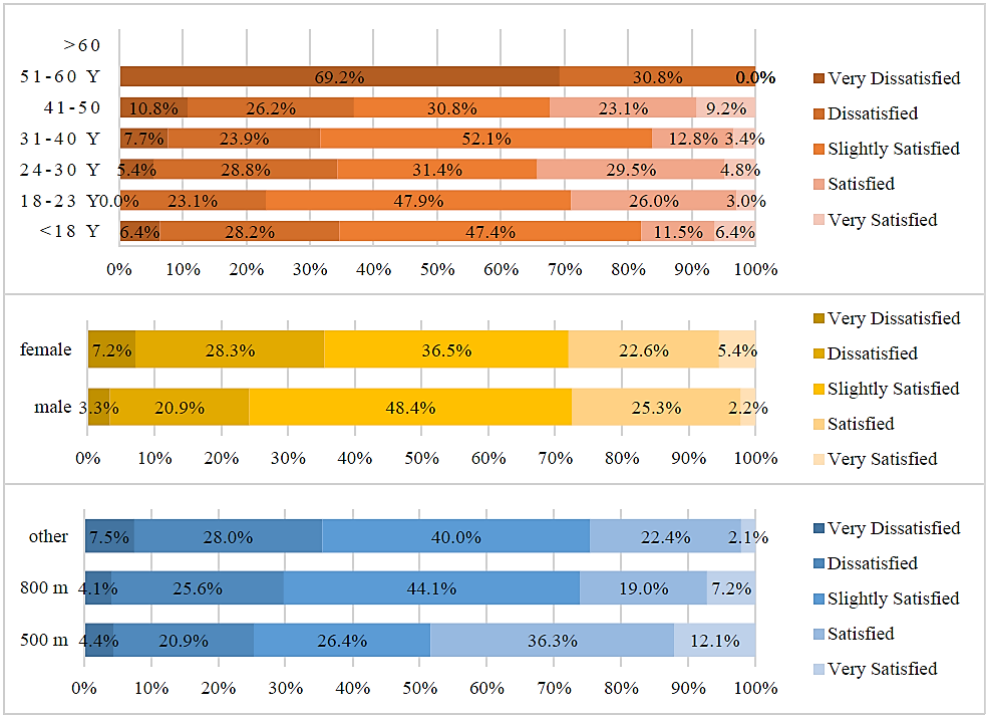


Figure 6.10 Relationship between Age, Gender, Location with Satisfaction in West Outer Ring Road Zone

6.5 CONCLUSION

- The relationship between passenger satisfaction and the pedestrian environment between each Urban area of the Bangkok region

According to the hypothesis, people's impressions of the pedestrian environment in various parts of the city will be entirely dissimilar, particularly in the Central Business District zone. When compared to other stations located in the Urban and West Outer Ring Road zone, the passenger experience regarding pedestrian access to the station in the CBD zone was rated as having a higher level of satisfaction. According to the findings of the study, however, pedestrians' levels of contentment in the CBD zone were only marginally higher than in other zones. In every district of Bangkok, residents had an impression of the pedestrian environment that was lower than the pleased level on average. Based on the findings of this study, it is possible to establish that even Central Business District zones have generated economic attractions, tourist, and housing units along the mass rapid transit line. However, pedestrian development areas are neither intended nor optimized for the physically of the region, particularly pedestrian access to the station. This is a significant issue.

- Evaluating passenger satisfaction pedestrian environment using walking indicators

The assumption states that if one's personal factors are different from those of another person, then that person will have a different impression of the pedestrian environment. The image and quality of life of city residents might be reflected in the degree to which passengers are satisfied. Although various factors hint to varying levels of average pleasure, most individuals believed that conflict was the least pleasurable pedestrian problem overall. However, different variables point to different scores of average satisfactions. Persons under the age of 18 were more worried with path enclosure and cleanliness on pedestrians, but people over the age of 51 were more concerned about pedestrian canopy on pedestrians.

People in their 24th to 50th years expressed worry over the upkeep of the sidewalk as well as the presence of trees. The view that there was a problem with conflict was shared by both male and female respondents, regardless of gender. In addition, in terms of proximity to the station, residents who lived within a radius of 500 meters had the most worry over the upkeep of the sidewalks and the enclosure of the walkway. Those who lived 800 meters or less away from the station were more concerned about the path enclosure, while those who lived in other locations were more concerned about violence.

6.6 GENERAL DISCUSSION AND FURTHER STUDY

Walking is a sustainable mode of transportation that has contributed to an improvement in the overall quality of urban life as well as a reduction in the number of automobiles that are found in the city. At this time, Bangkok is in the process of formulating continuing plans and policies for both urban planning and transportation. Nevertheless, the public sector has not yet finished the initiatives that were supposed to enable pedestrian access to the public transportation system. Although the rapid construction projects for mass transit are still moving forward as planned, the limited road restrictions are a significant obstacle to the development of pedestrians to enter transit stations in both current and future projects. This is because the road restrictions prevent vehicles from passing through the intersections where the stations will be built. According to the findings of this poll, the majority of Thai people have a perspective of the pedestrian environment that is "Slightly Satisfied." This finding may not be related to the actual physical state of the environment. The picture of some pedestrian routes in Bangkok, with stores or sellers positioned on the sidewalks, is representative of the places; nonetheless, the results from the study revealed that individuals traveling on pedestrian walkways were unsatisfied with the ambiance in those regions. In order to make Bangkok a more pedestrian-friendly city, the findings may be used to the planning and construction of pedestrian areas that are appropriate for people of all ages.

This study has an emphasis on studying and identifying the aspects that contribute to user happiness in the pedestrian environment. The pedestrian network at the microscale in terms of connection to the mass rapid transit station should be evaluated under the same environment indicators in order to gain a comprehensive understanding of the phenomenon of pedestrians at stations within the limits of physical road conditions in Bangkok. This will allow for a more complete comprehension of the phenomenon of pedestrians at stations within the limits of physical road conditions.

Notes

(1) Network and connectivity imply that the walkway is continuous and has excellent connections.

(2) Sidewalk width available denotes pedestrian width (suited for wheelchair/walking stick).

(3) Amenities refer to suitable amenities such as waiting areas, transit stations, and so on.

(4) The presence of trees implies sensations of a dark shade of trees.

(5) A pedestrian canopy provides ample sun and rain protection.

(6) Lighting denotes Lighting that is adequate (in case of travel in the evening).

(7) Fenced and walled structures indicate that buildings along the sidewalk have been ornamented to encourage people to stroll.

(8) When there are no obstacles, the walking route is clear.

(9) Street enclosures denote a distinct partition of pedestrian spaces.

(10) Conflicts indicate that no other cars are using the pedestrian space.

(11) Sidewalk Buffer (width) indicates that the sidewalk is adequately roped off or segregated from the road.

(12) Sidewalk maintenance include removing obstacles to walking from utilities such as power poles. Sewer lines, fire hoses, and so forth.

(13) Cleanliness implies that the sidewalks are free of rubbish and filth.

(14) Because this survey used an online questionnaire, the number of senior respondents was low.

CHAPTER 7
A STUDY OF URBAN VISIBILITY AND STREET NETWORKS AROUND MASS RAPID TRANSIT STATIONS IN THE CBD ZONE: CASE STUDY IN BANGKOK

7.1 INTRODUCTION

In the last few decades, Bangkok has changed considerably. It has become a “primate city” due to rapid population growth which continues unabated. Bangkok's urban development model in the past focused on suburbanization as the main strategy. In the initial stages of the city’s development, which began around the year 1907, there was not much expansion and development centered on the inner-city area. After 1957, the city of Bangkok began to expand and spread to the surrounding suburbs in all directions until about 1987, when people began to migrate to the suburbs. This caused the suburban area to expand further. Meanwhile, the urban area, the former center, began to deteriorate until the arrival of the mass transit system in 1997 which led to more people returning to inner-city areas. Along with the expansion of the suburbs, the center continues to thrive (UddC, 2015).

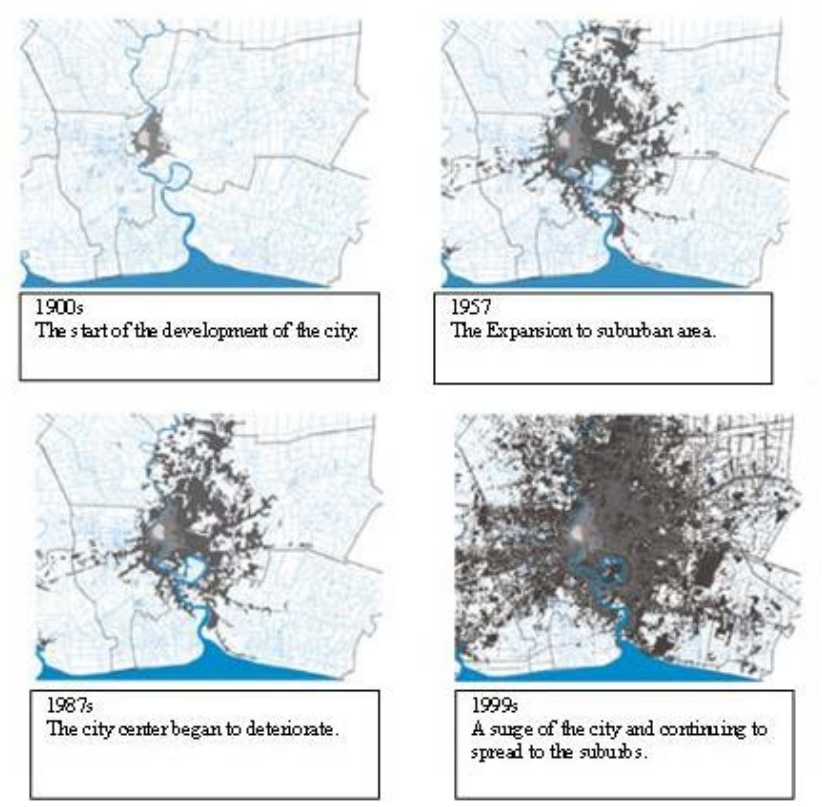
Apart from making Bangkok an economic center with financial institutions, recent developments, especially the Bangkok-based development plan, have helped accelerate the city's growth. Bangkok is also the transport centre of the country, with every major road, every train, and almost every ship targeted towards it. Consequently, Bangkok has become the main travel hub of Thailand (Tangcholathip, 2021).

As a result of conversion of land from large agricultural plots to urban developments without proper planning, the road capacity of Bangkok is lower than the standard expected of a city for easy commuting (the road area of Bangkok is about 10 per cent of the total city area, whereas it is 23 per cent in Tokyo, and 38 per cent in New York City). However, most of the people still require private cars, and most public transport systems share routes with them. Travel by mass rapid transit rail takes up only 3 per cent of the total travel mode choice. The main reason for this is the still incomplete network, and the lack of integrated management planning with other types of travel (BMA Information Center, 2013). The expansion of Bangkok in the past has brought many problems, in terms of reduced quality of life due to increased pollution from private car use. Air pollution in Bangkok is above that it’s the average over the year and the main source of ambient air pollution in Bangkok is road transport; the number of road vehicles in Bangkok increased by 54% from 2008 to 2020. (Department of Land Transport, 2022)

In almost all cities, pollution, crime, and economically deprived areas are problems, but traffic congestion is an issue that has a real impact on the livelihoods of people in urban communities. According to the Thai government (Phanchai, 2020), causes of traffic congestion in Bangkok can be summarised in term of road network and urban issues such as

Road network problems arising from the incomplete road network system due to poor urban planning, The number of cars is more than the traffic or road surfaces in Bangkok are able to support. Those issues have led to traffic congestion on the main roads.

Therefore, a 'mass rapid transit system' is the concept adopted by the government to develop a mass transit system to help solve or alleviate traffic congestion problems. The construction of 10 mass rapid transit lines in Bangkok and its vicinities is expected to allow people to travel easily, reduce travel time, and have a positive effect on the economy and the environment. Bangkok's first mass rapid transit system came into operation in 1999 in the business center. Then, urban development and expansion began along the railway line, especially around stations. Figure 1 shows the urban expansion in Bangkok.



Source: UddC (2015)

Figure 7.1 The changing urban expansion in Bangkok

However, over a decade later, the structural expansion, urban visibility and street connectivity of the city center boundary, especially the area around the mass rapid transit system, and urban space after spread to the suburban have yet to be studied in detail. There is no research study about mass rapid transit impact to urban visibility and space. Also, mass rapid transit stations are not effectively connected leads to a tendency to use private vehicles rather than the rapid transit system. The assumption base on the statistic of travel mode of

Bangkok passenger data in 2019, the number of people traveling on the road is more than 60 million with ratio of more than 55% compared to all modes of transport while rail was only 34% (National Statistical Office, 2020). This contributes to Bangkok's traffic congestion and public transportation failure.

According to the statistics, this outcome indicates that Bangkok's mass rapid transit system has been unable to establish itself as the primary means of transportation. Assuming for the moment that urban space and roadway or pedestrian connections do not facilitate people's access to stations.

Since Bangkok's expansion into the suburbs, the urban form has been fast altering (Figure 7.1) However, Bangkok's urban space knowledge is deficient, with no research study or apparent urban open space and street connect to mass rapid transit stations. Therefore, the analysis process draws on two methods, first is the popular technique for undertaking visibility analysis in architecture and urban space is the concept of the “isovist” (Ayu Wandira Puspitasari, 2020). This analysis illustrated the visible area model as a function of color, from blue to red. The blue region denotes the density zone, whereas the red area denotes the open space zone. Second is street network connectivity that capable to determine the spatial integration of human with space. (Saiful Mohamad, 2014).

Both methodologies are carried out to analyze visibility properties using Depthmap software.

Consequently, this study aims to understand the urban characteristics of visibility and street connectivity around mass rapid transit stations in the CBD zone and access to station buildings from local streets within an 800-metre walking distance. Regards to walking distance, The walking distance to the station or terminal is between ten minutes and 800 meters (Sony S.WIBOWO, 2015). Therefore, this study uses this criterion to quantify the analysis from the center of stations.

The assumptions of this study are related to three key issues:

There would be less visible space and a visible connecting area in terms of open space as a result of the high density of buildings in the Central Business District (CBD). This would be apparent to the urban visual flow as a consequence of the high density of buildings in the CBD. Additionally, there would be less open space. It's possible that this will have an impact on the city's capacity for growth in the years to come.

- In terms of connectedness, the streets around mass rapid transit stations would have a high level, but they would have a lower level of connectivity compared to the surrounding local streets. This is due to the fact that the main streets that

allow access to the stations are less connected to the urban local streets that connect to residential districts.

- Despite the fact that the walking catchment area is located 800 meters away from the station, the bulk of the building types that are related to it will be commercial and office in character, and the most of them will be built on streets that are already in existence. The majority of residential building types will be connected to the station via a lengthier path that is based on the streets that are already there.

The conclusions of this study will give valuable information on the urban features and street connection network of Bangkok's central business district, particularly with regard to accessibility to station buildings. In order to assist the future CBD area in its development, the research will also report on certain present concerns.

The current three CBD areas in Bangkok, where the main mass rapid transit stations are located, were chosen as the case study areas. These areas also have the highest land prices (Pornchokchai, 2020) and have various types of buildings and land uses, such as universities, parks, shopping centres, and low-rise and high-rise residential buildings. As a result, the case study criteria concentrated on locations in the central business district, which comprised eight stations within an 800-meter walking area.

Figure 7.2 depicts the study areas in the CBD that are served by mass rapid transit lines and stations: Area A (which includes Siam station, which is currently the largest interchange station; B = national stadium station; and C = Ratchathewi station); Area B (which includes Chit Lom station and E = Ploenchit station); and Area C (which includes Nana station, Asok station, and Phrom Phong station). There are a total of eight stations spread over these three zones. The case study regions are continuous and separated into three zones, with each zone being subjected to a geographical analysis.

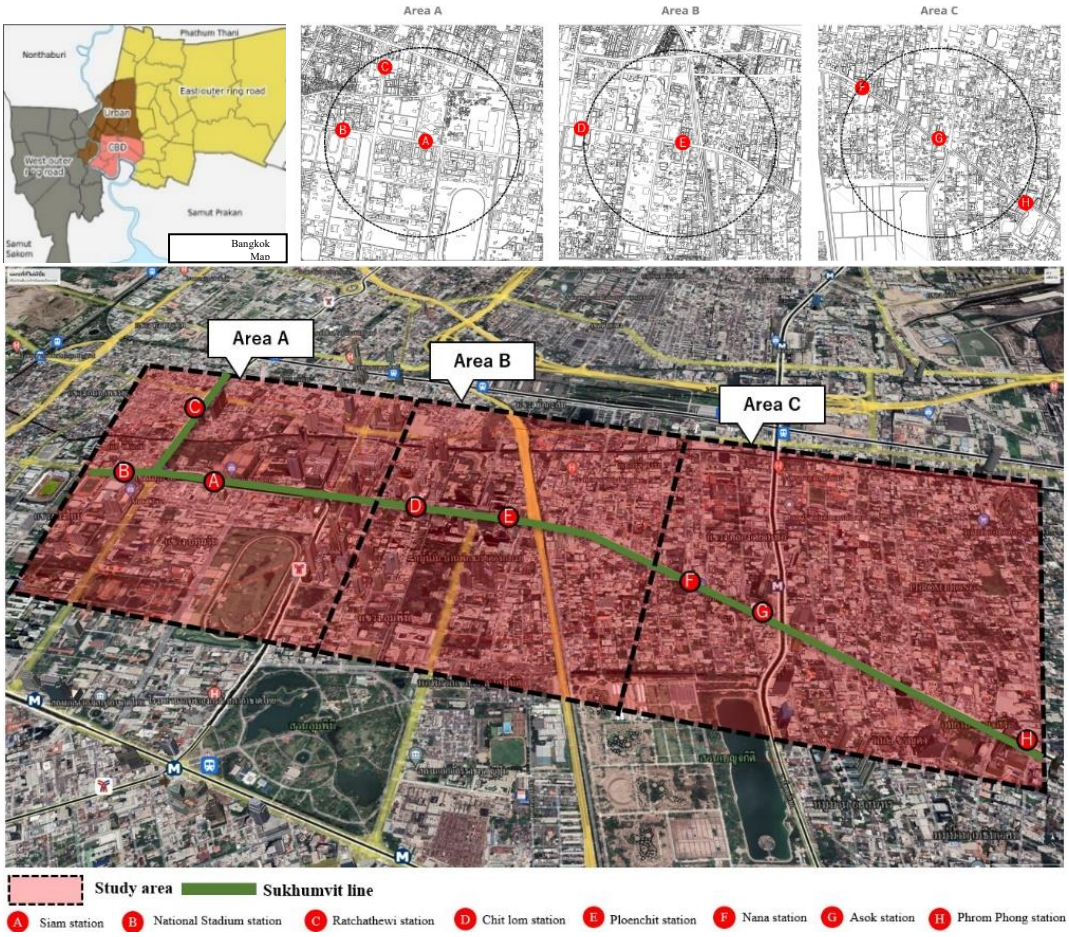


Figure 7.2 The study areas

7.2 LITERATURE REVIEW

7.2.1 SPACE SYNTAX

A set of concepts and methods for studying spatial arrangements developed by Bill Hillier and Julienne Hanson, who coined the word "space syntax," is referred to as "space syntax" (Hillier B., 1984). For example, the analysis of spatial layouts and human activity patterns in buildings and metropolitan regions is typically done using space syntax. It also refers to a collection of theories that relate space and civilization. (University College London, UCL Space Syntax, 2022). The notion of space syntax may be represented graphically as a map or graph that displays the relative connectivity of space based on three essential concepts: isovist, axial, and convex (see Figure 1). In addition, for street network analysis, the terms integration, choice, and depth distance are frequently used interchangeably.

As demonstrated by the analytical methodologies, isovist, which is the field of vision from any specific point and depth distance, will be used to evaluate the urban area and street network surrounding a mass rapid transit station in this research. Isovist is defined as the field

of vision from any specific point and depth distance. The distance in a straight line between the center points of each street segment and the centers of the other street segments is represented by this symbol. There has been some investigation of the spatial pattern of the Kampong area, which has made use of Space Syntax. The purpose of this study is to discover the calculations that are utilized for pattern recognition in urban planning. Pindo Tutuko (Pindo Tutuko, 2021)

7.2.2 ISOVIST AND VISIBILITY GRAPH ANALYSIS

Isovist field Isovist is a visual representation of a viewer's perspective from a specific location in the built environment. It may be thought of as a visual record of what is seen in a 360-degree or 180-degree view from a given position. (Hillier B, 2001).

Visibility graph analysis, i.e. analysis of visual relationships of points in space, is conducted using isovists. An isovist is a set of all points visible from a given vantage point in space in a particular environment. Connectivity measures the number of spaces immediately connecting a space of origin (Turner, 2007). Several studies have applied this analytical technique to explain the visual impact of buildings and urban space. A study of three skyscrapers in Turin, Italy applied this technique and suggested that urban visibility can become a shared methodology for landscape analyses, not only for urban settings, and integrate both terrain and building models which are now a consideration particularly in environmental impact assessment procedures (Garnero, 2015). A visibility graph may be developed for a landscape. It records the pattern of mutual visibility relations in the landscape and provides a convenient way of storing and further analyzing the results of multiple viewshed analyses for a particular landscape region (O'Sullivan & Turner, 2001). The horizontal view and urbvisibility are also used for the vertical view of urban landmarks. Kalin and Yilmaz (2012) used the case study of Hagia Sophia in Trabzon to evaluate a landmark effective in the city silhouette from a single viewpoint. Visibility analysis has also been performed at a small urban scale like the Chinese University of Hong Kong. The concept of this method is the illustration of a measurable relationship between the physical environment and human visual perception, including distance, visual angle impact, and visual field (a 3D isovist conception), and human cognition (Lin, Lin & Hu, 2013). The above studies show that visibility analysis can be used at various dimensions, from the urban scale to master plan scale and from the horizontal to the vertical view. This study will apply this methodology to the case study of Bangkok.

7.2.3 STREET NETWORK ANALYSIS

Many studies have investigated street networks for various purposes and in different locations. The ASEAN Smart Cities Network (ASCN) was initiated to develop a sustainable

transport system for ASEAN, with characteristics of drivable and walkable street networks measured and compared for 26 pilot ASCN cities by applying multiple network metrics (Zhao et al., 2019). Street network orientation, configuration, and entropy are studied around the world using OpenStreetMap data and OSMnx. These investigations measure the entropy of street bearings in weighted and unweighted network models (Boeing, 2019). An analysis of the accessibility of an urban mass transit node considered the characteristics of connectivity and accessibility of existing transit stations and station buildings based on the theory of space syntax (Noichan & Dewancker, 2018). This study analysed street accessibility to the station itself, but not from an 800-metre walking distance and the surrounding streets. In Bangkok case study investigated road characteristics in relation to urbanisation patterns to explore the impacts of the latter on road safety (Iamtrakul & Hokao, 2011).

There is another methodology to measure about street network analysis by using Visibility Graph Analysis (VGA). A step depth will be used for the analysis based on the number of visual turns from one location to another. And the metric step depth used a weighted version of visibility graph in metric distance from location to another. This calculation process will consist of an analysis of the Depthmap program. (Alasdair Turner, 2014)

While some research has been conducted on the accessibility of mass rapid transit stations in Bangkok using Space Syntax, station access is unrelated to the roadway network. (Rungpansa Noichan B. D., 2018). Another research was undertaken in Bangkok to compare accessibility and connectivity indicators generated from pedestrian and street networks in metropolitan areas outside of Asia. Study site network characteristics (400m). By counting, the indicator calculated street dimensions and elements such as length, connection, and node. (Daniel Martin Pearce, 2021)

According to the literature studies, the majority of research involving spatial and connectivity analysis was done using the Space Syntax and Depthmap tools, which are often used for spatial and connectivity analysis. Not just on a massive scale, as in urban planning, but also on a micro size, as in architecture. However, the primary challenge of this methodology would be the need for simulations or circumstances to determine the optimal configuration of spatial and connection.

Several prior studies have used the same methods, such as analysis of accessibility using space syntax, but in various situations and with other signs. Due to the fact that previous research was conducted that did not focus on linking the street network to the station within walking distance, the outcome would differ from the purpose of this study.

7.3 RESEARCH METHODOLOGY

The study locations were located in Bangkok's Central Business District (CBD), which is the city's most developed area, surrounded by office buildings, commercial areas, and residential districts comprised of both high-rise and low-rise units. And this area consists of 8 stations for mass rapid transit. The study areas consisted of three areas in CBD zones in Bangkok within a walking distance of 800 metres from the centre of the station with a calculation area of four-square kilometres.

To understand the urban spatial characteristic and the street connectivity, this study was qualitative and concentrated on comprehensive of three analysis topics which were consist of a) Urban visibility around stations, which was used to conduct a global-scale analysis of the characteristics of urban space as measured by isovist area connectivity; connectivity was defined as the area (Area or Av) of all space visible from a subject point in the plan, b) Street Connectivity, in visibility graph terminology, refers to the number of other point nodes that are 'linked' to a place directly and measure how many street connect to other street, and c) Type of building steps reach to stations. In this c) section, the analysis was divided into two issues, first was walking step to the stations measurement by using metric step depth analysis, and second was categorized building types of step access to stations.

The process is described in four steps: 1) enter the data gathering for the exiting case study, 2) simplify data using AutoCAD program, and 3) 3) Conduct analysis using the Depthmap to have a better understanding of the urban space and street network connectivity. Finalize, assess, and summarize the outcome.

This study used a secondary data which were collected from the aerial photographic map file, a 2D map drawing file, of Bangkok, which included data on streets, local roads, existing buildings, utilities, and public transportation lines, to determine the site location by using AutoCAD. After generalizing and evaluating the data, the isovist and street connections were analyzed using Depthmap. And then evaluate the correlation between variables by IBM SPSS. Regard to the spatial analysis, the isovist calculated the mean radial length squared for every subject point, in the plan. The outcome was multiplied by pi and the number of samples in one full cycle to obtain an absolute value of area (Benedikt, n.d.). After that, the street network around the station was analysed to explain connectivity and integration of the street networks.

In order to comprehend the phenomenon of the connectivity in these areas, the streets were evaluated using “metric step depth” analysis which measured the number of metric steps from each origin, or more simply, the walking distance to reach every segment in the network. Origins can be specific land-use attractors, such as shopping centres, and/or major transport attractors, such as railway stations (UCL, 2021).

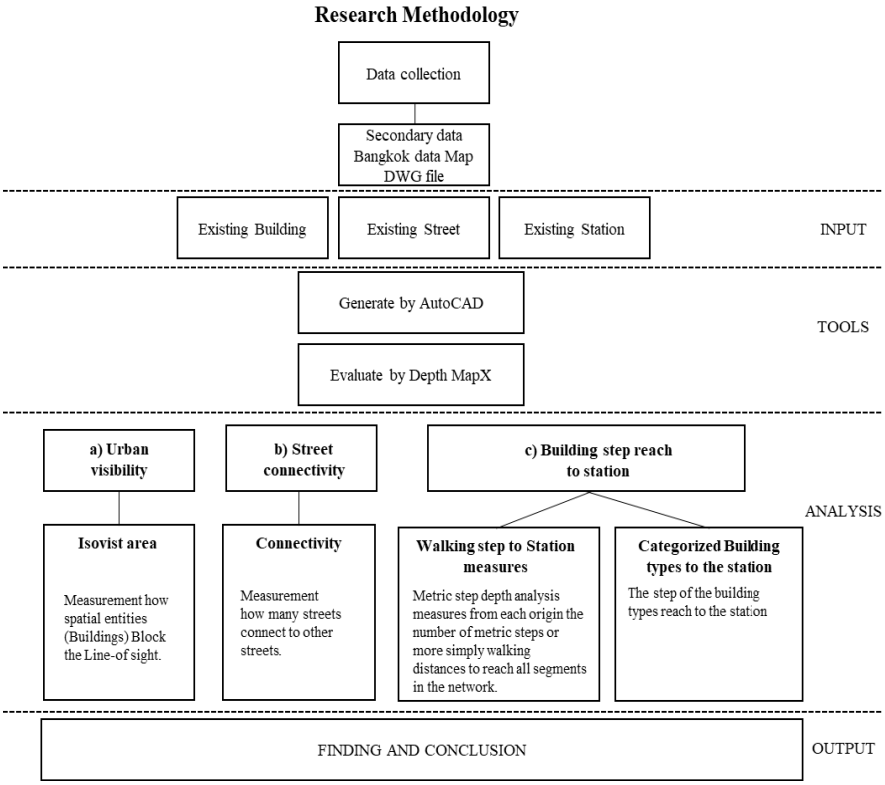


Figure 7.3 Research methodological process and framework

7.4 FINDINGS AND DISCUSSION

7.4.1 ISOVIST CONNECTIVITY ANALYSIS

The study area was divided into three large CBD areas. In this section, the analysis of the isovist connectivity area map will be individualized for each area to understand the buildings and the visibility of urban characteristics. The analytical comparison of the isovist field of the three different areas could explain the spatial arrangement of Bangkok's CBD. The analysis obtained the average and the minimum and maximum values of the isovist connectivity area, average connectivity, counting area, and the ratio between connectivity and counting area.

The three areas covered a walking distance of 800 meters from stations. Urban space visibility analysis involved four square kilometers of each area. Figures 7.4 compare the isovist connectivity area map with the ESRI satellite photograph. The figures show the isovist connectivity area at the urban scale, from the lowest indicated by blue and the highest by red.

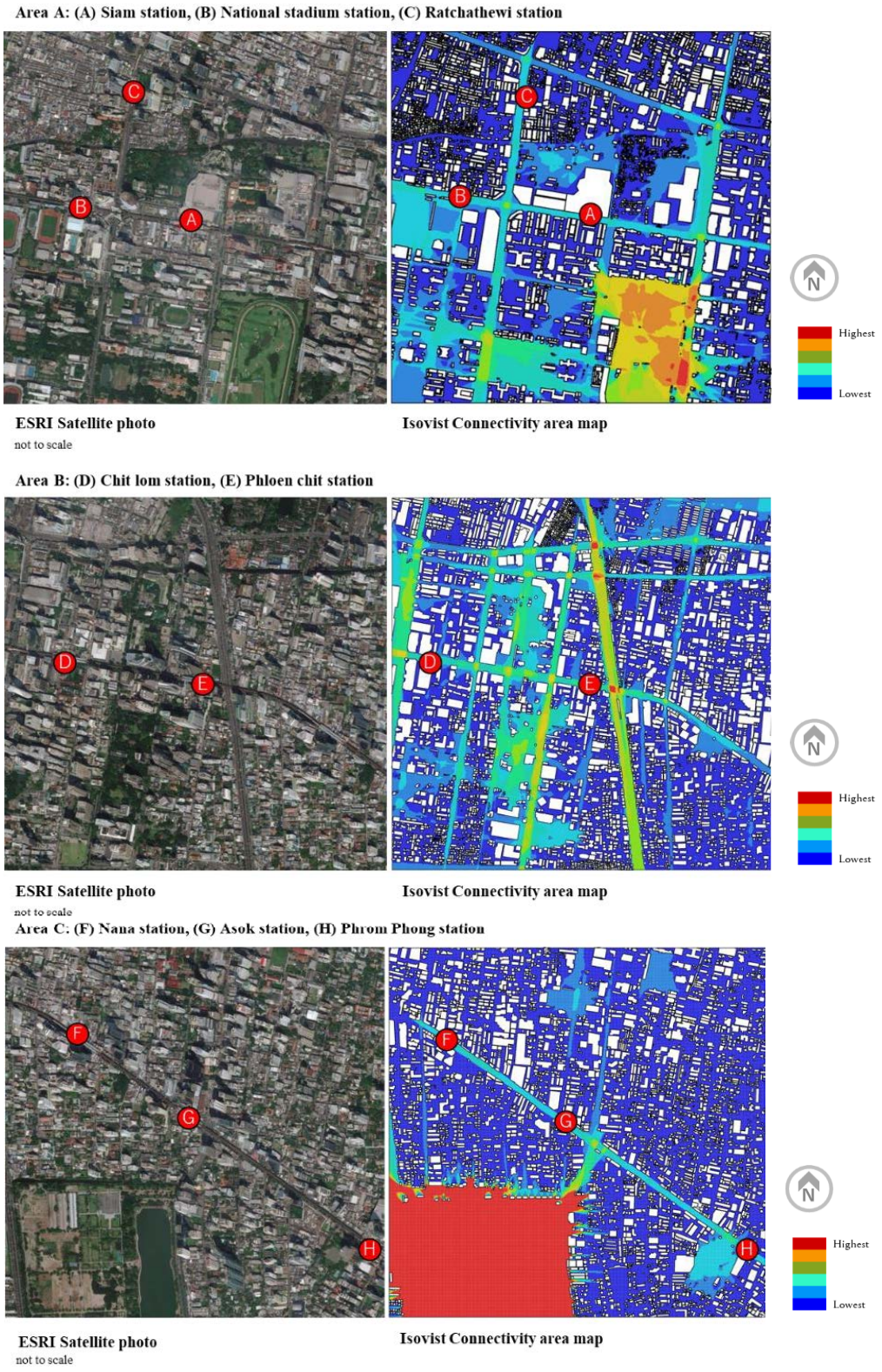


Figure 7.4 ESRI satellite map and isovist connectivity map of study area

The comparative analysis of the three areas shows different levels of isovist connectivity. Although the three areas were contiguous, they showed differences in the patterns of open and enclosed spaces and the density of buildings. The maps show enclosed and open spaces ordered from blue, indicating the lowest, to red, indicating the highest. Area C has dense clustered areas as well as open spaces, which are large urban parks.

Table 7.1 presents a detailed comparison of the connection values for the three areas. The average, minimum, and maximum values of isovist area, which is another term that means overall value of visible space, are used to analyze qualities. Additionally, the average connection area, which refers to the ways in which each place may be connected.

Table 7.1 Comparison of the isovist connectivity maps

Area A		Area B		Area C	
Attribute	**Value**	**Attribute**	**Value**	**Attribute**	**Value**
Average isovist area	67,402	Average isovist area	26,556	Average isovist area	156,764
Minimum	6.08	Minimum	6.40	Minimum	5.04
Maximum	357,412	Maximum	168,938	Maximum	662,129
Average connectivity area	304,553	Average connectivity area	293,303	Average connectivity area	316,242
Counting area	7,486.12	Counting area	2,949.05	Counting area	17,410.60
Ratio between connectivity and counting area	40.68	Ratio between connectivity and counting area	99.45	Ratio between connectivity and counting area	18.16

Upon comparison of the three regions, it was discovered that area B had the smallest average isovist area (26 556) and area C had the biggest (156 764) and that area A was in the middle (67 402); as a result, area C had the most enclosed area, or the highest density of building space. There was a significant similarity in average connectivity area across the three areas: area A had 304,553 points of connectivity, area B had 293,303 points of connectivity, and area C had 316,242 points of connectivity. A disproportionately high ratio of 99.45 was found in Area B, which had the lowest average isovist area while having the highest average isovist area. Although Area C had the greatest average isovist area, it had the lowest ratio of 18.16 between connectedness and counting area.

Table 7.2 shows analysis the correlation between Average isovist area and Average connectivity area, the Pearson Product Moment Correlation Study, which is used to determine the link between two variables, provides the outcome of this analysis. The result of that there was no significant between Average isovist area and Average connectivity area.

Table 7.2 Correlation between Average isovist area and Average connectivity area

		Average isovist area	Average connectivity area
Average isovist area	Pearson Correlation	1	0.98
	Sig. (1-tailed)		0.064
Average connectivity area	Pearson Correlation	0.98	1
	Sig. (1-tailed)	0.064	

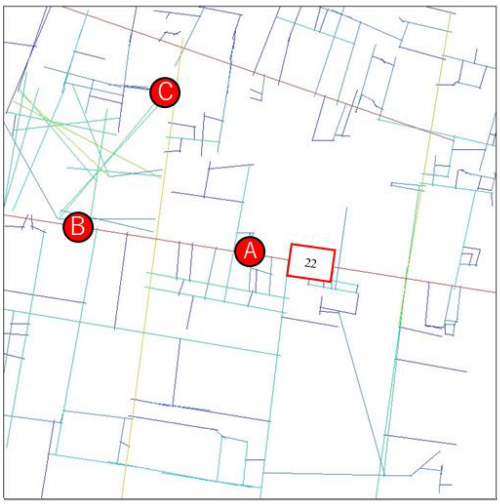
Furthermore, the findings revealed that in our research locations, the greatest average isovist area was related with the lowest connection and counting area, with the lowest connectivity and counting area being the most common. The lowest average isovist area, on the other hand, was shown to be related with the strongest connection. This finding demonstrates that the urban visibility of Bangkok's central business district exhibits a distinct trend from the trends in connection and accessibility of public transportation.

7.4.2 STREET CONNECTIVITY ANALYSIS

Street connectivity demonstrates the direct connection of a node to other nodes. Figures 7.5 show connectivity represented by a colour, with red indicating the highest connectivity and blue the lowest. The comparison of street connectivity of the three areas found that area C had the highest connectivity (an average of 5.46) and area B the lowest (an average of 3.56), whereas the connectivity of Area A was intermediate (average of 3.57). Area B had the highest street count (346), followed by area C (305), and area A (214).

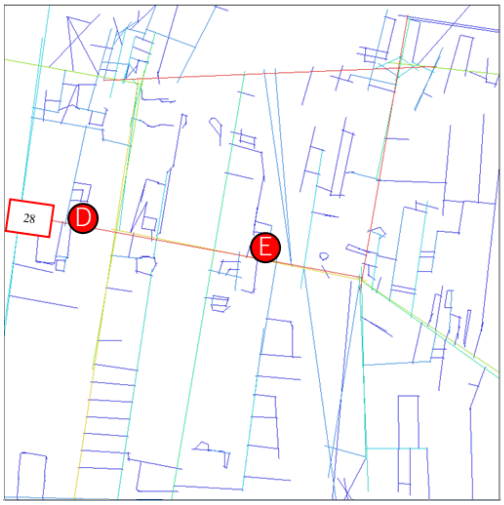
The maximum value for road connections in the three case study areas was observed for the main road, with area A having a maximum value of 22, area B of 28 and Area C of 49. However, the image of road connections, with the level of connection indicated by colour, shows the majority of the connections of minor roads in blue. This means that connection to secondary roads surrounding the station was low. All three case study areas show a similar pattern. Figures 7.6 shows the relationship between street connectivity and line length. They indicate that all study areas had the same pattern. The majority of the short-length streets had less connectivity, whereas high-length streets had high connectivity. Compared to the connectivity ratio, all areas were similar. In both area A and area B, the lowest to intermediate connectivity was 96 percent, and in area C it was 97 percent.

Area A: (A) Siam station, (B) National stadium station, (C) Ratchathewi station



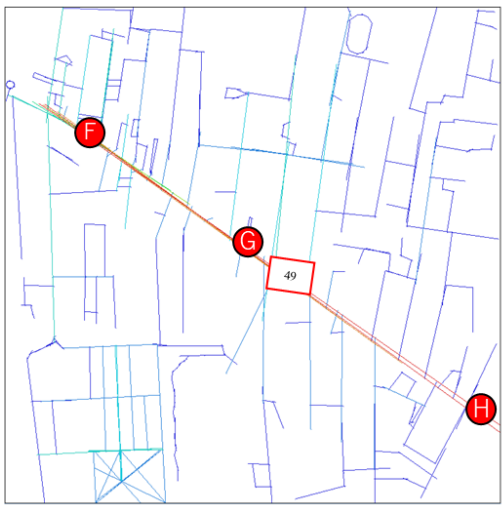
Area A	
Value	Attribute
Average	3.57
Minimum	0
Maximum	22
Std Dev	3.06
Count	214
<2.2	111
2.2 to 4.4	62
4.4 to 6.6	17
6.6 to 8.8	9
8.8 to 11.0	6
11.0 to 13.2	5
13.2 to 15.4	1
15.4 to 17.6	1
17.6 to 19.8	0
> 19.8	2

Area B: (D) Chit lom station, (E) Phloen chit station



Area B	
Value	Attribute
Average	3.56
Minimum	1
Maximum	28
Std Dev	3.78
Count	346
<3.7	256
3.7 to 6.4	50
6.4 to 9.1	17
9.1 to 11.8	3
11.8 to 14.5	4
14.5 to 17.2	4
17.2 to 19.9	0
19.9 to 22.6	2
22.6 to 25.3	0
>25.3	4

Area C: (F) Nana station, (G) Asok station, (H) Phrom Phong station



Area C	
Value	Attribute
Average	5.46
Minimum	1
Maximum	49
Std Dev	6.82
Count	305
<5.8	225
5.8 to 10.6	46
10.6 to 15.4	16
15.4 to 20.2	10
20.2 to 25.0	0
25.0 to 29.8	2
29.8 to 34.6	0
34.6 to 39.4	1
39.4 to 44.2	3
>44.2	2

Figure 7.5 Street connectivity analysis

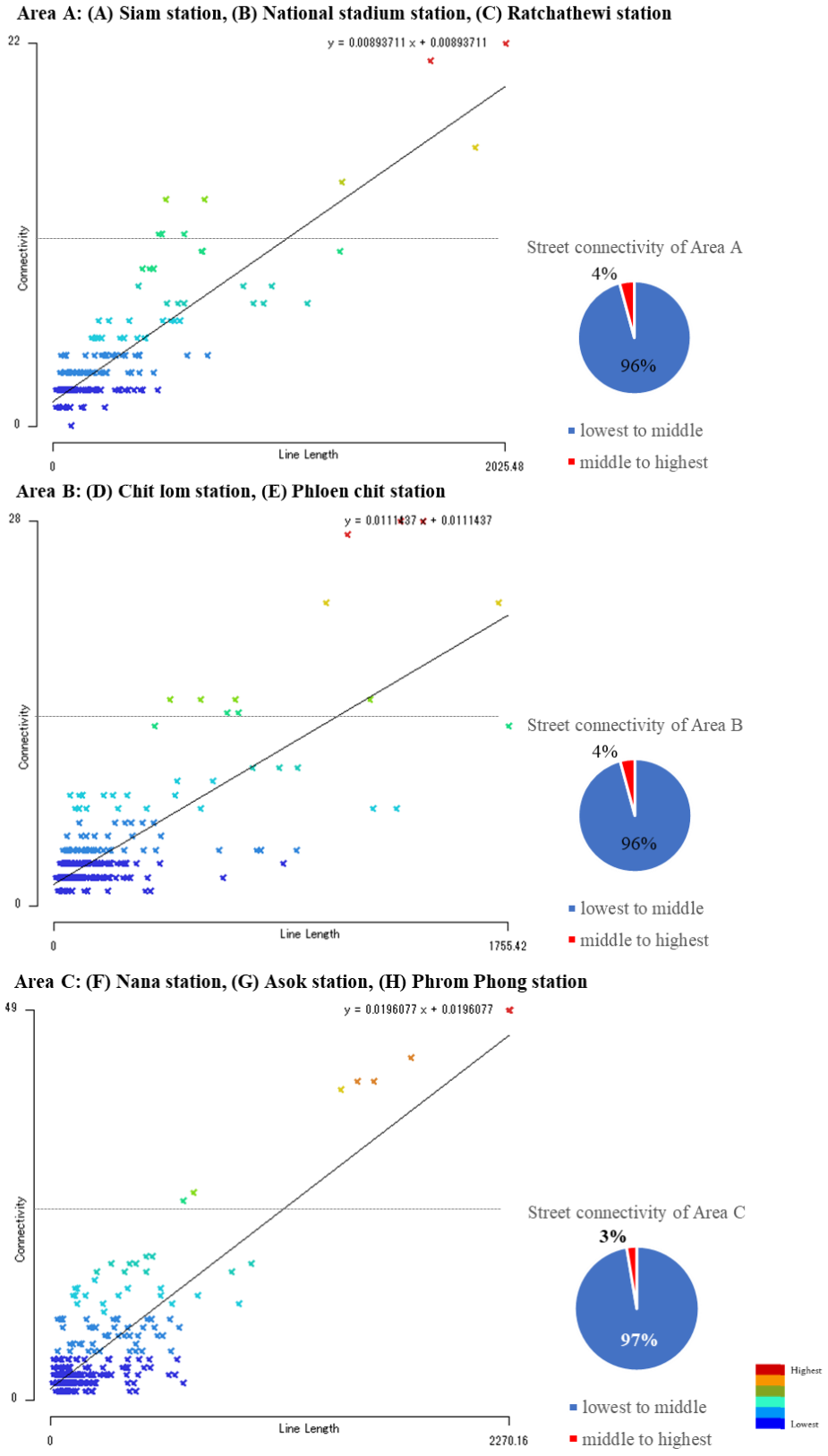


Figure 7.6 The relationship between line length and street connectivity

7.4.3 METRIC STEP DEPTH SEGMENT ANALYSIS

This section presents the results of the metric step depth analysis of existing street access to stations. The analysis started from the first step to the station in each study area. A colour scale from red to blue is used to represent the shortest to the longest metric step depth segment from the original segment.

1) Area A

The average metric step depth of area A was 835.57 (minimum = 0 and maximum = 1,915.76) and the count was 461 (Figure 7.4). The highest percentage count was between 383.15 and 574.72 or 17.1 percent and the lowest was >1724.18 or 3.7 percent.

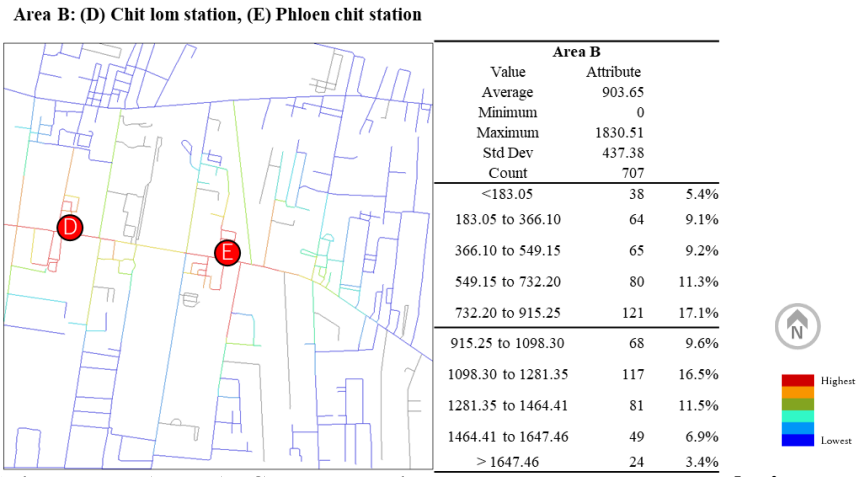


Figure 7.7 Area A: Street metric step depth segment analysis

2) Area B

The average metric step depth was 903.65 (minimum = 0 and maximum = 1,830.51) and the count was 707 in area B (Figure 15). The highest percentage count was between 732.20 and 915.25 or 17.1 percent, and the lowest was >1647.46 or 3.4 percent.

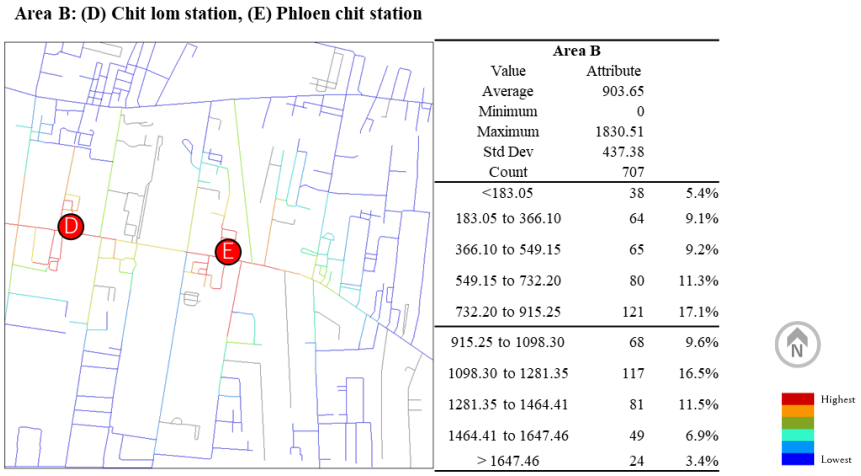


Figure 7.8 Area B: Street metric step depth segment analysis

3) Area C

The average metric step depth was 878.14 (minimum = 0 and maximum = 2234.48) and the count was 505.38 in area C. The highest percentage count was between 670.34 and 893.79 or 16.8 percent, and the lowest was between 1787.58 and 2011.03 or 1.4 percent.

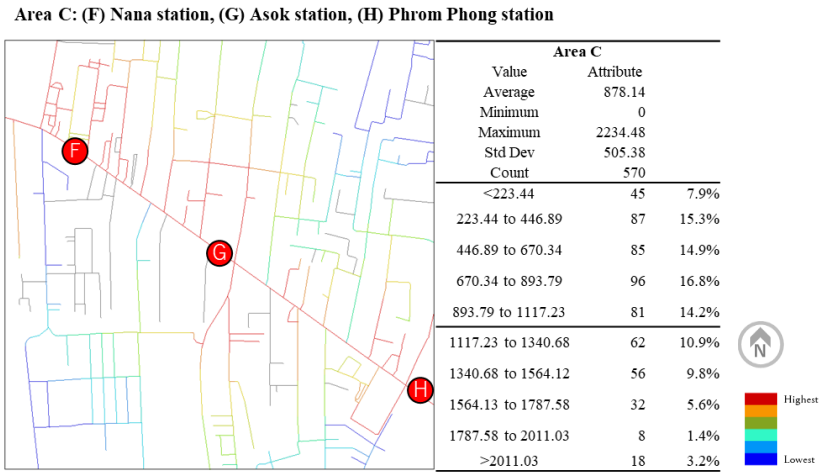


Figure 7.9 Area C: Street metric step depth segment analysis

With respect to area A, 52 percent in area B, and 69 percent in area C, a comparison of the three areas using the criterion of the middle segment count from the original step from each station revealed that the step depth of the shortest part to the middle part from the station was 60 percent in area A, 52 percent in area B, and 69 percent in area C (Figure 7.8).

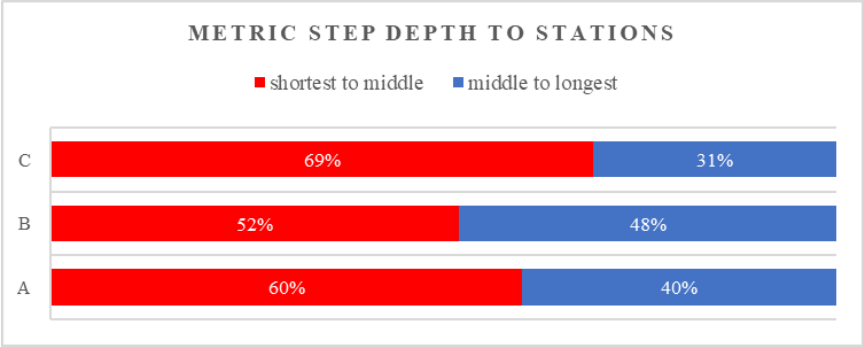


Figure 7.10 Area C: Metric step depth to stations in each area

7.4.4 Analysis of access from different building types to stations

As a result of this research, buildings were divided into eight categories: low-rise residential buildings, high-rise residential buildings, shopping malls/commercial spaces, office spaces, university/education buildings (including hotels), stadiums (including stadiums), and museums (including museums).

The findings revealed that low-rise residences had the highest metric step depth (an average of 1,107 depth steps) for reaching the station throughout the study area, whereas shopping centers had the lowest metric step depth (an average of 480 depth steps) for reaching the station compared to the other types of buildings. The depth of the metric phases in each research region, as well as the overall mean, are shown in Table 7.3. The step depth analysis charts are shown in Figures 7.11, and 7.12 respectively.

An investigation into access to the BTS station within 800 meters of corridors, or approximately four-square kilometers from the station's center, discovered that the walking distance from small residential buildings or communities established along alleyways or soi is significantly greater than the walking distance from other buildings, accounting for nearly half (49 percent) of the total walking distance in the area. Among the structures with metric step depth segments to stations were universities and other educational institutions, hotels and office buildings, high-rise residential buildings, the stadium, museums and other buildings, and retail centers.

Table 7.3 The average metric step depth to stations

	Building type	Area A	Area B	Area C	Mean
1	Low-rise residential	987	1078	1256	1107
2	High-rise residential	145	157	247	183
3	Shopping center/ commercial	37	29	30	32
4	Office	127	267	356	250
5	University/education	307	-	-	307
6	Hotel	167	245	345	252
7	Stadium	60	-	-	60
8	Museum	43	-	-	43

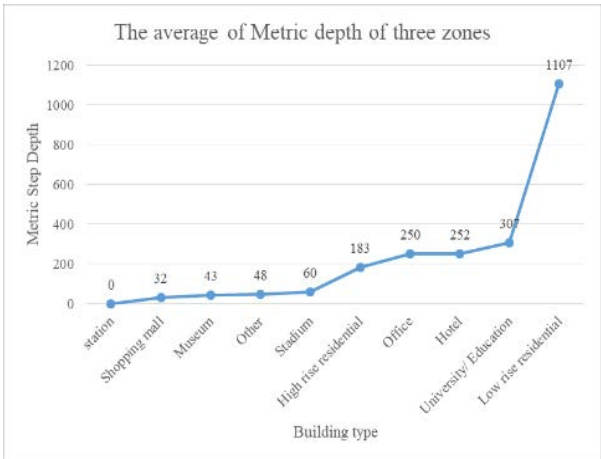


Figure 7.11 Metric step depth level

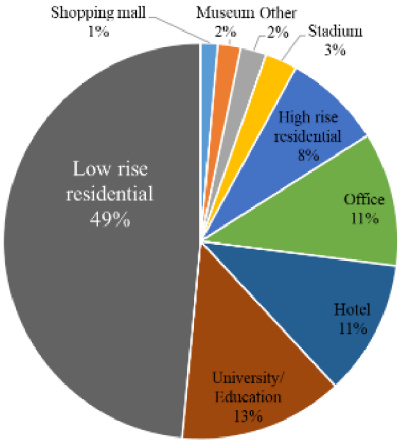


Figure 7.12 Percentage of station to the stations distance

7.5 COMPARISON OF STREET AND PEDESTRIAN CONNECTIVITY CHARACTERISTIC IN DIFFERENT URBAN AREA

The examination of street and pedestrian connection in CBD regions revealed that there was no difference in terms of connectivity on existing streets. Mochit and Bangwa stations were chosen to be investigated alongside Siam station in order to have a better understanding of how they compare to other metropolitan areas in different contexts.

The methods and analysis were the same as those used for the connectivity study in CBD regions. The existing conditions of two stations' streets and pedestrians were generated using Depth Map software analysis to determine the connection value and scatter plot analysis. Figure 7.13 shows the comparison of connectivity map between 3 area

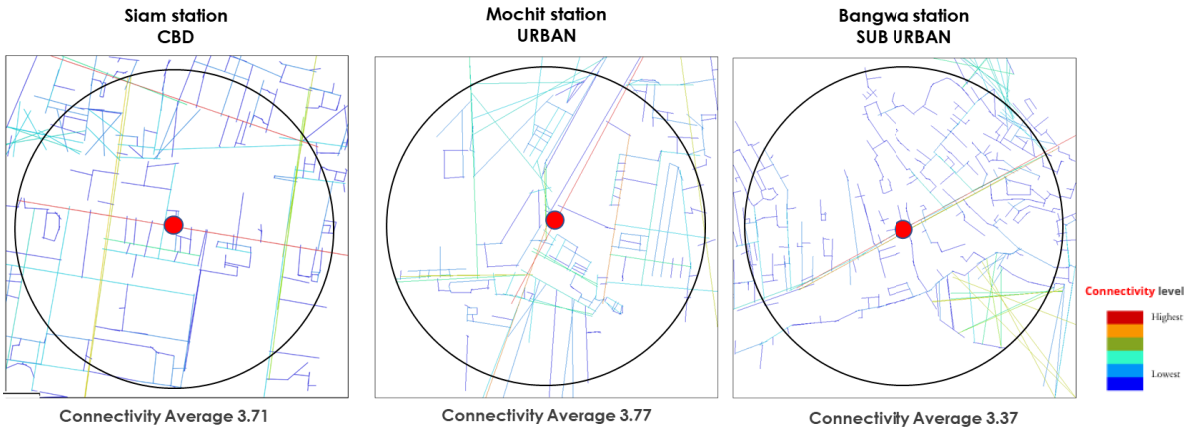
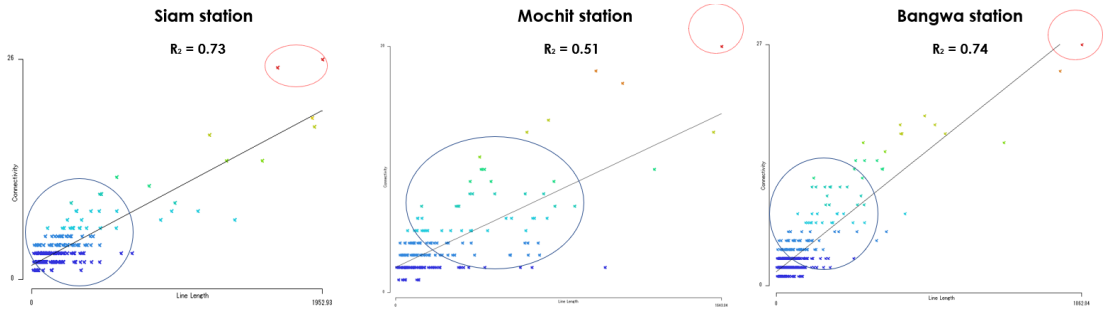


Figure 7.13 Connectivity Average between 3 areas

Regarding Figure 7.13, found that there were not much different between 3 urban area compared to CBD area, in Urban area had slightly higher connectivity area (3.77), while in suburban area had lowest score. In terms of connectedness, the level that was found to be the greatest was solely on the main street, whereas the bulk of other streets and pedestrian connections to stations were found to have a low level.

In a similar manner, the scatterplot of the correlation between connectivity score and line length discovered that all of the area had a positive correlate; the value of R2 at Siam station was 0.73, while Mochit station was at 0.51 and Bangwa station was at 0.74. Figure 7.14 illustrates the characteristics of a scatter plot, and it was discovered that the majority of the lowest connectivity was associated with a short length, but just a few of the highest connectivity scores were associated with a high length. The pattern is the same over this area.



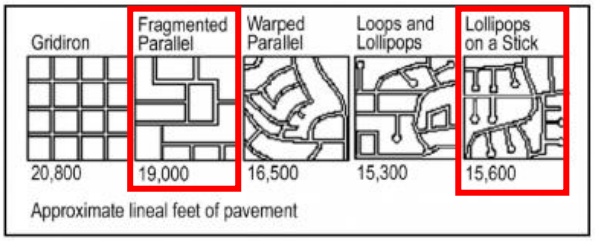
Attribute	Minimum	Average	Maximum
Connectivity	1	3.71	26
Line Length	11.16	220.86	1952.93

Attribute	Minimum	Average	Maximum
Connectivity	1	3.77	20
Line Length	5.31	228.96	1643.04

Attribute	Minimum	Average	Maximum
Connectivity	1	3.37	27
Line Length	5.05	124.78	1862.84

Figure 7.14 Street and Pedestrian connectivity scatterplot

A study of approximate lineal feet of pavement by ULI,1980, the pattern of street by the element found that Siam station was Fragmented parallel which can describe those Straight lines parallel with each other partially, not well interconnected, More three-leg intersections as well as Mochit station. while Bangwa station the street pattern was Lollipops on stick Treelike roads consist of several main roads such as stems and cul-de-sacs like branches More three-leg intersections.



Source: Prince George's County, Maryland, 1999 (adapted from ULI, 1980).

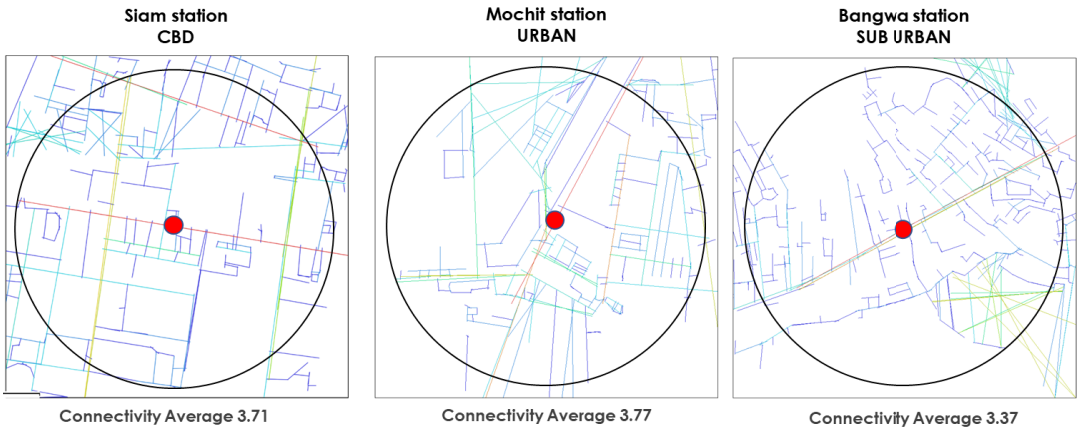


Figure 7.15 Street layout pattern

7.6 CONCLUSION

Regarding the three assumptions of this study as a framework, the findings are analyzed below:

Because of the high density of buildings in the Central Business District (CBD), there would be less visible space and a visible connecting area in terms of open space that would be apparent to the urban visual flow as a result of the high density of buildings in the CBD. This might have an influence on the city's ability to expand in the future.

The results of the analysis indicated that the visible area or the isovist value varied in the contiguous regions of research based on the urban environmental circumstances present at the time. Because of the high density of buildings in between them, the results of the urban visibility study suggest that open space is accessible only on a separate basis. Parks dominate the open spaces in Areas A and C, however there is little open space in Area B. Area A and Area C are the most densely areas. Furthermore, the majority of the high-visibility places are roadways. This finding may help to explain the existing urban features of Bangkok's central business district, which includes a scarcity of modest open space aside from large parks. Furthermore, the density of buildings is quite great, resulting in a relatively confined environment. While the street connectivity around mass rapid transit stations would be high in terms of connectivity, it would be less connected to the local streets, which would be low on the scale of connectivity. This is because the urban local streets that connect to residential neighborhoods have less connectivity to the main streets that provide access to the stations.

In terms of connectedness values, there was no statistically significant difference between regions A and B, however there was a substantial difference between zones C and D. However, all of the locations shared the same characteristics, and the path to the main street,

notably the transit system, was found to have the highest level of connection. Aside from that, the scatter-plot analysis revealed the same trend between connectedness and the longest line as the previous one. When it came to street length, the bulk of them were short and had poor connection, while only a few were lengthy and had better connectivity. This would demonstrate the assumption that the major street on which the stations are located has a high level of connectedness, but that the minor streets are difficult to link to the station.

Even though the walking catchment area is 800 meters away from the station, most of the building types connected to it will be commercial and office in nature, with the majority of them being based on existing streets. Most residential building types will be connected to the station through a longer route that is based on existing streets.

The pattern of step-depth for access from various types of buildings to the stations was the same at each of the research locations, and this pattern was maintained for the entirety of the study. The distance between each station was greatest while traveling between residential neighborhoods and industrial complexes., while the step depth between stations and low-rise residential structures was greater than both the stations and high-rise residential buildings such as condominiums, this depth of the steps was almost the same throughout all public building types, including universities, offices, and hotels. This study result would demonstrate that, as compared to commercial areas, low-rise residential areas in the CBD have a greater distance to the stations within walking distance. Apart from that, the examination of street connection, which has less connectedness, might explain the phenomena of urban design that is characterized by how difficult it is to access the stations of people who live within walking catchment areas, according to the findings.

In terms of comparative analyses to other regions, it was discovered that the average scores for connection in urban and suburban areas were not all that different from one another. In addition, there is a relationship between the length and the connection. Because of this finding, it is important to emphasize that the masterplan should be used to enhance the streets and currents in every location.

7.7 DISCUSSION

Traffic congestion is the problem that has the greatest influence on Bangkok's urban environment, despite the fact that the city's central business district is mostly reliant on public transportation, such as the mass rapid transit system. The findings of this study highlight the fact that difficulties with street networks produced by the urban planning system have not yet been resolved as a result of a lack of coordination between urban master planning and transportation master planning in Bangkok.

The significant expansion of the city center in the central business district is accompanied by increasing land values in the CBD. As a result, there is intense rivalry for construction space. According to the results of the spatial and visibility research, there are more enclosed places than open spaces in the city. Aside from that, while much emphasis has been placed on street connections to the main line, local streets have relatively little utility as a means of connecting to the main line. According to the findings of this study, limited connectivity and a scarcity of open spaces in metropolitan areas make mass rapid transit use difficult due to poor visibility and poor street linkages. This is a phenomenon that may be observed in Bangkok's central business district.

Another finding of this study is that the features of Bangkok's central business district, as well as its mass rapid transport system, have prioritized commercial districts over residential neighborhoods. It was discovered that the metric step depth segment of existing streets from the stations is between 52 and 69 percent, indicating that step access to the stations does not span lengthy distances to the location. For example, the requirement for a feeder transportation system, such as motorcycle taxis, in the region surrounding the station in order to access the mass rapid transit system is illustrated. In theory, the 800-metre walking distance should be sufficient to provide access to public transportation. While pedestrian access to Bangkok's public transportation system is crucial, it should not be overlooked. Because of this, it is possible that there are difficulties walking inside the 800 meters of the Bangkok corridor that will require more investigation through field observation.

In this study, it is recommended that urban environment visibility issues be resolved by reducing density and creating more open areas, particularly around mass rapid transit stations, which would encourage more people to use the stations as a result of the improved visibility of the physical urban environment in question. The study's findings revealed that local streets serving primarily low-rise residential buildings were less connected to mass rapid transit stations than other streets in the area. Furthermore, street connectivity, particularly the connectivity of local streets to mass rapid transit stations, should be given greater consideration.

In conclusion, this study concentrated on the central business district of Bangkok, and the findings show that there are issues with the urban fabric. Despite the fact that the government supports mass rapid transit as the principal means of transportation, the number of individuals who drive their own cars has not diminished, resulting in increased congestion and pollution in the city center. Specifically, the government should consider implementing policies that promote sustainable urban growth and the physical borders of restricted places, according to the findings of this study. One of the city's top priorities is sustainable urban development, which includes encouraging public transportation and reducing vehicle traffic

congestion. This study led to the realization that the existing situation in the CBD continues to be difficult to deal with. A reference for the future development of the CDB, which should be surrounded by mass rapid transit stations in the near future, is provided by this study.

CHAPTER 8
A STUDY OF PEDESTRAIN NETWORKS AND EVALUATE PEDESTRIAN QUALITY AND PEDESTRIAN CHARACTERISTIC AROUND INTERCHANGE MASS RAPID TRANSIT STATIONS

8.1 INTRODUCTION

There has been little research done on pedestrian characteristic or evaluate the pedestrian environment for the mass rapid transit system. This study has two main objectives: first, to evaluate pedestrian quality based on indicators of walkability from accessibility to attractiveness based on 7c indicators score. The second objective is to find out the characteristic of pedestrian connect with mass rapid transit stations with the building environment condition such as build type, frontage area and buffer zone. The study area where three station consists of Siam station which is located in CBD area, Mochit station which is located in Urban area, and Bang Wa station, which is located in sub urban area.

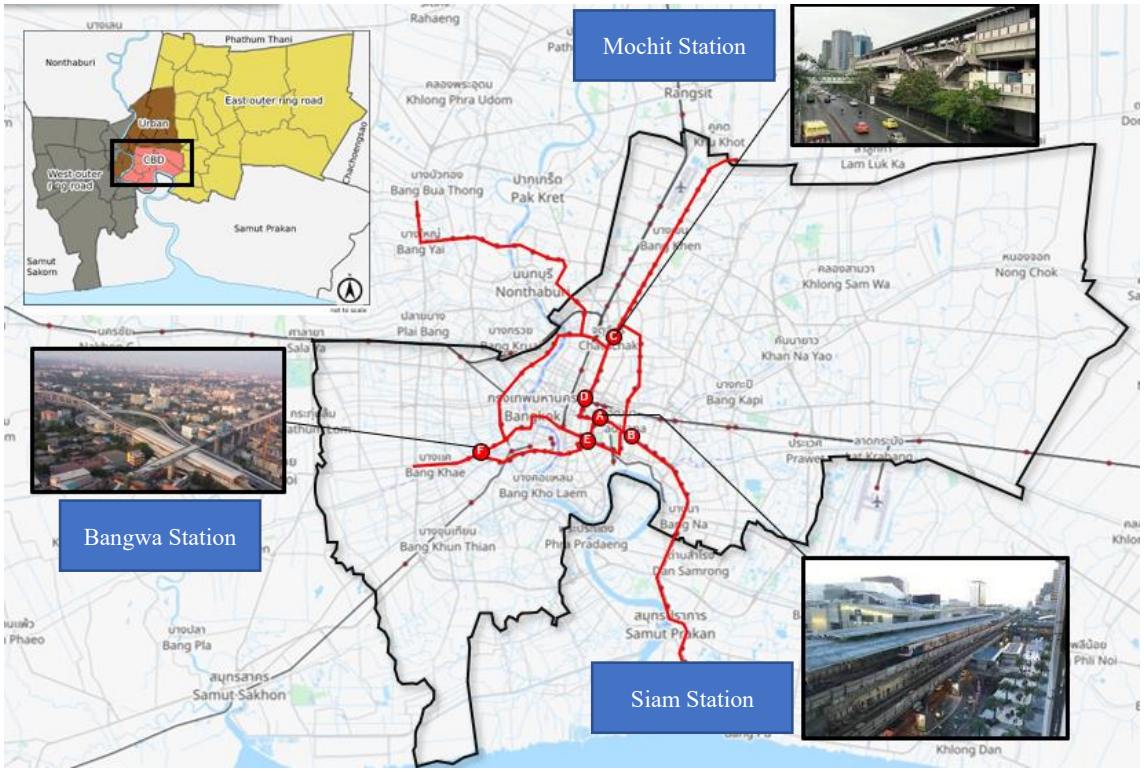


Figure 8.1 Case study area

8.2 RESEARCH METHODOLOGY

This study has 2 main methodologies, the first methodology is to evaluate the current walking quality environment, in this study applied IAAPE-pedestrian accessibility and attractiveness assessment tool to analyzed in term of walking environment in term of micro

scale level. The analysis step following.

1) Designing the observation sheet that will be used to collect the pedestrian physical data during the site survey.

2) Collecting and checking the secondary data from photos and records

- Siam station, number of pedestrians that used for calculating was N=31
- Mochit station, number of pedestrians that used for calculating was N=24
- Bangwa station, number of pedestrians that used for calculating was N= 32

3) Evaluating the data based on IAAPE (Indicators of Accessibility and Attractiveness of Pedestrian Environments), which is a walkability in terms of seven key dimensions (7C's layout) at a micro-scale level. The step of calculate divided into 3 steps;

(1) evaluate the pedestrian in each block by formular.

$$Walkability_{micro} = 0.1428 * Pedestrian\ network\ continuity + 0.1428 * Sidewalk\ available\ width + 0.0357 * Amenities + 0.0357 * Trees + 0.0357 * Climate\ protection + 0.0357 * Lighting + 0.0714 * Blind\ buildings + 0.0714 * Transparent\ buildings + 0.1428 * Path\ enclosure + 0.0714 * Conflicts + 0.0714 * Sidewalk\ buffer\ width + 0.0714 * Maintenance + 0.0714 * Cleanliness$$

Being assessed 13 environmental factors and the result being given in a 0 to 100 interval

(2) evaluate the pedestrian in each path by formular;

$$Walkability_{micro}:PathSide\_0 = \frac{\sum_i Segment\ score_i \times length_i}{\sum segment\ length\ (side\ 0)} + Walkability_{micro}:PathSide\_1 = \frac{\sum_j Segment\ score_j \times length_j}{\sum segment\ length\ (side\ 1)}$$

(3) evaluate the overall score by formular.

$$Walkability_{micro}\ Path = \frac{PathSide\_0 + PathSide\_N}{Number\ of\ PathSide}$$

For the second objective, to understand the pedestrian physical environment, cross-section analysis will be use in this study.

Regarding pedestrian zone standard by National Association of City Transportation Officials, there are 4 areas on the pedestrian sidewalk consists of 1) Frontage zone, 2) Pedestrian Through zone, 3) Street and Furniture zone and 4) Enhancement zone

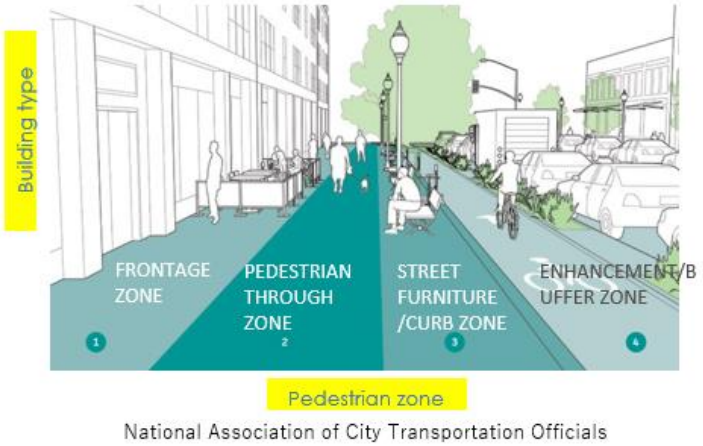


Figure 8. 2 The standard of pedestrian zone

8.3 RESULTS

8.3.1 Pedestrian quality environment around Mass rapid transit station

Regarding from the analysis result found that comparison to all station, the scores were less than average. Siam station were 48.23, Mochit station were 41.28, and Bangwa station were 38.95

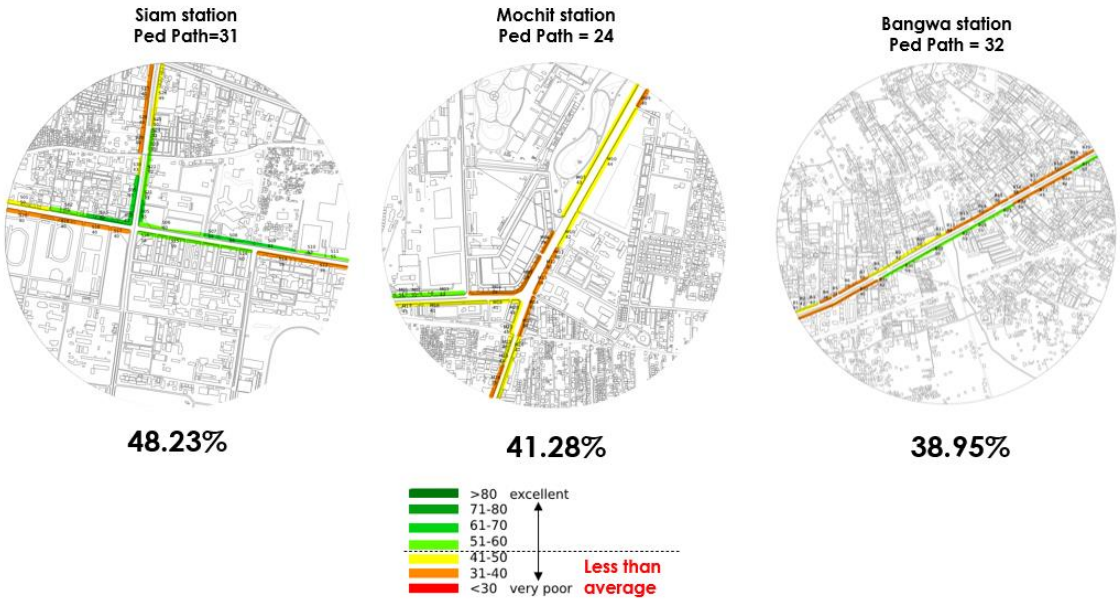
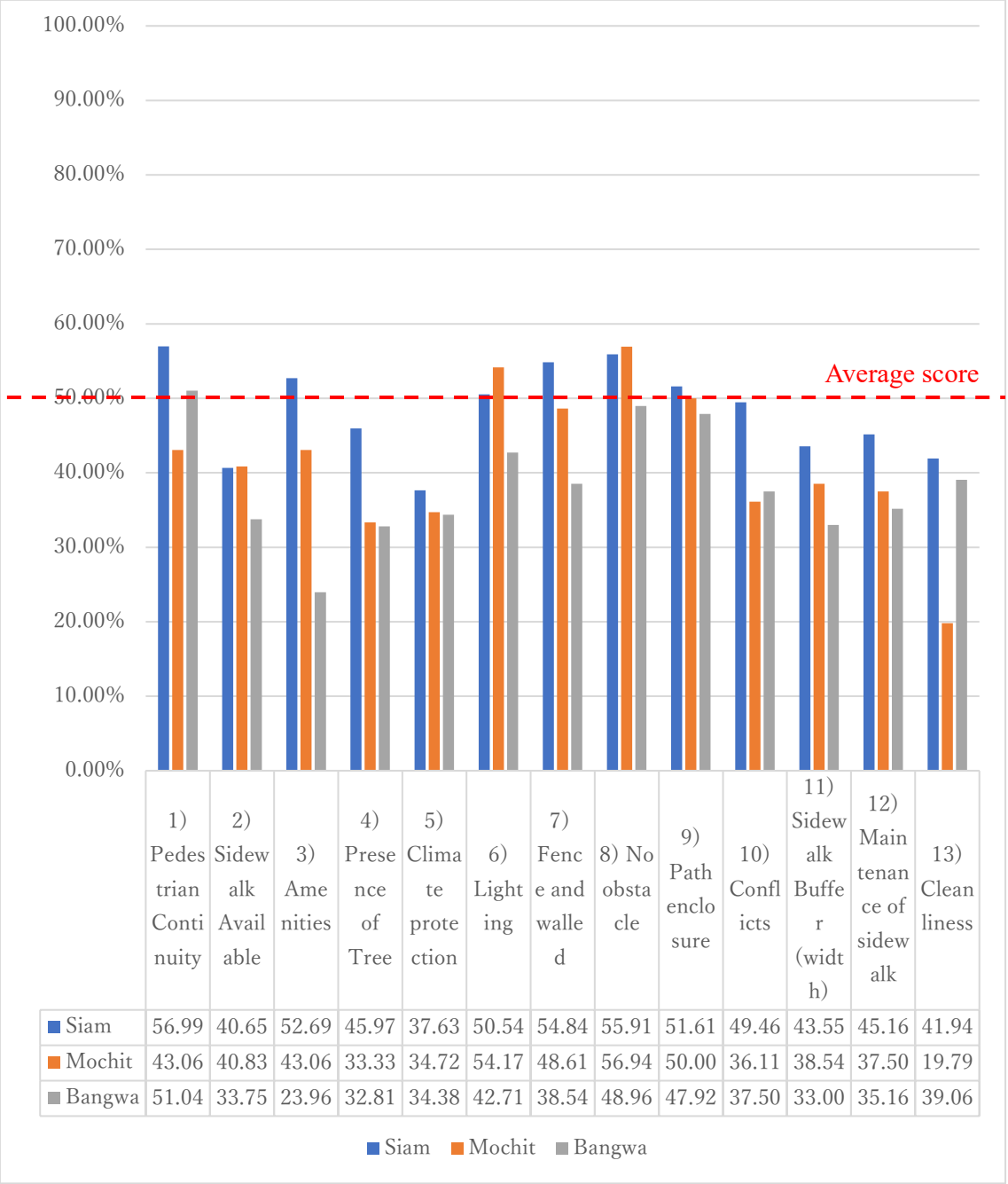


Figure 8. 3 Overall quality score of pedestrian environments

Considering each walking indicator comparison, found that most of environment score were lower than average especially in Bangwa station, the only indicator that higher than 50% was Pedestrian Continuity (51.04%).

The chart in figure 8.4 shows the analysis that each indicator needs to be improved in each station.



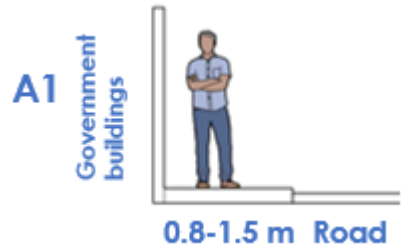
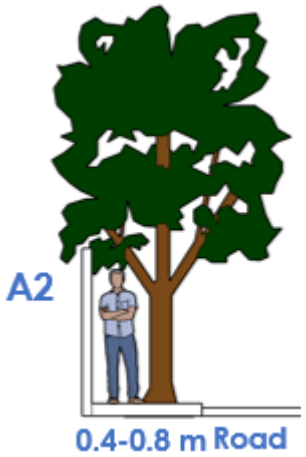
	1) Pedestrian Continuity	2) Sidewalk Available	3) Amenities	4) Presence of Tree	5) Climate protection	6) Lighting	7) Fence and walled	8) No obstacle	9) Path enclosure	10) Conflicts	11) Sidewalk Buffer (width)	12) Maintenance of sidewalk	13) Cleanliness
Siam	56.99	40.65	52.69	45.97	37.63	50.54	54.84	55.91	51.61	49.46	43.55	45.16	41.94
Mochit	43.06	40.83	43.06	33.33	34.72	54.17	48.61	56.94	50.00	36.11	38.54	37.50	19.79
Bangwa	51.04	33.75	23.96	32.81	34.38	42.71	38.54	48.96	47.92	37.50	33.00	35.16	39.06

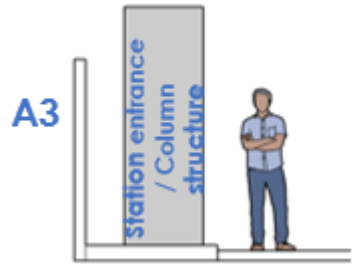
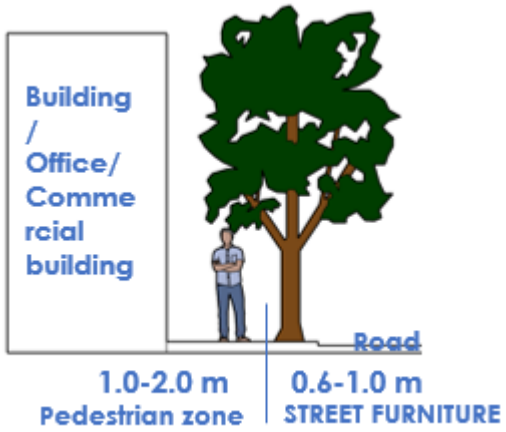
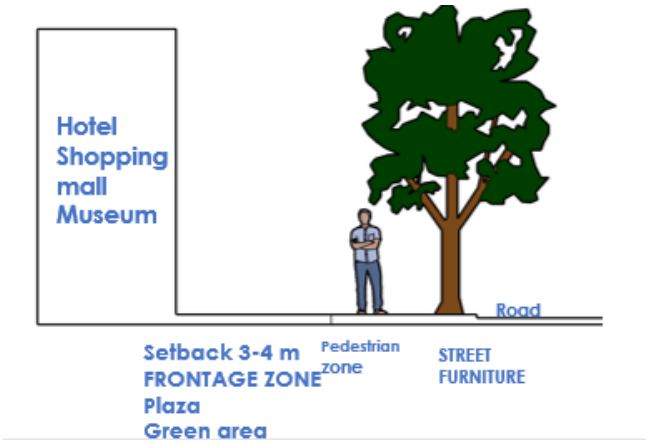
Figure 8. 4 Pedestrian Environment indicator analysis

8.3.2 Pedestrian characteristic

It was discovered from all of the cross-sectional studies that there are five different sorts of urban areas. The findings of the analysis, which were compared to the criteria for pedestrian zones, may be found in section (figure 8.2). The information from each of the parts may be found in table 8.1.

Table 8. 1 Pedestrian characteristic connect to mass rapid transit in Bangkok

Type	Characteristic	Description
A1		This sort of pedestrian primarily frequented the sidewalk in the vicinity of the government building. The only kind of path that exists is a sidewalk, and its width ranges from 0.8 to 1.5 meters. There is neither a buffer nor a furniture area, nor is there a frontage zone that is protected by a solid wall from the building.
A2		This style of sidewalk is quite similar to Type A1, with the exception that a portion of it is attempting to install an amenity right on the pavement, without taking into account the surrounding context, such as the width or the pedestrian walk route. This type is typically found in conjunction with the kind of building used by the government as well as Type A1.

Type	Characteristic	Description
A3		People are unable to walk on this form of pedestrian since it does not allow them to do so. Because there are significant work locations on the pavement, they are forced to stroll on the street instead. The vast majority of examples of this type may be discovered in the region that is located close to the station entrance.
B		The pedestrian zone of this kind consists mostly of pedestrian zone and furniture zone. The width for pedestrians ranges from one to two meters. In general, this kind of walkway may be seen in the vicinity of offices and other modest business buildings.
C		This form of pedestrian is comparable to the regular variety due to the fact that they have a frontage zone and a street furniture zone. Generally speaking, you may see this sort of pedestrian at high-rise hotels, large retail malls, and museums.

In term of Siam station, the majority is type A1 (36%) while Type C (25%) and Type A3 (17%) respectively. Mochit station, The majority is type A2 (36%), Type A3 (26%) and Type A1 and B are same with 15%. Bangwa station, majority is Type B (54%), Type A2 (18%) and Type A3 16%

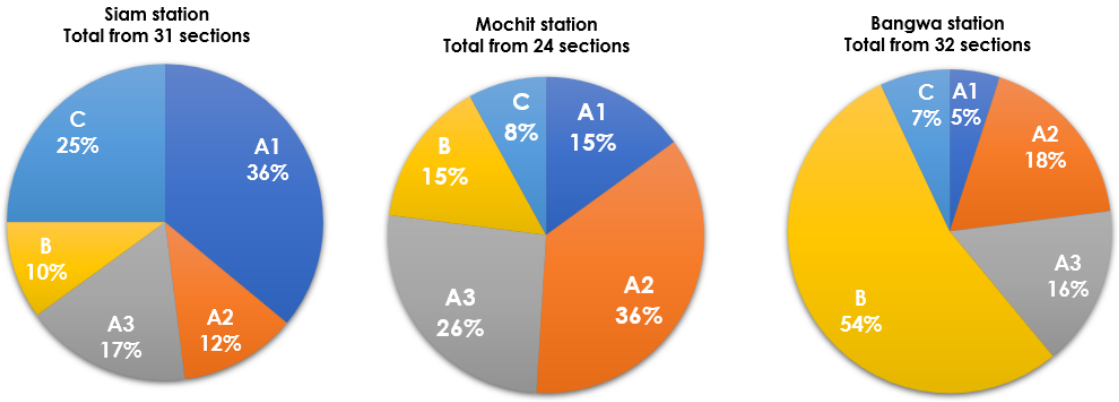


Figure 8. 5 Type of Pedestrian zone cross-section analysis

8.4 CONCLUSION

The quality of the pedestrian environment in any metropolitan region was below average, and there was not much of a difference in the quality of the environment whether it was in the central business district or in the suburbs. If the total quality of each element's indication is considered, it was discovered that climate protection has a somewhat lower quality than the other aspects. Elements of cleanliness had the lowest quality at Mochit station, which may be because the buildings around the area are close to an outdoor market. In the case of the Central Business District, the Siam station was somewhat superior than the other stations overall, although climate protection is one of the factors that must be taken into consideration.

In terms of the characteristics of pedestrians as determined by a cross-section, based on all three stations combined. It was discovered that there is not more than one kind of pedestrian pattern; moreover, it does not depend on the location; rather, the kind of building is one of the essential factors that might have an influence on the pedestrian environment.

This analysis demonstrates the deficiency in the quality of the single physical portion. It will be analyzed in the next chapter how to determine the association between passenger perception and physical state in order to determine the conclusion and offer a suggestion in the following chapter.

CHAPTER 9
A STUDY OF RELATIONSHIP BETWEEN USER'S PERCEPTION TOWARD TO PEDESTRIAN ENVIRONMENT CONNECT TO MASS RAPID TRANSIT

9.1 BACKGROUND

The most significant issue is undoubtedly the congestion that results from transportation. Even though the new station of the mass rapid transit system is still in the process of being built, the accessibility to get to the station is very poor due to the pedestrian environment condition which makes it difficult to walk. This is the case despite the fact that the new station is still being built.

The purpose of this study is to get a better understanding of the relationship between the level of satisfaction experienced by passengers and the environment experienced by pedestrians about the same metrics. As a micro-scale metric of walkability, the 7Cs was selected as the indicator. The purpose of this experiment is to investigate the hypothesis that there is a positive association between perception and the physical performance of pedestrians.

9.2 RESEARCH METHODOLOGY

The gathering of data was carried out in two ways: 1) through an online questionnaire; and 2) pedestrian environment observation survey. In order to find the correlation between passenger's satisfaction score and pedestrian environment physical score, the same environment indicator will be used which are based on 7C indicators to find out the significant of which element has strong impact associate to passenger perception. The statistical analysis called Eta-squared has been used in this analysis because there are different type of variables.

Eta-squared is a descriptive measure of the degree to which the independent factors in the sample are associated with the dependent variables. Researchers are able to gain a descriptive understanding of the behavior of the variables in their sample by utilizing the eta-squared statistic, which is one of the advantages of using this metric. (ZACH, 2022)

The formula to calculate Eta squared is straightforward:

$$\textbf{Eta squared} = \textbf{SSeffect} / \textbf{SStotal}$$

where:

SSeffect: The sum of squares of an effect for one variable.

SStotal: The total sum of squares in the ANOVA model.

The value for Eta squared ranges from 0 to 1, where values closer to 1 indicate a higher proportion of variance that can be explained by a given variable in the model.

The following rules of thumb are used to interpret values for Eta squared:

.01: Small effect size
.06: Medium effect size
.14 or higher: Large effect size (ZACH, 2022)

The analysis generated by IBM SPSS analysis from the result of questionnaire survey and observation survey which will be explained in next topic.

9.3 FINDINGS: AN ANALYSIS OF RELATIONSHIP BETWEEN VARIABLES

This section will explain about the result from SPSS analysis of Eta Squared between two variables and explain which element that are impact to passenger perception from large effect size to small effect size.

Table 9. 1 Siam station: Correlation between passenger satisfaction and physical score

	Eta Squared
4) Presence of Tree * Mean Satisfaction	0.69
2) Sidewalk Available * Mean Satisfaction	0.49
5) Climate protection * Mean Satisfaction	0.42
8) No obstacle * Mean Satisfaction	0.42
3) Amenities * Mean Satisfaction	0.39
10) Conflicts * Mean Satisfaction	0.37
6) Lighting * Mean Satisfaction	0.32
7) Fence and walled buildings (including building shop) * Mean Satisfaction	0.31
1) Pedestrian Network Continuity * Mean Satisfaction	0.26
13) Cleanliness * Mean Satisfaction	0.16
9) Path enclosure * Mean Satisfaction	0.09
12) Maintenance of sidewalk * Mean Satisfaction	0.08
11) Sidewalk Buffer (width) * Mean Satisfaction	0.05

Note: .01: Small effect size/.06: Medium effect size/.14 or higher: large effect size

The analysis result from Siam station found that most of pedestrian environment indicators have large size effect size, from Present of Tree (0.69), Sidewalk Available (0.49) and climate protection and No obstacle (0.42) were large effect size respectively.

Table 9. 2 Mochit station: Correlation between passenger satisfaction and physical score

	Eta Squared
7) Fence and walled buildings (including building shop) * Mean Satisfaction	0.67
4) Presence of Tree * Mean Satisfaction	0.43
3) Amenities * Mean Satisfaction	0.42
5) Climate protection * Mean Satisfaction	0.38
12) Maintenance of sidewalk * Mean Satisfaction	0.34
9) Path enclosure * Mean Satisfaction	0.33
2) Sidewalk Available * Mean Satisfaction	0.31
8) No obstacle * Mean Satisfaction	0.26
11) Sidewalk Buffer (width) * Mean Satisfaction	0.24
6) Lighting * Mean Satisfaction	0.2
10) Conflicts * Mean Satisfaction	0.2
1) Pedestrian Network Continuity * Mean Satisfaction	0.18
13) Cleanliness * Mean Satisfaction	0.1

Note: .01: Small effect size/.06: Medium effect size/.14 or higher: large effect size

In case of Mochit station, the result found that all of element has large effect size to passenger satisfaction. From highest is Fence and walled buildings (0.67), Presence of Tree (0.43), and Amenities (0.42)

Table 9.3 Bangwa station: Correlation between passenger satisfaction and physical score

	Eta Squared
1) Pedestrian Network Continuity * Mean Satisfaction	0.92
9) Path enclosure * Mean Satisfaction	0.30
7) Fence and walled buildings (including building shop) * Mean Satisfaction	0.20
5) Climate protection * Mean Satisfaction	0.19
2) Sidewalk Available * Mean Satisfaction	0.16
6) Lighting * Mean Satisfaction	0.15
10) Conflicts * Mean Satisfaction	0.13
8) No obstacle * Mean Satisfaction	0.11
13) Cleanliness * Mean Satisfaction	0.11
11) Sidewalk Buffer (width) * Mean Satisfaction	0.10
4) Presence of Tree * Mean Satisfaction	0.09
12) Maintenance of sidewalk * Mean Satisfaction	0.08
3) Amenities * Mean Satisfaction	0.05

Note: .01: Small effect size/.06: Medium effect size/.14 or higher: large effect size

Bangwa station, most of the pedestrian elements have large effect size except Amenities. From highest large effect size, Pedestrian Network Continuity (0.92), Path enclosure (0.30), Fence and walled buildings (0.20) respectively.

9.4 DISCUSSION AND CONCLUSION

In this chapter, the research findings reveal that the majority of pedestrian features have a significant impact on passenger satisfaction; nevertheless, other elements, the influence of which is contingent upon the location and the specifics of the urban context, are examined. This could be explaining the phenomenon between different type of variable about how they are strong associate to each other. For example, in term of Siam station Presence of Tree was the highest strong associate to passenger perception. While Fence and walled buildings at Mochit station has a large effect to perception.

This result can be used to demonstrate that, despite the findings of the overall study, the pedestrian environment has been negativing in both terms of passengers and physical conditions. However, the elements or indicators that are impact between variables are different in regard to the environmental conditions. As a result, in order to make improvements in the future, policy makers or urban designers should consider the user's perspective in addition to the environmental context.

CHAPTER 10
A REVIEW OF POLICY LAW AND REGULATIONS OF PEDESTRIAN IN BANGKOK

This chapter provides a review of the laws and regulations that are relevant to the implementation of pedestrian infrastructure in Bangkok. The goal of this review is to gain an understanding of the regulations that are applicable, as well as to evaluate and direct the study's results toward further development in the following chapter.

10.1 CURRENTLY LAW AND REGULATION IMPLEMENTATION IN BANGKOK

In general, Laws directly related to the study of increasing pedestrian safety measures to use the crossing in accordance with the Road Traffic Act 1979, which has been amended to No. 11, 2016, and Order of the National Council for Peace and Order No. 14/2017 on measures to increase efficiency in the enforcement of the law on road traffic, the provisions of the Road Traffic Act 1979 relating to this study can be divided into 3 parts.

First part: The operator's actions in accordance with road traffic laws only in connection with crossings and pedestrians using the crosswalk.

The key major of First part which are related to pedestrian can be explained as below.

- Most of regulations related to the rider, which is involved here, is to the rider. Cars, motorcyclists, motor vehicles, motorcyclists.
- When using a road, the rider must take care to prevent the vehicle from hitting or hitting pedestrians, regardless of where they are in the road.
-

Second part: The pedestrians according to road traffic laws

- Walking on the shoulder or the pavement if that road no way to threaten to allow the road to walk along its right side.
- It is forbidden for pedestrians to cross over the road beyond 100 meters from the crossing distance.
- In crosswalks with traffic lights controlling pedestrians When pedestrians want to cross the road, they must follow the traffic lights that appear in front of people.

Third part: Powers of competent officials under road traffic laws.

In term of law and regulation, this mentioned in the event that the driver has hit a pedestrian or being hit by a pedestrian who stoops off the road and stays on the way traffic

sign.

Specifically in Bangkok, Presently, there are 2 regulations which are implementation in Bangkok consists of

1) The Cleanliness and Orderliness Act of the Country, 1992
2) Bangkok ordinances, regulations, orders and announcements issued by powers under the Act on Maintaining Cleanliness and Orderliness of the Country

Regarding regulations above, there are definition which are related to pedestrian consists of

- "Public place" means the public domain of the land other than the desolate place and includes roads and waterways.
- "Road" includes a roadway, sidewalk, curb, shoulder, crosswalk under the law on land traffic, lane, alley, bridge or private road. which the owner agrees to People can use the commute.

Besides the Bangkok regulation, there is another law called Road Traffic Act, 1979 determined the definitions with are relevant to pedestrian

- Footpath means an area made for pedestrians on either side of the road or both sides of the way or the part that is on the edge of the road which is a place for pedestrians.
- Pedestrian means a pedestrian and shall include users of wheelchairs for people with disabilities or vehicles for children.

10.2 BOTTLE NECK OF LAW AND REGULATION IMPLEMENTATION

Pedestrian legislation and regulation in Bangkok is the subject of a small number of studies, some of which focus on revising existing laws and regulations.

A study from Bangkok Civil Service Development Institute had done the analysis about pedestrian improvement base on government training (Surnin, 2020) found that the weakness point of pedestrian management was Municipality officials are often assigned to important, urgent tasks, among other duties lack of continuity in organizing, Operators still lack knowledge of laws and procedures and the patronage system made it difficult to enforce the law.

Regarding the review of the current law and regulation implementation in Bangkok, there are 2 mains documents and 1 organization including The Act on Maintaining Cleanliness and Orderliness and the Guideline by Government and Construction and restoration office

1) **The Act on Maintaining Cleanliness and Orderliness**, there are only 3 parts which are related to pedestrian:

Pedestrian safety

- Prohibited to park or drive a car, motorcycle or wheels on the pedestrian

Pedestrian Cleanliness

- The owner or occupant of the building or the area of the building adjacent to the sidewalk has a duty to maintain cleanliness**.**
- Stall on street or pedestrian is prohibited.

Pedestrian lively environment (tree and garbage)

- The owner or occupant must not neglect to let the trees or grains that they plant or grow on their own land to wither or become cluttered.

Bottom neck: Law and regulation concern only safety one issue. And cleanliness and trees just only in front of building or landowner.

2) **Guideline by Government,** currently, most of the road work construction and maintenance use Standard form for road works of Bangkok. In term of pedestrian, there are only 3 topics that relevant

- There are 3 dimensions of Pedestrian width consists of 2 m/2.6 m/3.2 m.
- There are many utilities and facilities located on pedestrian such as trees, bench, garbage area, public toilets etc.
- There is no definition of pedestrian walking paths.

Bottom neck: Lack of data analysis backup to develop a design guideline which is consider of identity of the area.

3) **Construction and restoration office,** there is a sector in BMA, **Construction and restoration office** which has responsibility of maintenance and improve physical and road structure of pedestrian pavement following **Standard form for road works of Bangkok** guideline. This sector has management system divided by district.

Bottom neck: Only take responsibility by maintenance and cleanliness. And don’t have design and operational center in term of overall pedestrian development.

CHAPTER 11
SUMMARY CONCLUSION AND RECOMMENDATION

11.1 SUMMARY OF KEY FINDING

This chapter will summary key finding of all the conclusions in each objective, as well as present more particular findings and recommendations in each station and location.

11.1.1 To investigate the Pedestrian Environment with regards to the travel behavior perception and attitude of Passengers Regarding Mass Rapid Transit Stations.

Overall, this study surveyed Thai people in Bangkok and found that the perception of the pedestrian environment mostly was "Slightly Satisfied," The image of specific pedestrian paths in Bangkok with shops or vendors located on the sidewalks represents the areas; however, the study data showed that people walking on pedestrian walkways were dissatisfied with that atmosphere. However, considering about in each urban area, the research found that each area has different outcome in detail. This conclusion explain about user perception and satisfaction can be descript into 3 urban areas

1) **Stations located in Central business area**

   Travel behavior: Passengers who live within walking distance area 500 m from station, they can reach to station within 10-30 mins and travel by public transportation, those who live within 800 m from station can reach to stations within 30 mins and travel by private car but other than that can reach to stations more than 1 hours and travel by car.

   Transportation Mode: Majority is using public transportation then private car and taxi and motorcycle taxi and walking respectively.

   Attitude to walking as main transportation: Strongly disagree

   Overall satisfaction: Slight satisfied

2) **Stations located in Urban area**

   Travel behavior: Passengers who live within walking distance area 500 m from station, they can reach to station within 10-30 mins and travel by walk, those who live within 800 m and travel by public transportation from station can reach to stations within 30 mins but other than that can reach to stations more than 1 hours and travel by public transportation.

   Transportation Mode: Majority is using public transportation then motorcycle taxi and taxi and walking and private car respectively.

   Attitude to walking as main transportation: Strongly disagree

   Overall satisfaction: Slight satisfied

3) Stations located in Sub urban area

Travel behavior: Passengers who live within walking distance area 500 m from station, they can reach to station within 10-30 mins and travel by public transportation, those who live within 800 m and travel by public transportation from station can reach to stations within 30 mins but other than that can reach to stations more than 1 hours and travel by public transportation.

Transportation Mode: Majority is using public transportation then car, taxi and other respectively.

Attitude to walking as main transportation: Strongly disagree

Overall satisfaction: Slight satisfied

11.1.2 To investigate the level to which passengers are content with the quality of pedestrian connections to interchanges between mass rapid transit stations in different of Bangkok urban zones.

Even if the people are somewhat content with the pedestrian environment, each urban person has a distinct level of dissatisfaction with regard to the pedestrian environment. This is especially true in terms of environmental conditions.

In Central Business area: 1) Maintenance of sidewalk 2) Path enclosure 3) Conflicts 4) Climate protection

In Urban area: 1) Sidewalk Available 2) Amenities 3) Climate protection 4) Sidewalk Buffer

In Suburban area: 1) Sidewalk Available 2) Presence of Tree 3) Climate protection 4) Conflicts

11.1.3 To investigate of street and pedestrian connectivity and characteristic

The key conclusion that emerged from the study was that the entire region has a low connectedness, and that strong connectivity has a positive correlation to length. This was determined to be the case. In addition, the majority of the streets and pedestrian paths that now lead to the station have a limited length and poor connection. Not only has it made it more difficult to get to the station by the pedestrian walkway, but it has also made it more difficult to get there using the present street route line.

11.1.4 To investigate and analyze the pedestrian environment using the 7Cs as indications.

Regarding the result of pedestrian physical survey analysis, the conclusion found that every area are lower and average even CBD area, but different element by urban condition.

Siam station (CBD area): the less pedestrian quality is Climate protection.

Mochit station (Urban area): the less pedestrian quality is Cleanliness.

Bangwa station (Suburban area): the less pedestrian quality is Amenities.

11.1.5 To investigate on the relevance of the correlation between pedestrian behavior, passenger perception, and the pedestrian environment in Bangkok.

The result of passenger satisfaction and the pedestrian environment score had been calculated and finding the correlation by using Measures of Association to explain how impact or effect of each element to passenger satisfaction. Most of element have a large size effect. And each area have different pedestrian element effect conditions.

Siam station (CBD area): Presence of Tree

Mochit station (Urban area): Fence and walled buildings

Bangwa station (Suburban area): Pedestrian Network Continuity

11.2 CONCLUSION AND RECOMMENDATIONS

Based on the most important findings from each objective, the conclusion would be explained in terms of both a simple way, such that even passengers feel slightly satisfied towards pedestrians, and in terms of the physical condition, such that the pedestrian environment that connects to stations in Bangkok needs to be improved in many different ways. To be more specific in terms of the proposal, every station has to be enhanced in the methods for instant Station of the Siam, the presence of trees is the aspect of the pedestrian environment that has the most influence on the level of happiness experienced by passengers; hence, this aspect should be given top priority in any short-term strategy. Within 800 meters, the majority of building types are government and university, and certain parts of these buildings have high walls along pedestrian areas. As a result, the majority of pedestrian patterns are not conducive to pedestrians surrounding walking areas. It is imperative that the public sector establish a design center that is vested with the authority to oversee the masterplan as a whole.

According to travel behavior data, even within 500 m. walking distance area, the commuting time to station is between 10-30 mins and most people still travel by car to get to station. Regarding the finding of pedestrian environment which impact to people perception, for instant, the improvement of Siam station should be consider of creating more green area or landscaping for making livelier pedestrian environment in case of Mochit station, Fence and walled building is a large impact to perception, and Bangwa station is Pedestrian network continuity.

People who do not live within a walking distance of 800 meters must commute for more than one hour in order to reach the station, and the vast majority of these commutes are made on public transit. This is another huge issue. This data indicates that passengers take a significant amount of time to go to mass rapid transit stations. And in order for passengers to get to the station, they need to make use of other modes of transportation, the majority of which are vehicles that go on roads. Because of this, the issue of traffic congestion has not been resolved. Even now, Mas rapid transit system is under construction. But the action plan of improving pedestrian reach to station have yet been study due to lack of information in term of passenger side and physical side.

In terms of setting up regarding policy maker, the application of the design guideline and the management system is now one of the most significant challenges. In terms of laws and regulations, the majority of terms of use include issues pertaining to cleanliness, but they do not discuss issues relating to other walking environments or safety. The second issue is that the design guidelines and maintenance procedures don't take into account the walking paths used by pedestrians. The utility guidelines are construction on the sidewalk, but there is no clearance for people to walk, which might be difficult for persons who are elderly or who use wheelchairs.

Regarding the study methodology, this study would be applied to other stations both current operation and future station which are under construction. The data from both passenger side and pedestrian physical side would be apply for improving the design guideline or back up data for urban policy planner.

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APPENDIX: A
QUESTIONNAIRE SURVEY

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	Questions	Answer							
A	**Demographics**								
A1	Age	□	< 18	□	18 - 23	□	24 - 30	□	31 - 40
		□	41 - 50	□	51 - 60	□	> 60		
A2	Gender	□	Female	□	Male				
A3	Occupation	□	Employee	□	Public servant	□	Self-employed	□	Student
		□	Other						
A4	Current Address (Zone and District)	□	Zone A (500 m from station)	□	Zone B (800 m from station)	□	Other		
A5	Number of Family member	□	1	□	2	□	3	□	>3
A6	Number of own private cars	□	1	□	2 - 3	□	> 3	□	No personal car
B	**Travel Behavior**								
B1	What is your main reason to use the BTS station?	□	Travel to work	□	Visit family / friends	□	Go shopping	□	Other
B2	Do you use the BTS SkyTrain to transfer traffic to alternative transport systems?	□	Change to another train line. (BTS/MRT)	□	Change to bus	□	Change to semi-public transportation (Taxi, Motobike taxi)	□	Able to walk between the station and the destination.
B3	Before COVID-19, how often did you use BTS per week?	□	Everyday	□	5-6 days	□	3-4 days	□	1-2 days
		□	Rarely						
B4	After COVID-19, how often have you used use BTS per week?	□	Everyday	□	5-6 days	□	3-4 days	□	1-2 days
		□	Rarely						
B5	For the most part, how do you get to the BTS station?	□	Private car	□	Public transportation	□	Walking	□	bicycle
		□	motocycle	□	taxi, motor bike taxi	□	Grab	□	Other
B6	How many minutes does it take from the house to the station?	□	< 5 mins	□	5-10 mins	□	10-15 mins	□	15-30 mins
		□	30 mins - 1hour	□	> 1hour				
B7	How many minutes does it take you from the bus stop or car park to the station?	□	< 5 mins	□	5-10 mins	□	10-15 mins	□	> 15 mins
B8	In your opinion, Why do you not want to use the pedestrian path to the train station?	□	Rough pavement, uneven surfaces.	□	The pedestrian route is shared with other vehicles.	□	Sidewalks are dirty	□	The sidewalk is narrow.

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		□	There is a commercial use of sidewalk or advertising space such as hopping on stalls or installing large billboards.	□	No facilities	□	No shading of trees or roof	□ Flooding
		□	A beggar or a homeless person living on the sidewalk	□	other			
B9	As for your point of view about traveling in Bangkok, how is a private car?							
	This is the first travel mode choice in Bangkok.	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Convenient	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Cost effective	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Safety	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Travel on time	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
B10	As for your point of view about traveling in Bangkok, how is Mass Rapid Transit system?							
	This is the first travel mode choice in Bangkok.	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Convenient	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Cost effective	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Safety	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Travel on time	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
B11	As for your point of view about traveling in Bangkok, how is walking?							
	This is the first travel mode choice in Bangkok.	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Convenient	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Cost effective	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Safety	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
	Travel on time	□	Strongly agree	□	Agree	□	Disagree	□ Strongly disagree
C	**Level of satisfaction (pedestrian access to station)**							
C1	Network and connectivity	□	Very satisfied	□	satisfied	□	Slightly satisfied	

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		□	Dissatisfied	□	Very Dissatisfied		
C2	Sidewalk avalible (widht)	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C3	Amenities	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C4	Presence of Trees	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C5	Climate protection	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C6	Lighting	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C7	Fence and walled buildings (including building shop)	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C8	No obstacle	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C9	Path enclosure	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C10	Conflicts	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C11	Sidewalk Buffer (widht)	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C12	Maintennance of sidewalk	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C13	Cleanliness	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		
C14	Universal design	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		

D	**Sensibility (Safety and Satisfaction)**				
D1	Have you ever felt unsafe on the pedestrian due to the following; *Motorcycles that ride on sidewalks*	□	yes	□	no

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	A beggar or a homeless person who uses the pedestrian space	□	yes	□	no		
	Stalls that use the pedestrian area	□	yes	□	no		
	Stray dogs and other animals	□	yes	□	no		
	The rugged and uneven path.	□	yes	□	no		
	People are overcrowded.	□	yes	□	no		
D2	Overall satisfaction with the performance of pedestrian pathways to the station	□	Very satisfied	□	satisfied	□	Slightly satisfied
		□	Dissatisfied	□	Very Dissatisfied		

E	**Point of view and comment**							
	In your opinion, what components of a pedestrian pathway that accesses the station should be improved or considered the most important?	□	The pedestrian walkways are continuous and are well connected to the station.	□	A pedestrian width is suitable for all types of people.	□	There are adequate facilities such as waiting seats, public parking lots, etc.	□ The shady of trees.
		□	Provide appropriate weather protection.	□	Provide good lighting for pedestrians.	□	The building close to the pavement is decorated to improve the walking environment.	□ The path is unobstructed
		□	The pedestrian area is clearly divided.	□	No other vehicles are used in the pedestrian area.	□	Pedestrians are protected from roads because of proper blocking.	□ Do not have obstructions to walk from utilities such as power poles, drains, fire pipes, etc.
		□	Cleanliness	□	Supporting children, the elderly, and the disabled, such as ramps, handrails, etc.			