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MODELING PEDESTRIAN LEVEL OF SERVICE IN DEVELOPING COUNTRIES

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คุณลักษณะเฉพาะของสภาพทางเดินเท้าในกรุงเทพมหานครและกรุงจาการ์ตาได้แก่กิจกรรมการค้าขายบนทางเดินเท้า การศึกษานี้มีวัตถุประสงค์เพื่อตรวจสอบผลกระทบของผู้ประกอบการค้าขายบนทางเท้าต่อประสิทธิภาพของทางเดินเท้า และศึกษาถึงความสัมพันธ์ระหว่างตัวแปรแฝงที่เกี่ยวข้องกับประสิทธิภาพของทางเดินเท้า โดยอาศัยการรับรู้ของคนเดินเท้า จากการศึกษาเปรียบเทียบการรับรู้ของคนเดินเท้าเกี่ยวกับประสบการณ์ในการเดินบนทางเท้าบริเวณที่มีผู้ประกอบการธุรกิจการค้าขายบนทางเท้าระหว่างกรุงเทพมหานครและกรุงจาการ์ตาพบตัวแปรแฝง 4 ตัวแปร ประกอบด้วยสภาพทางเท้า การจราจรบนทางเดินเท้า พฤติกรรมของคนเดินเท้า และประสิทธิภาพของการให้บริการบนทางเดินเท้า จากข้อมูลในงานวิจัยนี้พบว่าตัวแปรเชิงคุณภาพบนพื้นฐานของการรับรู้ของคนเดินเท้ามีบทบาทสำคัญในการประเมินประสิทธิภาพทางเท้า ผลลัพธ์จากแบบจำลองสมการโครงสร้างแสดงให้เห็นว่าการรับรู้ของสภาพทางเดินเท้าเป็นประเด็นที่สำคัญที่สุดต่อการประเมินประสิทธิภาพทางเดินเท้า ผลจากการศึกษานี้สนับสนุนให้เห็นถึงความสำคัญในการผนวกรวมตัวแปรทั้งเชิงปริมาณและคุณภาพด้วยกันเพื่อใช้พิจารณาประเมินประสิทธิภาพของทางเท้า นอกจากนี้ผู้กำหนดนโยบายและนักวางแผนในเขตเมืองควรให้ความสำคัญถึงการรับรู้ของคนเดินเท้าต่อการออกแบบทางเดินเท้าด้วย

ภาควิชา วิศวกรรมโยธา ลายมือชื่อนิสิต..........

สาขาวิชา วิศวกรรมโยธา ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก..........

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NURSYAMSU HIDAYAT: MODELING PEDESTRIAN LEVEL OF SERVICE IN DEVELOPING COUNTRIES. THESIS ADVISOR: ASSOC. PROF. KASEM CHOOCHARUKUL, Ph.D., THESIS CO-ADVISOR: ASSOC. PROF. KUNIHIRO KISHI, DR. ENG., 158 pp.

A unique characteristic of the sidewalk condition in commercial areas in Bangkok and Jakarta is street vendor activities. The objective of this study is to investigate impact of street vendors on sidewalk performance, and to investigate relationships among latent variables related to sidewalk performance based on pedestrian perceptions. A comparison of pedestrian perceptions on walking experience along the sidewalk with street vendor activities between Bangkok and Jakarta is demonstrated. Four latent variables are determined covering sidewalk condition, pedestrian traffic, pedestrian behavior, and sidewalk performance based on pedestrian interview survey data. Using empirical data, it is found that qualitative variables based on pedestrian perceptions have a relatively significant role in assessing sidewalk performance. The structural equation modeling result reveals that pedestrian perception of sidewalk condition is the most important aspect in assessing sidewalk performance. The findings encourage the importance of combining qualitative and quantitative variables in sidewalk performance assessment. In addition, it is recommended for policy makers and urban planners to pay more attention to user's perception in sidewalk design.

Department : Civil Engineering	Student's Signature ....
Field of Study : Civil Engineering	Advisor's Signature ....
Academic Year : 2010	Co-Advisor's Signature 岸 邦宏

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Chapter I
Introduction

1.1 Background

Sidewalk, a special lane separated from vehicle traffic and designed to provide pedestrian accessibility, is considered a critical component of pedestrian facilities. Sidewalk may be designed parallel to a street or highway and restricted for bicycles or users (ITE, 1998; TRB, 2000). Nowadays, much advancement can be seen from models and techniques in designing pedestrian ways or sidewalks. But in some developing cities, transport authorities or researchers still focus on only motorized vehicles. Pedestrians, which are the most vulnerable road users, are neglected for their safety, as well as their convenience and comfort.

Walking has become an important part of urban transport in many large cities in developed countries, but most people in developing countries prefer driving and riding to walking. Weather conditions (heat, dust, and air pollution), sidewalk conditions, and distance of a trip are among many reasons unfavorably affecting the decision to walk. Nevertheless, walking is one of the significant transport options in some developing cities as a result of the introduction of mass rapid transit system, such as BTS/MRT/BRT in Bangkok or BRT in Jakarta. However, the walkability in Bangkok is partly constrained by physical conditions of sidewalks and supported facilities, such as pedestrian crossing bridges and traffic signals (World Bank, 2007). For safety and comfort reasons, pedestrians need appropriate sidewalks and walkways, but in some locations only narrow sidewalk is available for pedestrians, causing danger for them.

Differences in sidewalk characteristics exist between developing and developed countries. One of the distinctions is kind of obstructions along the sidewalk. In developed countries, most of the obstructions are utility tools, such as telephone boxes, postboxes, billboards, shelters, and bus stops. These types of utilities exist in developing countries also; however, some sidewalks in developing countries may be filled with a variety of on-street vendors that commonly found in dense commercial areas in central business district.

Street vending is considered one of the important informal activities in urban areas. The amount of street vendors increased significantly especially in some Asian countries after the financial crisis in 1998 (Bhowmik, 2005). In this context, street vendors can be defined as person/people who sell goods for buyers and do not have permanent built-up structure as a shop. Street vendors may take a place in either public or private area, along the roadside, mobile by carrying the goods with a push-cart or basket, or may take a permanent location but without fix borders (Bhowmik, 2005). Generally, street vendors can be found in locations that have various activities, such as shopping areas, residential areas, or terminals. Activities of street vendors may range from eating and drinking, food sales, product sales, service sales, performances (dancing and music) and amusements (Deguchi, 2005). These activities essentially depend on local community needs and type of activities in the location. Street vendors commonly occupy space inside the sidewalk width. Reduction in total width due to vendor's existence leads to obstructions for pedestrian movements. Specific characteristic of vendor's activities in many developing cities include:

a) Vendors are commonly found along sidewalks and usually side by side and/or face to face with permanent shops. As a result, reduction of total sidewalk width occurs in both sides of sidewalk and causes substantial problem to pedestrian traffic, and
b) A special lane is needed for buyer activities in front of vendor's shop.

In Bangkok and Jakarta, which are big developing cities in South East Asian countries, street vendors exist as well, in which their existences can be either legal or illegal. In Bangkok, where street vendors exist, iron fences are commonly built along the sidewalk to separate sidewalk activities and vehicular traffic. Longitudinal lines are painted along the sidewalk surface in order to bound space occupied by vendors. Otherwise, sidewalks in Jakarta have no fix border separating vehicle traffic and pedestrian movement. Besides street vendor activities, other obstructions may be caused by improper on-sidewalk parking (ITDP, 2003). Figure 1.1 illustrates the typical sidewalk conditions with street vendor activities in Bangkok and Jakarta.

(a) Bangkok (b) Jakarta

Figure 1.1 Sidewalk with Street Vendor Activities in Bangkok and Jakarta

1.2 Problem Statement

Nowadays, standards or guidance to assess potential impact of on-street vendors on pedestrian's facilities are unavailable. Estimation of pedestrian level of service is the most common approach to evaluate quality of operations of sidewalks. Pedestrian level of service reflects the degrees of sidewalks that satisfy pedestrian's demands of comfort and safety. Generally, it illustrates conditions when pedestrian volume is less than the sidewalk capacity. Pedestrian level of service manuals have been issued in several developed countries, but it would be inaccurate to directly use those manuals (such as US HCM 2000) to evaluate sidewalk performance in developing countries. The current HCM method attempts to provide a universal guideline in pedestrian analysis regardless of the various sidewalk's environmental and physical conditions, city size, the type of pedestrian and psychological factors that may have impacts on the pedestrian walking experience (Bloomberg and Burden, 2006). Accordingly, HCM can be applied easily in various conditions of sidewalk, but the result of calculation does not accurately reflect the complex sidewalk situation under various circumstances, for example, many on-street vendors in developing countries may not be seen in developed countries. Taking into account local condition, researchers and planners outside the developed countries have published studies in order to better assessment of pedestrian level of service in their region. In terms of on-street vendor's activities, it is necessary to objectively quantify how well sidewalks or walkways accommodate walking activities.

1.3 Objectives of this Study

One of the unique sidewalk characteristics in developing countries is on-street vendor that their activities have direct impact to the sidewalk performance. Therefore, this study primary focuses on two points: investigate impact of street vendor activities, and use pedestrian perception as qualitative variable on sidewalk performance assessment.

The purpose of this study can be described as follows:

1 To demonstrate using empirical data that pedestrian perception can be used as determinants for assessing sidewalk performance.

2 To examine relationships among pedestrian perception of sidewalk condition, perception of interaction, perception of traffic, and perception of sidewalk performance.

3 To propose an alternative model of sidewalk performance at the sidewalk with street vendor activities that considers pedestrian perception incorporated with pedestrian traffic.

1.4 Limitation and Terminology

The scope of this dissertation contains some important limitations:

1. Observed sidewalks are limited to the sidewalk in dense commercial areas in Bangkok and Jakarta.
2. Since the study focuses on impact of street vendor's activities on sidewalk performance, eight locations with appropriate sidewalk condition, dense pedestrian, and vendor activities are selected in both Bangkok and Jakarta. Selected sidewalks in Bangkok are a segment of sidewalks located in Pratunam, Silom, Bang Rak, and On Nut areas; whereas four locations with similar characteristic in Jakarta are the sidewalks placed in Sabang, Mampang, Jatinegara Pondok Kopi, and Jatinegara Stasiun areas.
3. The study mainly focuses on pedestrian perception in developing sidewalk assessment model, so it is less in considering sidewalk geometry and land use physical characteristic variables.

4. Concerning vendor characteristics, data collections are limited during daytime period, so this study disregards the differences of vendor characteristics between day-time and night-time.
5. The number of pedestrian who interact with the street vendors is limited within the 10 meters length of the sidewalk.

Some terminologies are used in this study and defined as follows:

1. Pedestrian is any person who is on foot and passes on the sidewalk.
2. Sidewalk is defined as specific lanes in one side or both sides along the roadway that provide people with space to travel within the public right-of-way that is separated from roadway vehicles.
3. Street vendor is a person who sells goods to the public without having a permanent built-up structure from which to sell (Bhowmik, 2005). They occupy space in one side and/or both sides along the sidewalk.

1.5 Expected Benefits

This study focuses on pedestrian’s perceived sidewalk performance. Although the sidewalk performance has been extensively studied using many variables such as level of service, pedestrian/vehicle traffic, geometric, and roadway environment; the present study would be a pioneering study that considers pedestrian opinion to establish sidewalk performance model.

Most studies done in this topic are conducted in developed countries and consider quantitative variables or focuses on the measured parameters, not on the pedestrian point of view. In this study, field observations are performed on the sidewalk where street vendors exist. Street vendor activity is considered an important factor in the present study because it is a unique characteristic in the sidewalk particularly in dense commercial areas in Bangkok and Jakarta, and cannot be found in most of the cities in developed countries. Therefore, pedestrian opinions would incorporate street vendor presence in correlation with sidewalk performance. The finding of this study could shed some new light on how the sidewalk performance should be quantified and how user perceptions make an impact on sidewalk performance assessment.

1.6 Dissertation Outline

This dissertation contains seven chapters. First chapter is the introduction chapter that describes introduction, background, problem statements, study objectives, research limitation, and expected benefits.

The second chapter reviews existing literature on pedestrian facilities, pedestrian level of service, researches on user perception, and street vendor. Pedestrian researches are summarized into ten topics, namely, description of pedestrian facilities, pedestrian level of service, traffic, pedestrian behavior and attitude, level of service model, comparison among pedestrian LOS, user's perception, sidewalk perspective, the impact of street vendors, and space requirement.

The research framework is presented in the third chapter, which describes the research activities in chronological order, followed by discussion on the statistical methods that are used for developing the model.

The forth chapter discusses data collection and data processing. Characteristics of sidewalks in the study areas are presented first, followed by the description of data collection procedures and results. Next section describes descriptive of questionnaire data. Summary of respondent's characteristics is presented at the end of the chapter.

The development of sidewalk performance model is presented in the fifth chapter. How to determine variables considered important to the model through factor analysis technique is detailed. Specify the independent variables, measurement model, and structural model is described, as well. This chapter explains development the pedestrian level of service model using regression analysis. Investigating structural relationship among latent variables using structural equation modeling (SEM) explain in detail in the last part of this chapter, and respondents are divided in some categories based on: cities (Bangkok and Jakarta), gender (male and female), age (young and old), walking frequency (daily and rarely), and trip purpose (work/school and recreational).

Discussion of the study results are presented in the sixth chapter. Relationships among the latent variables will be explained deeply. Lastly, the seventh chapter discusses conclusions, recommendations, policy implications, and some suggestions for future study.

Chapter II
Literature Review

This chapter explains literatures related to this study. Firstly, explanation of various pedestrian facilities is discussed. Then, discussion continued with explanation about pedestrian level of service. Some literatures on pedestrian behavior, attitude, and traffic are presented in the next sections. Next section discusses about some previous studies of approaches in pedestrian level of service model, and then followed by comparison among the models. After that, researches about user's perception on transportation facilities and relationship among the variables of level of service are explained. The last part of this chapter presents some previous studies about street vendors and pedestrian space.

2.1 Pedestrians Facilities

Providing safe and comfort places for people to walk is a responsibility of transport authority or government included in constructing and regulating, especially the construction of public rights-of-way. Safe places should be well designed for people to walk along the public rights-of-way, where it will be accomplished depend on the type of land-use and road. Federal Highway Administration (FHWA) divides the pedestrian facilities into several categories (McMahon et al., 2002):

a) Sidewalks, that are the most preferred pedestrian facilities that exist on both sides of the street and provide the greatest degree of comfort and safety for pedestrians. Sidewalks exist in urban streets, and are paved with either concrete or asphalt.

b) Off-Road Paths/Side-paths. Two type off-road paths are paved and unpaved. Both of them are usually available in rural roads and low-density suburban areas. A path is usually separated from the roadway by green areas or trees and follows the road alignment.

c) Shoulders. Shoulders should be provided on both sides of a road at least in pedestrian zone, and can be up-graded to be sidewalk. For pedestrians, shoulder may not be safe and comfortable like sidewalk, but it is still better than nothing.

d) Shared Streets. Shared streets are found in special conditions where a street is shared by people walking, cycling, and driving. Generally, the street is designed as a pedestrian street. A shared street is a narrow street without curb and sidewalk; vehicles are slowed by trees, parking areas, and other obstacles along the street. Pedestrians are the main users and vehicles are as intruders; hence, vehicles must travel at a speed less than 16 km/h (Zegeer et al., 2002). A shared street exists in residential area, or in a commercial area populated by restaurants, cafes, merchant displays, street vendors, and other outdoor commercial uses.

2.2 Pedestrian Level of Service

Assessing pedestrian level of service is one of the ways to improve walking traffic. Pedestrian level of service reflects the degrees of sidewalk facilities that satisfy pedestrian's demands of comfort and safety. Generally, it illustrates conditions when pedestrian volume is less than the sidewalk capacity.

In general, level of service (LOS) is a qualitative measurement to explain operational conditions of transportation facilities, such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000). The level of service is usually designated with letters ranging from LOS A, representing good operating conditions with little or no delay, to LOS F that represents stop-and-go conditions with frequent and long delays (TRB, 2000). Level of service is employed to simplify complex numerical performances into a letter grade system that represents traveler's perceptions regarding quality of service provided by the facilities (NCHRP, 2008). In case of pedestrian facilities, level of service is a kind of qualitative measurement of sidewalks to serve pedestrians.

The Federal Highway Administration (FHWA) has developed a method for assessing pedestrian level of service based on some variables, namely, effective walkway width, walking speed, pedestrian space, and pedestrian flow. As one of the chapters in the Highway Capacity Manual 2000, this approach considers sidewalk as an uninterrupted pedestrian facility that pedestrians are separated from vehicular traffic and their movement can be obstructed by interactions with other pedestrians only (TRB, 2000). This method provides an outline for evaluating pedestrian facilities. Under this context, uninterrupted pedestrian facilities are both exclusive and shared pedestrian path (indoor or outdoor) designed for pedestrian usage.

2.3 Pedestrian Behavior and Attitude

Environmental design and urban form are the crucial components that influence pedestrian travel behavior. A proper design of pedestrian infrastructure can encourage walking activities without compromising safety, comfort, and convenience (Shriver, 1997). In order to increase pedestrian safety and comfort, walking facilities can be improved without significant side effects on vehicle traffic (Carsten et al., 1998). Concerning issues such as safety, comfort, and convenience can be improved by separation of pedestrian and vehicle traffic, control of pedestrian and vehicle flow, improvement of visibility, proper communication through signs, and assistance of pedestrians with special needs.

In addition to some studies on pedestrian safety problems, there are other studies in the literature that specifically tackle pedestrian perceptions and attitudes regarding their facilities (Carsten et al., 1998; Zegeer et al., 2002). From literature, one study presented the impact of traffic on behavior and perceptions of safety of pedestrians (Hine, 1996), while another study focused on the sufficiency of crossing facilities and the willingness of pedestrians to use them (Tanaboriboon and Jing, 1994).

2.4 Pedestrian Traffic

The basic principle of pedestrian flow is generally similar to vehicular flow in terms of the freedom to select speed and to overtake others. However, pedestrian flow includes the ability to cross pedestrian traffic stream, to maneuver and to change in speed for avoiding conflict, and to walk in reverse direction facing major flow (TRB, 2000).

Environment factors that have contribution to the walking experience and influence the level of service include comfort, convenience, safety, and security of the walkway system. Items that influence the comfort factors are weather protection, climate controls, arcades, transit shelters, and other pedestrian amenities. Convenience factors comprise items such as walking distances, pathway direction, grades, sidewalk ramps, and directional signing. Separation of pedestrians from vehicular traffic at the same horizontal plane, providing traffic control devices for time separation between pedestrian and vehicular traffic, providing underpasses and overpasses, are considered important regarding safety features. Security factors deal with good lighting, open lines of sight, and the degree and level of street activity. Supplemental factors explained above can influence pedestrian perceptions on the overall quality of the street environment (TRB, 2000).

2.5 Approaches in Pedestrian Level of Service (PLOS) Model

Basically, researchers have developed three types of approaches to assess pedestrian level of service. The first approach considers pedestrian traffic and sidewalk geometry (Huang and Chiun, 2007; TRB, 2000). The second type is developed on the basis of road environment quality (Dixon, 1996; Jaskiewicz, 2000; Rahaman et al., 2005; Sarkar, 2003). The last approach takes into account both traffic flow operations and road physical characteristics (Dixon, 1996; Landis et al., 2001).

2.5.1 PLOS Model Considering Traffic and Geometry

Huang and Chiun (2007) performed a study to propose a model of pedestrian LOS based on 263 walkways in Taipei using stepwise regression method. Some attributes were considered, such as safety, comfort, effective width, width of barriers, pedestrian flow in 15 minutes during peak hour, pedestrian flow rate, and vehicle flow volume in peak hour. The developed model focused on the environment and impact of pedestrian walking environment. The following model was proposed:

$$\text{Ped. LOS} = 1.002 \ln (0.266\, W_s + 0.252\, W_b - 0.130\, Q_p - 0.282 \ln F + 4.089) + 1.004 \ln (0.271\, W_s + 0.13\, W_b - 0.101\, Q_p - 0.43 \ln F + 2.878) \quad (2.1)$$

where:

W_s = effective width of walkways (m)

W_b = width of barriers (m)

Q_p = pedestrian flow rate = N_p/W_s (ped./min-m)

F = vehicle volume in peak hour (veh./hr)

Even the model claims to provide pedestrian level of service evaluation method that consider environment aspect, it does not include in the model equation. Moreover, safety and comfort of pedestrian facilities that stated as important factors are not include in the model, as well. Researchers were not use questionnaire survey to gather data of sidewalk environment, safety, and comfort. They conducted physical observation on 263 walkways to collect data about pedestrian walking environment, included lateral clearance, traffic characteristics, and pedestrian characteristics.

Landis et al. (2001) performed a study to identify some factors within right-of-way that have significant influence on pedestrian's perception of safety and comfort. A mathematical model had been developed based on five variables: lateral separation of pedestrian from motor vehicle traffic, presence of physical barrier and buffers, outside lane traffic volume, motor vehicle speed, and vehicle mix. The model was developed based on a stepwise regression analysis of 1250 observations from an experiment that placed 75 people walking on a roadway course in the Pensacola Metropolitan, Florida. The pedestrian LOS model was developed as a measure of a roadway segment's performance with respect to pedestrian's primary perception of safety or comfort. The research carried out several Pearson Correlation analyses using a variation of traffic and roadway variables. Some potential independent variables affecting pedestrian's sense of safety and comfort were generated and then tested with stepwise regression. The independent variables included:

a) Lateral separation elements between pedestrians and motorized vehicle traffics, including presence of sidewalk, width of sidewalk, buffers between sidewalk and motor vehicle travel lanes, presence of barriers within the buffer area, presence of on-street parking, width of outside travel lane, presence and width of shoulder or bike lane
b) Motorized vehicle traffic volume
c) Effect of (motor vehicle) speed
d) Motorized vehicle mix (i.e., percentage of trucks)
e) Driveway access frequency and volume

The researchers conducted step-wise regression analyses using the 1250 real-time observations. The following model was developed:

$$\text{Ped LOS} = -1.2021 \ln (W_{ol} + W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times W_s) + 0.253 \ln (Vol_{15}/L) + 0.0005\ SPD^2 + 5.3876 \quad (2.2)$$

where

W_{ol} = width of outside lane (feet)

W_l = width of shoulder or bike lane (feet)

f_p = on-street parking effect coefficient (= 0.20)

%OSP = percent of segment with on-street parking

f_b = buffer area barrier coefficient = 5.37 for trees spaced 20 feet on center)

W_b = buffer width (distance between edge of pavement and sidewalk, feet)

f_{sw} = Sidewalk presence coefficient = 6 – 0.3 Ws

W_s = width of sidewalk (feet)

Vol_{15} = average traffic during a fifteen (15) minute period

L = total number of (through) lanes (for road or street)

SPD = average running speed of motor vehicle traffic (mi/hr)

The goal of the study was to fill lacking of pedestrian level of service assessment consider the roadway environment, and safety and comfort aspect. To reach the objectives, researchers conducted a questionnaire survey in order to collect respondent perception on roadside environment and feeling of comfort and safety, then quantified the perceptions into a model to provide pedestrian level of service measurement method. The variables of proposed model covered more factors compared to model proposed by Huang and Chiun (2007) in terms of road physical characteristic variables, but there was still not include qualitative variables that reflect feeling of comfort or safety of pedestrians. It was similar in approach to the methods used to assess the level of service established in the Highway Capacity Manual.

2.5.2 PLOS Model Considering Environment Quality

Rahaman et al. (2005) conducted a research to explore the qualitative level of comfort of pedestrians in Dhaka City by offering six broad categories of roadside walking environment in terms of safety, security, convenience and comfort, continuity of the walkway, system coherence, and attractiveness by some specific facilities. Some qualitative data had been collected from observation survey, whereas walker's responses had been recorded through questionnaire survey. The questionnaire was designed to get pedestrian opinions concerning the sidewalks environment with those six criteria. Based on the responses, Rahaman et al. (2005) concluded that pedestrians were neglected for their safety and convenience, and suggested to city authorities that more attention must be given to pedestrian infrastructures than motorized vehicles.

Studied by Sarkar (2003) introduced some theoretical guidelines for qualitative evaluation of the levels of comfort offered along walkways in major activity centers. Research from urban design, environmental psychology, landscape architecture, and urban planning were used to develop the method. The method included two separate evaluations: service level, which gives standards for overall desirable and undesirable comfort condition at the macro level, and quality level, which looks at the micro level finer details of comfort of pedestrians. Service level and quality level were based on physical, physiological and psychological comfort. Comfort requirements were vary depending on cultural and spatial. The method described in this research was hoped to offer a useful framework to assess comfort requirements in order to efficiently pedestrian circulation system in major activity centers.

Jaskiewicz (2000) proposed a method of evaluation pedestrian LOS based on trip quality. Nine specific evaluations were measured for pedestrian systems in terms of pleasantness, safety, and functionality. The nine measures were enclosure/definition, complexity of path networks, building articulations, complexity of spaces, transparencies, buffers, shades, trees, overhangs/awnings/varied roof lines, and physical conditions. Each of these measures was derived from a combination of safety issues, volume and capacity consideration, and qualitative design factors. A simple scale has been applied to assess the level to measure degree of conformity to the nine proposed evaluation. A scale of 1 to 5 was used to accurately cover the range of conformity: 5 = excellent; 4 = good; 3 = average; 2 = poor; 1 = very poor. The scores can be averaged to an overall LOS with following ranges:

LOS A = 4.0 to 5.0 = very pleasant

LOS B = 3.4 to 3.9 = comfortable

LOS C = 2.8 to 3.3 = acceptable

LOS D = 2.2 to 2.7 = uncomfortable

LOS E = 1.6 to 2.1 = unpleasant

LOS F = 1.0 to 1.5 = very unpleasant

The research was performed in Winter Park, Florida. All of the city's circulation elements, roadways, transits, bicycles, and pedestrians were analyzed for their performance and sustainability. Table 2.1 summarizes the sample of evaluation matrices representing analysis the city's commercial corridor and district.

Table 2.1 Sample Pedestrian LOS Evaluation Matrix (Jaskiewicz, 2000)

Principles of pedestrianization	Lee Road	Orlando Ave.	Morse (west)	Morse (east)	Fairbanks Avenue	Orange Ave.
Enclosure/ definition	1	1	2	5	2	2
Complex spaces	1	1	2	3	1	1
Highly articulated buildings	1	1	3	5	2	2
Overhang/awning	1	1	1	5	3	3
Complex path network	1	1	3	5	2	2
Buffer	1	1	1	5	1	3
Shade trees	1	1	1	3	1	1
Transparency	2	2	2	4	3	3
Physical condition	2	2	2	5	1	4

Tabel 2.1 Sample Pedestrian LOS Evaluation Matrix (Jaskiewicz, 2000) (Continued)

Principles of pedestrianization	New York Ave.	Park Ave.	Aloma Ave.	Rolling College	Winter Park Hospital	Hannibal Square
Enclosure/ definition	3	4	1	4	1	3
Complex spaces	1	5	1	5	2	1
Highly articulated buildings	2	4	2	5	2	3
Overhang/awning	1	4	1	2	1	3
Complex path network	4	5	1	5	3	3
Buffer	1	4	2	4	3	3
Shade trees	3	3	1	4	3	1
Transparency	2	5	2	3	2	2
Physical condition	3	4	4	5	3	4

Note: *5: excellent; 4: good; 3: average; 2: poor; 1: very poor.*

Table 2.1 lists each of the twelve distinct commercial areas/corridors inside Winter Park and groups the scores for each of the nine pedestrian evaluation measures. These scores were determined based on site inspection.

The nine parameters proposed in this research, were the qualities that have contribution to positive pedestrian experience. The usage of these nine parameters in pedestrian analyses could help generating some of specific adequate improvements at precise location in a study area. Jaskiewicz (2000) revealed that pedestrian level of service needs more than volumes and capacities. For developing walking more attractive mode of transportation, it is essential to pay more attention in pedestrian comfort and safety in addition to volume and capacity factors.

2.5.3 PLOS Model with Different Approaches

Most of the existing methods of assessing pedestrian level of service are developed by considering the pedestrian flow operation only, and using space occupancy and sidewalk capacity as the assessing parameters to reflect the walking movement. Therefore, these methods still lack consideration of the pedestrian perceptions. As an individual action, walking is affected by pedestrian's physiology and psychology. Therefore, walking assessment factors should consider pedestrian's physiological characteristics such as gender, age, and psychological characteristics such as perceptions regarding sidewalk facilities and traffic operations.

Some researchers considered pedestrian perceptions to determine level of service. Tan et al. (2007) developed a method to assess pedestrian LOS with pedestrian perceptions. A questionnaire survey was conducted and respondents were categorized into three groups based on age, gender and walking experience. Stepwise regression method was used to build a model. Variables that were considered in this model were bicycle volume, pedestrian volume, vehicle volume, driveway access quantity per meter, and distance between sidewalks to vehicle lanes. To determine the LOS, some factors affecting pedestrian safety and comfort were considered, such as road transect forms, pedestrian flow characteristics, vehicle and bicycle flow characteristics, obstructions, and frequency of the driveway access. Twelve segments of roadway sidewalks in China had been surveyed covering vehicle traffic volume, bicycle traffic volume, pedestrian traffic volume, and bicycle speed. For the questionnaire, the contents of question included:

a) Pedestrian characteristics, namely, age, gender, and walking experience.
b) Factors have impact to pedestrian's comfort and safety, such as sidewalk width, vehicle traffic, bicycle traffic, presence of other pedestrians, and obstructions.
c) Pedestrian perceptions about sidewalk's comfort and safety. Six degrees of comfort and safety were provided as choice, as can be seen in Table 2.2.

Table 2.2 Rank of LOS (Tan et al., 2007)

Pedestrian LOS	Score	Perception
A	1	Pleasant
B	2	Reasonable
C	3	Acceptable
D	4	Poor
E	5	Unpleasant
F	6	Unsuitable

Stepwise regression analyses were conducted using 395 real-time observations. The proposed model for determining pedestrian LOS was:

$$\text{Ped. LOS} = -1.43 + 0.006Q_B - 0.003Q_P + 0.056Q_V/W_r + 11.24(P - 1.17P^3) \quad (2.3)$$

where

Q_B = bicycle traffic during a five-minute period

Q_P = pedestrian traffic during a five-minute period

Q_V = vehicle traffic during a five-minute period (pcu)

P = driveway access quantity per meter

W_r = distance between sidewalk and vehicle lane (m)

Based on the survey, medium value of pedestrian LOS was about 3.0. With the symmetrical principle, Table 2.3 may be used as a basis for setting the model's numerical result into the rank of pedestrian LOS.

Table 2.3 Level of Service Categories (Tan et al., 2007)

LOS	LOS Value
A	$LOS < 2.0$
B	$2.0 \le LOS < 2.5$
C	$2.5 \le LOS < 3.0$
D	$3.0 \le LOS < 3.5$
E	$3.5 \le LOS < 4.0$
F	$LOS \ge 4.0$

Muraleetharan (2004) proposed a term called "overall LOS", which combined all factors affecting pedestrian LOS together and indicates an overall value for the pedestrian LOS. Conjoint analysis method was used to evaluate pedestrian LOS. A methodology was developed to estimate the overall LOS of pedestrian for sidewalks and crosswalks based on total utility value. Site characteristics were collected to calculate the total utility value for each sidewalk and crosswalk. The method proposed in this research for the assignment of overall LOS to the roadways maybe useful to produce a map for pedestrian to show them the overall LOS they can expect on each roadway segment.

The research was conducted in Hokkaido University area. To collect participant's opinion, mail-back survey was chosen by distributing 1000 questionnaires in study area. Only 531 questionnaires were sent back by respondents. Field measurement was conducted with survey of the site, examining the geometric and operational aspects of the sidewalks and crosswalks. Field pedestrian observation was performed in some locations inside study area to determine the level of service. In this approach, real photos of sidewalks and crosswalks were used and the locations of sidewalks and crosswalks were indicated on maps.

A term called "overall LOS" was proposed to make difference with other methods, such as HCM 2000 that define LOS analysis in detail for each factors (Muraleetharan, 2004). Overall LOS offered more detail descriptions in combination of each factor. The concept of overall LOS provided an easy understanding about the overall condition of sidewalks and crosswalk. Total utility values, which obtained from calculation of site characteristic data, were a basic data to develop methodology for estimating overall LOS. The level of each factor of every sidewalk and crosswalk was determined using field measurement data, then the factor's level were used to determine utility values from conjoint analysis. Total utility could be obtained from adding the utilities from each factor's level. In the end, the total utility value from each sidewalk and crosswalk was converted to an overall LOS designation.

2.6 PLOS Model Comparison

Byrd and Sisiopiku (2006) completed a study about comparison of level of service methodologies for sidewalk. This research compared among four methods: Highway Capacity Manual 2000 (TRB, 2000), Australian method (Gallin, 2001), Trip Quality method (Jaskiewicz, 2000) and Landis method (Landis et al., 2001). A field study was performed in Birmingham, Alabama to obtain appropriate data for estimating LOS for each of methods reviewed.

The method of HCM 2000 for sidewalk based on the space and some addition criteria of pedestrian flow rate, speed, and volume-capacity ratio. Because of its general criteria of the parameter, the HCM 2000 is the easiest method to be used and the most widely accepted, but the estimation result tends to be not accurate. Compared to HCM 2000 method, the Australian method consider more factor that includes three categories: physical characteristics (path width, surface quality, the number of obstruction, crossing opportunities, signage, lane markings, rest area), locations (connectivity, path environment, potential for vehicle conflict), and user factors (pedestrian volume, mix of path users, security which includes lighting, path visibility). Trip quality method is based on the studied by Jaskiewicz (2000), as described in the section 2.5.2. This method consists of nine qualitative environment measures and the variables are independent of pedestrian and vehicle flow. One advantage of this method is the ability to use the system to describe each factor separately rather than just determining LOS, that can be used to recommend specific actions to improve attractiveness of the sidewalk. In this method, observer's opinions hold the most important role in determining the value for each factor, but the method has developed a standardized system based on the descriptions in order to insure consistency scored of the segment. The Landis method focuses on factors that considered influence the safety and comfort of the pedestrians, and attempts to covered the HCM 2000 limitation that the evaluation is only from the perspective of "walking space" and cannot be used to evaluate or prioritize retrofit construction (Byrd and Sisiopiku, 2006). Difference with the previous methods, the Landis method takes into account pedestrian's perception of safety and comfort in addition to sidewalk capacity and the quality of the walking experience.

The results of this study showed the difference reliance of traffic flow, both vehicle and non-vehicle. The HCM 2000 method considers only non-vehicle traffic and disregards the impact of vehicle traffic. The Landis method includes some motorized traffic, and the Australian method considers some non-motorized traffic, whereas the trip quality method disregards all traffic.

The study revealed that the HCM 2000 methodology consistently overestimates LOS as it disregards factor related to pedestrian preferences and perceptions, and the quality of the walking environment. Therefore, it was recommended to modify HCM method by incorporating both qualitative and quantitative variables, more take into account some additional issues regarding characteristics and needs of various pedestrian user groups, and calibration issues. The trip quality method resulted in the lowest ratings of overall LOS for the sidewalk. Since the trip quality method disregards all traffic, fluctuation in traffic would not influence the ratings. The inclusion of both non-motorized and motorized traffic in the Australian and Landis methods did not influence the LOS of the sidewalk as compared to the other levels of traffic factors. The result shown on both methods tent to be similar one another, so calibration was recommended to account for local conditions (Byrd and Sisiopiku, 2006). In addition, the Australian, trip quality, and Landis methods tried to measure the LOS based on pedestrian intention to walk along a particular path or corridor. This was an improvement over the HCM 2000 method since an unoccupied sidewalk space was not necessarily an indication of a good LOS (Byrd and Sisiopiku, 2006).

Overall, the study recommended that a combined model must be developed to incorporate the main quantitative and qualitative variables, specific urban characteristics with wide range of pedestrian, sidewalk, and traffic condition that affect the quality of pedestrian operations for pedestrian facilities.

2.7 User Perceptions in Transportation Facilities

Transportation users are considered one of important aspects in facilities assessment (Burde, 2008; Lee et al., 2007; Nakamura et al., 2000). Nakamura et al. (2000) studied interrelationships among three variables on rural motorways, namely traffic flow conditions, driving behavior, and degree of drivers' satisfactions. Both first variables were quantitative variables including traffic volume, vehicles' speed, lane utilization ratio, lane changing, adjustment of acceleration and adjustment of spacing. The latest was qualitative variable, came from questionnaire survey conducted including drivers' evaluation of the traffic flow condition, driver characteristics, and vehicles' characteristics. Method of successive intervals was used for quantifying degree of drivers' satisfaction. Analysis on the factors affecting the degree of drivers' satisfaction was conducted by multiple linear regression. Another method for determining relationship between traffic flow and degree of satisfaction was simple linear regression. Nakamura et al. (2000) revealed that traffic flow rate was the most strongly affects the degree of drivers' satisfaction, others variables affected traffic condition were the number of lane changing, the elapsed time of car-following situation, and the driving experience.

Burde (2008) studied road user's perceptions and characteristics for assessing overall perceptions of highway maintenance service quality. The research used road user interviews data for evaluation three factors: tangible (physical facilities, equipment, and appearance of personnel), reliability (ability to perform the service dependably), and assurance (knowledge of employees and their ability to inspire trust and confidence). The study performed factor analysis method for determining variables considered significant in the service quality evaluation. Multiple linear regression and cumulative logit model regression were used for determining level of service quality. The most important finding of this study was that safety and reliability were the most significant service dimensions.

Lee et al. (2007) incorporated user perception into evaluation of service quality of signalized intersections. The method was based on user perceptions about signalized intersection service quality, and tried to investigate relationships between individual perception and perceptions of users as a group. The research conducted fuzzy aggregation method to transform subjective opinion of respondents into fuzzy membership function to be used in extended algebraic operations. Cultural consensus analysis was undertaken to estimate the degree of consensus and to evaluate the level of competence of participants as well as culturally participant's correct answer based on existence of a consensus in the survey location. The study results stated that user perceptions on service quality ratings do not correspond to the level of service (LOS) method by HCM 2000. Users considered many criteria to evaluate service quality rather than traffic conditions. The signalized intersection quality of service based on user actual perceptions was better than the quality of service evaluated using conventional method (Lee et al., 2007).

2.8 Perspective of Sidewalk in Asian Countries

In the transport field, Eastern nations have been influenced by Western model. The Western standard of transport infrastructure has been adapted to establish road design in some Asian countries. For example, the present sidewalk designs in some Asian developing countries have been based on the U.S. Highway Capacity Manual (HCM 2000). The pedestrian level of service estimation considers flow rates, mean speed, and space, which is originally established in the field of traffic engineering. Therefore, it assumes that pedestrian movement characteristics are similar to vehicles, such as traveling in a linear path, faster speed indicates efficient flow, and more people to a degree indicated congested condition (TRB, 2000). As a result, application of this method produces inaccurate result because walking movement patterns are more complex than vehicles, such as tend to swerve to avoid obstructions, flexibility in route choice, to stop and buy food from street vendors, rest on bench, and chat with an acquaintance, in other words changing from moving to nonmoving behavior. Hence, sidewalks have function as venue for communication (Babiano and Ieda, 2007). Most of developing cities in Asian countries copy transport policy in general, and pedestrian infrastructures regulation in particular from those in Western. Hence, there were mismatch between user and facility as a result of lacking consideration of the socio-cultural value of the place.

In Western countries, sidewalks are defined as walkways that are parallel to highway or street, designed as exterior routes to provided pedestrian accessibility. In some cases, walkways are generally pedestrian path including plazas and courtyard. Pedestrian plaza, outdoor café, or gathering area may provide in front of some building in business district or downtown, depending on available space within the right-of-way (WDOT, 1997; Zegeer et al., 2002).

Compare to those in Western, Asian are social individuals wherein they usually prefer to do activities together and are always in group than go out alone. Therefore, the streets become destinations themselves and are changed into their activities such as eating places, shopping venues or meeting areas. The differences between private and public space are not clear. Asian pedestrians use the communal area as an extension of living area, a venue for commerce and exchange, and a place for socialize (Babiano and Ieda, 2007). There is a direct correlation between walking and non-movement spaces. Non-movement activities tend to rise in a location with high volume of pedestrians.

Social equity is a major component in street space sustainability. Therefore, it should be provided the accessibility of the street to all users i.e. pedestrians, street vendors, and other street users. Though, the latter is often considered as obstruction of main function of sidewalk to serve pedestrian flow. However, the street vendors are commonly found in most of sidewalk in Southeast Asia. In the name of city's cleanliness and beauty, and reinforce of policy, street vendors are being cleared out from the sidewalks, even this is often met with low compliance. This case rise as a result of difference sidewalk concepts takes on the Western view that it is solely for movement. However, Asian sidewalks do not only serve pedestrian movement but also as a market place and trading venue as well (Babiano and Ieda, 2007). Most of this informal economic sector is a significant presence in commercial areas.

2.9 Vendors Effect on Sidewalk

The amount of street vendors increased rapidly especially in some Asian countries after the financial crisis in 1998 (Bhowmik, 2005). Street vendor was one of the alternative choices for some people who lost their jobs in the formal sector during the crisis (Bhowmik, 2005; Walsh, 2010). Regarding street vendor issue, two totally different opinions rise, some disagree with the existence of street vendor at all, while some think that vendor is interesting and made a walk more enjoyable. In Bangkok, based on Bangkok Metropolitan Administration (BMA) regulation, street vendors were only permitted in specific locations. In 2005, there were 653 permitted locations with 18,663 street vendors (World Bank, 2007). But there were 211,983 violators in the same year. Figure 2.1 illustrates the condition of sidewalk with street vendor activities.

Figure 2.1 Street Vendor Activities on Sidewalks in Bangkok

The impact of street furniture and street vendors on pedestrian level of service have been investigated (Kim et al., 2008). The research was performed in Waikiki, Hawai. This research observed the impact of fourteen different obstructions. They included fixed items such as bicycle racks, planter boxes, trees, phone booths, water fountains, mail boxes, brochure bins, newspaper bins, trash bins, and bus stops. The movable items also were observed, such as benches, tables and chairs, coffee carts, and vending carts. All of the obstructions were measured in terms of length and width, and setback dimension which include adjacent area each of items with a 1’6” x 2’ border area. The impact of the various types of items was estimated using two approaches to measure pedestrian level of service. One emphasized the space per pedestrian and the other involved pedestrian flow rate. The observations were performed in four variables, namely, sidewalk width (w), street furniture/obstruction dimension (s), pedestrian volume (v), and number of costumers or users (c). Therefore, the pedestrian level of service could be expressed in following function:

$$PLOS = f\ (w,s,v,c) \qquad (2.4)$$

Regarding the number of costumers used the furniture; the research revealed that there were wide ranges of differences was not just the use rates for the different type of street furniture, but also differences regarding the impact on sidewalk space (Kim et al., 2008). Bus stops (13.9%), vending carts (9.25%) and coffee carts (4.91%) were generating the highest use rates per 15 minute interval. Vending carts and coffee carts also need longer time spent interacting (standing, waiting for service), then the potential impact was greater than a brochure bin or water fountain which not only a lower use rate but also a shorter time of use. The impacts of obstructions were estimated based on two conditions. The first condition was established from the baseline condition (without obstructions) and then simulated the effect of various obstructions on available width, the area for pedestrian, and the flow rate. This research revealed that the larger the dimension of the obstruction, the greater impact on pedestrian level of service. Also, it could be revealed that coffee and vending carts have a bigger effect which both show decreases in level of service measured regarding area per pedestrian and flow rate.

2.10 Pedestrian Space Requirement

The primary performance measure for walkways and sidewalks is space, which relates to the capacity (TRB, 2000). Capacity means the maximum possible ability to accommodate a flow. However, in traffic design, operation under capacity condition is undesirable, because flow near maximum capacity usually is unstable. In terms of pedestrian flow, space has effect on pedestrian movement. The lower volume of pedestrians means the less interaction among participants in the traffic stream and the more room for pedestrian to select his path and speed.

Walking space requires more spaces than standing to accommodate pedestrian movements and to anticipate disturbances for a buffer zone, and to take evasive action to avoid collisions. When longer distance between pedestrians is available, pedestrians need less action to anticipate conflict, and less possibility of collision. For faster movement, pedestrians need more spaces (Pushkarev and Zupan, 1975).

TRB (2000) recommends for standing area design a simplified body ellipse of 0.50 m x 0.60 m (see Figure 2.2), with total area of 0.30 m^2 as the basic space for single standing pedestrian. This study also recommends a body buffer zone of 0.78 m^2 for each walking pedestrian.

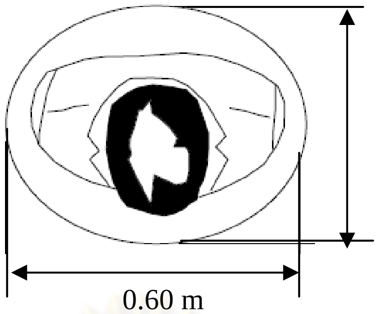


Figure 2.2 Pedestrian Body Ellipse
Source: (TRB, 2000)

Figure 2.3 illustrates requirement space for two or more pedestrian when walking side by side or passing each other proposed in *Pedestrian Facilities Guidebook* published by Washington State Department of Transportation (WDOT, 1997). Two people walking side by side or passing each other while traveling in opposite directions take up an average space of 1.4 m with adequate buffer areas on either side. The minimum width that best serves more than two pedestrians walking together or passing each other is 2.6-3.9 m, to accommodate situations where three or more people are walking abreast.

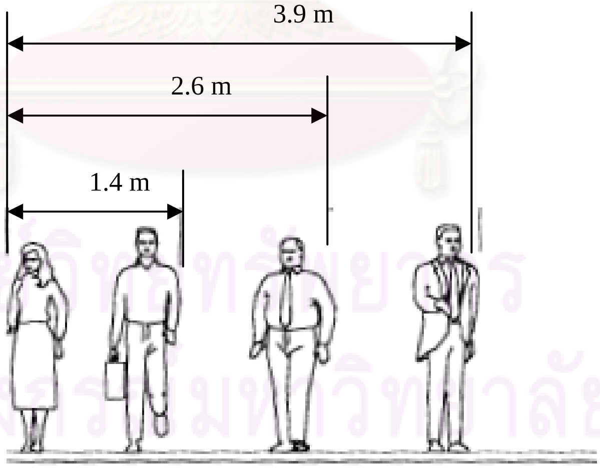


Figure 2.3 Pedestrian Dimension when Walking
Source: (WDOT, 1997)

Spatial bubble is the term for preferred distance of clear forward vision one experiences while walking under various circumstances. Figure 2.4 illustrates the spatial bubbles that are comfortable for the average pedestrian while walking in a public event, shopping, under normal conditions, and for pleasure.

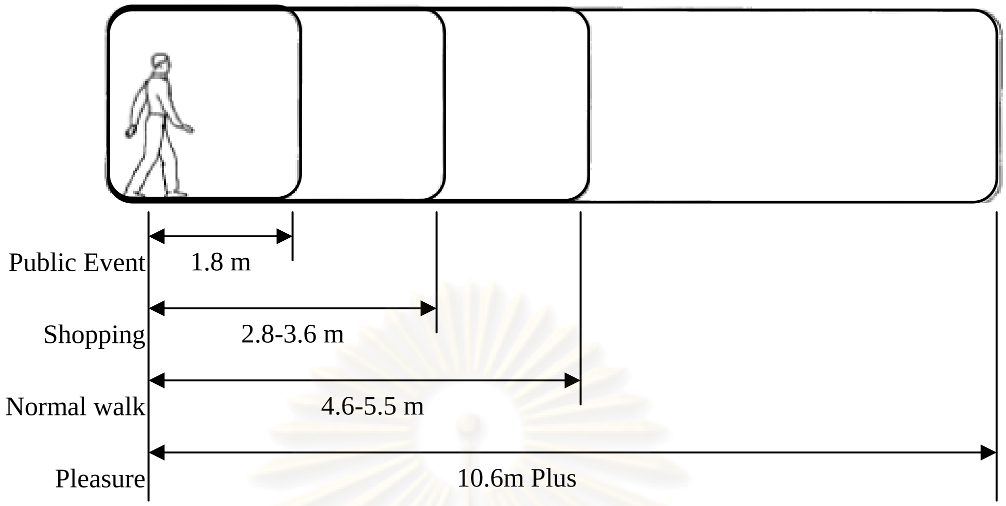


Figure 2.4 Spatial Bubble
Source: (WDOT, 1997)

2.11 Summary

From the discussion in this chapter, it can be concluded that sidewalk can be assessed using level of service. Many researchers have studied pedestrian level of service with various variables, such as spaces, traffic characteristics, environments, and pedestrian characteristics. However, there is still lack of studies on sidewalk performance considering pedestrian perceptions in the model. Besides that, on-street vendor as a part of sidewalk environment have not been considered as a variable in assessing sidewalk performance. Mostly, the researches include quantitative variables only; therefore, it should be investigated to incorporate qualitative variable such as user's perceptions to set up the sidewalk performance model. User actual perception variables can be considered in transportation facility assessment in addition to conventional traffic condition and geometry variables to reach better measurement (Byrd and Sisiopiku, 2006; Jaskiewicz, 2000; Lee et al., 2007; Washburn and Kirschner, 2006).

Chapter III
Research Framework and Statistical Design

This chapter describes research framework that was used in order to reach the objectives of the study as mentioned in the previous chapter. Firstly, research framework and main tasks, which were performed in this study, are discussed. This section includes the explanation about study design and procedures of data collection and data analysis. Secondly, detail of theoretical background about factor analysis, multiple regression, and structural equation modeling are explained.

3.1 Research Framework

The main objective of this study is to investigate pedestrian perceptions as determinants for assessing sidewalk performance and to propose an alternative model of sidewalk performance at the sidewalk with street vendor activities that considers pedestrian perceptions, incorporating with pedestrian traffic and pedestrian behavior. Pedestrian interviews and other data collections were performed at the sidewalk with street vendor activities in Bangkok and Jakarta. The reason of collecting data in these cities was because as typical of developing cities in South East Asian, walking in Bangkok and Jakarta is a transport mode option to support urban activities and to access public transportation.

As defined in the previous chapter, level of service is a qualitative measurement of sidewalks to serve pedestrians. Therefore, elements on the sidewalks and aspect of the pedestrians can affect the level of service. The concept of this study was to consider quantitative variables (pedestrian traffic and pedestrian behavior) and qualitative variable (pedestrian perception) in assessing pedestrian level of service. Based on this consideration, the study concept and framework are shown in Figure 3.1.

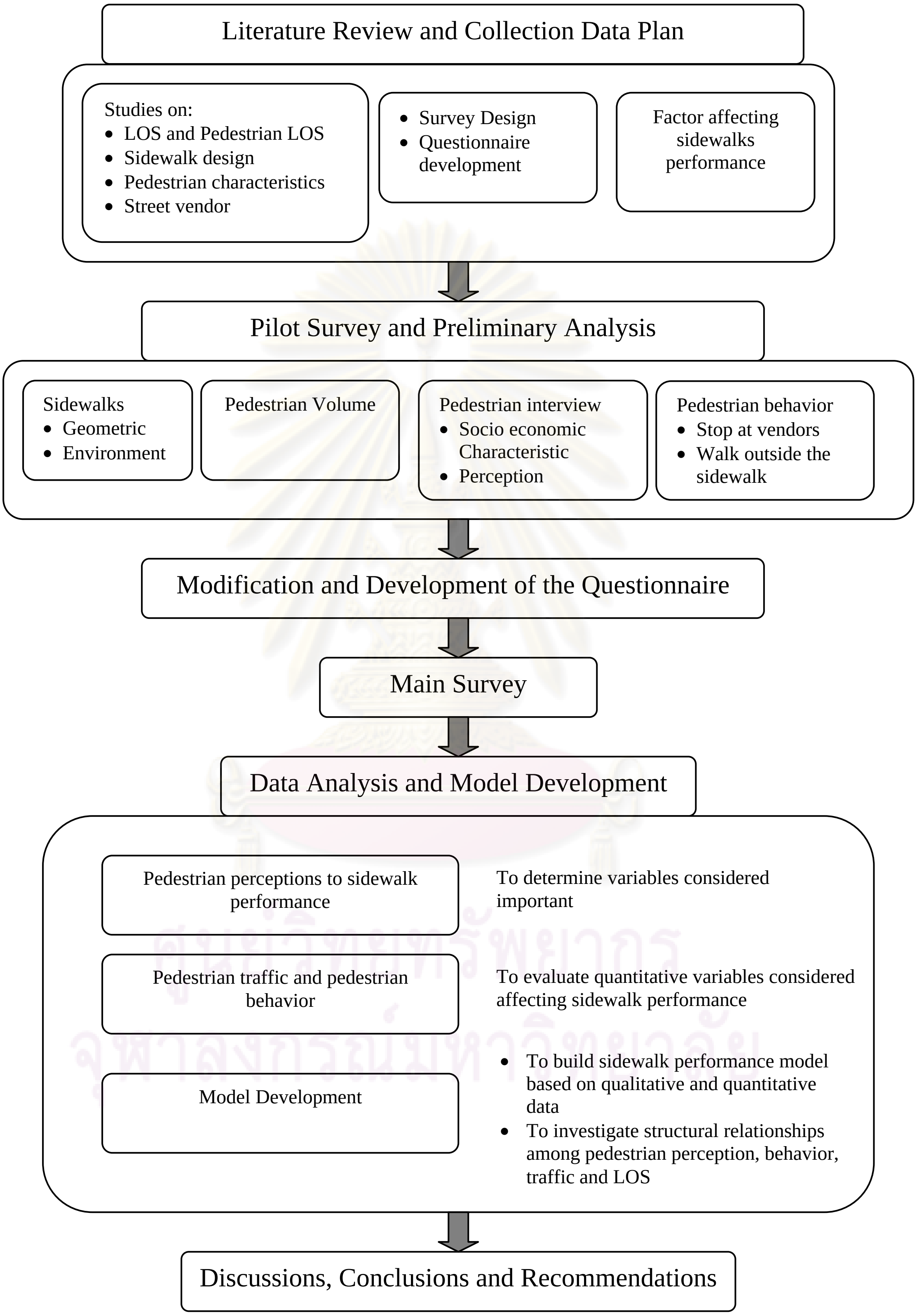


Figure 3.1 Flow Chart of Research Framework

From literatures, researches in pedestrian level of service were performed mostly in developed countries. Hence, detailed examinations need to be conducted in developing countries to adopt the method into local conditions. Sidewalk environment is one of the factors that influence pedestrian level of service. One of the sidewalk environment factors is street vendor activities along sidewalks that may be one of the unique characteristics of sidewalk in developing countries that may not be seen in developed countries.

Data collections were performed using pedestrian traffic surveys and interviews. Some factors influencing sidewalk performance were collected by site measurements and observations including geometric and operational aspects of the sidewalks. Pedestrian traffic characteristic data were collected by counting survey. Interview surveys were conducted in order to investigate pedestrian characteristics and perceptions by asking their opinions on sidewalks performance regarding safety/security, comfort, physical features, and street vendor activities.

3.1.1 Study Design

Field data collections were undertaken in total eight sidewalks in commercial areas in both Bangkok and Jakarta. Data required for the study were pedestrian interview in order to gather their perceptions, pedestrian volume count, the number of pedestrians who walk outside the sidewalk, and the number of pedestrians who interact with street vendors. Data collections were performed for two days in each location for eight hours per day from 10 a.m. to 6 p.m. In Bangkok, observations were conducted in Bang Rak, Silom, On Nut, and Pratunam districts in November, 2009 and June, 2010. Data collections in Jakarta were undertaken in Mampang, Sabang, Jatinegara Pondok Kopi, and Jatinegara Stasiun areas during June 2010. These locations were chosen because of following reasons:

a) sidewalks were available and considered feasible to observe,

b) the volume of pedestrian was considered high,

c) there were street vendor’s activities along the sidewalk.

The number of pedestrians, their interaction with the vendors, and pedestrian interview were recorded simultaneously to get the real pedestrian’s feeling on walking condition.

3.1.2 Data Collection

This study conducted following data collection: pedestrian interview, pedestrian volume count, the number of pedestrian who interact with vendor, and the number of pedestrian who walk outside the sidewalk. Data collection, one of the major procedures of data analysis, included below features:

3.1.2.1 Questionnaire

A set of survey questionnaire was designed based on literature review. The first part of the questionnaire measured pedestrian perceptions about current sidewalk conditions. Five different issues were asked, including, safety/security, comfort, vendors attraction, movement easiness, and sidewalk performance. The second part asked pedestrian perception about traffic and geometric condition, as well as behavior and attitudes. A seven-point Likert scale was used for both survey parts with “one” representing strongly disagree and “seven” representing strongly agree. Additionally, respondents were asked to score the overall sidewalk performance using “one” for the lowest point and “ten” for the highest. Respondent’s socioeconomic and travel characteristics were also gathered, covering gender, age, occupational status, monthly income, education level, frequency of walking, and trip purpose. Since this study was conducted in two cities in different countries, back translation technique was employed for the questionnaire in order to avoid possible error in measurement. The questionnaire sheet of the main study is presented in Appendix A.

3.1.2.2 Pedestrian Traffic Survey and Walking Behavior

Pedestrian traffic surveys included pedestrian volume count in order to count the number of pedestrian who walk in the sidewalk and performed for both directions. Impact of street vendor activities were investigated by counting the number of pedestrians who stop in front of vendor stalls to look around or buy something on vendor’s commodities. Another observation relating to walk behavior and to investigate the sidewalk sufficiency in accommodating pedestrian flow and vendor activities was conducted by counting the number of pedestrians who walk outside the sidewalk.

3.1.3 Analytical Methods and Procedures

Since the purpose was to demonstrate of empirical data that pedestrian perceptions can be used as determinants for assessing sidewalk performance and to propose an alternative model of sidewalk performance with consider pedestrian perceptions, the data were collected through a questionnaire and pedestrian traffic data collections. This study considered the requirements to integrate perspectives and determinants of sidewalk performance for achieving the model.

The first goal was achieved by investigating relationships among four constructs from pedestrian point of view such as perceptions on interaction with vendors, sidewalk condition, traffic, and sidewalk performance perception. Then, the second goal was investigated by establishing a model included sidewalk performance as dependent variable and some independent variables regarding sidewalk condition perception (qualitative variable) and pedestrian traffic (quantitative variable).

To achieve these objectives, the main analytical methods used were multivariate data analysis. To determine factors considered important on sidewalk performance based on pedestrian point of views, the analytical method used was exploratory factor analysis. Factor loadings and Cronbach's alpha procedures were employed to test of reliability. However, a stringent test of constructs' reliability, validity and constructs relationships was performed later by one of confirmatory factor analysis method, namely structural equation modeling. To establish model, the methodological adopted for the sidewalk performance model was multiple regression.

Factor analysis is a technique that can be useful to understand the underlying reasons for the correlations among the variables. Factor analysis can be categorized as exploratory and confirmatory. The exploratory factor analysis was used to determine variables considered important on sidewalk condition based on user's perceptions. In this phase the data were sensed, the interrogative description of cases and respondents were presented. Then the outlier data, missed data and the information which deteriorates the data were found that had to be either repaired or removed. Once the variables affected sidewalk condition determined, confirmatory phase could be done to investigate relationships among sidewalk condition as a latent variable (construct) and other latent variables in order to establish sidewalk assessment model. In this step, structural equation model (SEM) procedure was used to measure factor loadings among the constructs and to define they were acceptable or should be eliminated.

In terms of sidewalk performance assessment model, multiple regression analysis was used to determine combination of several independent variables to predict a value for dependent variable. In this study, various independent variables like pedestrian volume, the amount of pedestrian that interact with vendors, and pedestrian perception on sidewalk condition were used to predict value for dependent variable which was sidewalk performance. The multiple regression technique was chosen rather than other possible multivariate analysis method like multivariate analysis of variance because it could be used for data in which the independent variables were correlated with one another and even to an extent with the dependent variable. Multivariate analysis of variance was considered not suitable because it was applicable when there were more than one dependent variables exist. However, this study had single dependent variable and several independent variables, therefore the general linear regression model was considered applicable to examine group of differences on a single dependent variable. To conduct the analyses, the Statistical Package for the Social Sciences (SPSS) version 16.0 was employed to analyze exploratory factor analysis and multiple regression procedures, whereas Analysis of Moment Structure (AMOS) version 7.0 was applied to analyze structural equation modeling procedure.

It could be summarized that to obtain the objectives, this study conducted three kinds of statistical procedure. Firstly, exploratory factor analysis (next called factor analysis/FA) procedure was conducted to determine factors considered important in assessing sidewalk condition based on pedestrian perceptions. Secondly, structural equation modeling (SEM) was performed to investigate relationships among pedestrian perception latent variables. The last method was multiple regression, that used to analyze the proposed sidewalk performance model. Detail procedures of statistical method used in this study are explained in the following section.

3.2 Statistical Methods

Sidewalk performance model would be built from quantitative and qualitative variables. Qualitative variables come from pedestrian interview data. To analyze interview data, the following steps were considered.

In the first step, factor analysis technique was conducted to identify appropriate qualitative independent variables. For entire variables proposed, only some variables would be retained in further modeling analysis. When qualitative independent variables were determined and incorporated with quantitative variables, the subsequent procedures were to construct level of service model using multiple regression technique and structural equation modeling. Dependent variable was sidewalk performance, whereas independent variables were factors regarding pedestrian perception, pedestrian traffic, and pedestrian behavior.

3.2.1 Factor Analysis

Factor analysis is one of interdependence techniques in multivariate analysis. Interdependence technique is when the variables cannot be classified as either dependent or independent, but entire variables are analyzed simultaneously to construct the structure for all variables. Factor analysis can be employed to analyze the correlation among a large number of variables that are highly interrelated, known as factors. The main objective of using factor analysis is to summarize the information involved in large number original variables into smaller variables without loss of important information (Hair et al., 2006).

Factor analysis is a method for identifying groups of variables. Factor analysis technique has three main uses (Field, 2005):

a) To understand the structure of a set of variables
b) To construct a questionnaire to measure an underlying variable
c) To reduce of data set to a more manageable size while retaining as much of the original information as possible.

In other words, to search for and determine the basic constructions or dimensions assumed to underlie the original variables. For accepting these aims, it can be detailed some steps in factor analysis processing:

a) Specifying the unit of analysis

b) Achieving data summarization and/or data reduction

c) Variable selection

d) Using factor analysis result for further other multivariate techniques

Factor analysis yields two distinct outcomes, namely, data summarization and data reduction. In data summarization, factor analysis builds the dimensions that describe the data in smaller number of concepts than the original variables. The goal of summarizing data is to obtain a small number of factors that are adequate to represent the original variables. Data reduction can be achieved in factor analysis processing through:

a) Identify representative variables from a large number of variables for further multivariate analysis.

b) Create a new set of variables with much smaller in number to partially or completely replace the original variables

Both of outcomes aim to reduce the number of variables with retaining the original character of variables and to make subsequent analysis simpler.

In selecting variables, conceptual basic of the variables and judgments regarding the appropriateness of variables should be taken into account. The variables should be categorized into a potential dimension that can be identified through the character and nature of variables submitted to factor analysis (Hair et al., 2006).

3.2.1.1 Designing a Factor Analysis

In designing a factor analysis, there are three basic decisions (Hair et al., 2006):

a) Calculation of the input data (a correlation matrix) to find the specific objectives of grouping variables or respondents.

b) Designing analysis regarding the number of variables, measurement properties of variables and the type of variables.

c) Sample size determination.

The easiest way to construct data input can be performed by using a traditional correlation matrix (correlation among variables) called R-type factor analysis. It should attempt to minimize the number of variables, but still retain a reasonable number of variables per factor. In assessing a proposed structure study, several variables (at least 5 variables) that may represent each proposed factor should be included. When designing a study to be analyzed by factor analysis, several key variables that closely reflect the factors should be identified.

Regarding the sample size, several options can be concluded below:

a) The sample is not fewer than 50 observations and preferably more than 100 observations. As a rule of thumbs, the minimum sample is at least 5 times of the number of variables, and more acceptable sample size is 10 times of variables (Hair et al., 2006).
b) Tabachnick and Fidel (2007) agreed that for factor analysis, at least 300 cases should be considered.

3.2.1.2 Assumptions in Factor Analysis

Regarding the correlation of the data matrix, it must be ensured that the data matrix has sufficient correlation to justify the application of factor analysis. In case that all of the correlations are low or equal, it will lead to question about appropriateness application of factor analysis. Some approaches regarding variables correlation are explained as follow:

a) When there are no substantial number or correlations greater than 0.30, the application of factor analysis is probably inappropriate.
b) For determining the appropriateness of factor analysis, it can be examined by Bartlett test of sphericity, which examining overall correlation matrix. Bartlett test of sphericity is a statistical test for presence correlation among the variables.
c) The third method is measure of sampling adequacy (MSA), which can be used to quantify degree of inter-correlation among the variables and the appropriateness of factor analysis. Index range from 0 to 1 is used in MSA, that index 1 represent each variable is perfectly predicted without error by the other variables.

All variables must have MSA value above 0.50 before proceeding with factor analysis. For reaching this requirement, the researcher should examine the MSA value for each variable and delete those falling in the below 0.50 (unacceptable range). This process can be performed iteratively, the researcher should first delete the variable with the lowest MSA and recalculate the factor analysis. This process is conducted continuously until all variables have an acceptable MSA value (Hair et al., 2006; Tabachnick and Fidel, 2007).

3.2.1.3 Deriving Factors and Assessing Overall Fit

To determine how many factors should be extracted, the following criteria can be used as guidance (Hair et al., 2006),

a) Latent root criterion; factor with eigenvalue greater than 1.0
b) A priori criterion; a predetermined number of factors based on research objective and/or prior research
c) Percentage of variance criterion; enough factors to meet a specified percentage of variance explained, usually 60% or higher.
d) Scree test criterion; factor before inflection point in eigenvalue is against the number of factors graph.
e) Heterogeneity of respondents; more factors are needed if heterogeneity presents among respondents.

3.2.1.4 Interpreting the Factors

After deriving factors, the subsequent stage is interpreting the factors. There are three processes of factor interpretation, namely, estimate the factor matrix, factor rotation, and factor interpretation and re-specification

When the un-rotated factor matrix is computed, it contains the factor loading for each variable on each factor. Factor loading is the correlation between each variable to the factor that shows degree of correspondence between them.

Un-rotated factor solutions can achieve the objective of data reduction, but in most cases un-rotated factors do not provide information that offers the most adequate interpretation of variables. Accordingly, factor rotation should be done to achieve simpler and more meaningful results. There are two methods in rotation of factors:

a) Orthogonal rotation method.

Orthogonal rotation is the most widely used in factor analysis, especially when the aim of the research is to reduce the data to be smaller number of variables or a set of uncorrelated measures for subsequent use in other multivariate methods.

b) Oblique rotation method.

This method is more flexible because the axes need not be orthogonal. Oblique rotation method is the most suitable if the objective of the factor analysis is to obtain several theoretically meaningful factors or construct, because few construct in the real world are uncorrelated.

3.2.1.5 Assessing the Significance of Factor Loadings

The decision in interpreting factor must be undertaken based on the factor loadings. Factor loadings represent the correlation between variables and its factors. A factor can be described based on the variables and the relative importance of them for that factor. By discovering which factors exist and estimating the equation that describe them, it should be possible also to estimate a person's score on a factor, based on their score to the variables. For estimating score of a person, it can be done by placing their scores on the various measures into equation. This method known as weighted average (Field, 2005).

For starting point in interpreting factor loadings, the following guidance can be used with lower loadings considered significant and added to the interpretation based on other considerations (Hair et al., 2006). The following guidance are based on using practical significance

- Factor loading of ± 0.30 to ± 0.40 are the minimal level for interpretation of the structure
- Factor loading greater than ± 0.50 are considered practically significant
- Factor loading greater than ± 0.70 are indication of well defined structure

The guidance as mentioned above are applicable when the sample size is 100 or greater, and the emphasis is on practical, not statistical.

3.2.1.6 Interpreting a Factor Matrix

The objective of factor loading matrix interpretation is to determine the most significant variables in the structure. The researcher must sort all of the factor loadings to identify those most indicative variables in the structure. These following steps can be conducted for interpreting factor loading matrix.

a) Examine the factor matrix of loadings

Factor loading matrix contains factors in their columns and variables in rows. The correlation between factors and variables are represented in intersection between the column and row.

b) Identify the significant loadings for each variable

This step can be done by sorting the highest loading (the largest absolute factor loadings) for each variable. The significant value is determined by the criteria discussed earlier. When a variable is found to have more than one significant loadings, it is called a cross loading.

c) Assess the communalities of the variables

Commonly, variables should have 0.50 in communalities value.

d) Re-specify the factor model if needed.

After all the significant loadings are identified and the communalities are examined, some problems may arise: a variable without significant loadings, a variable has cross loading, and a variable's communality is deemed too low. Some alternative steps may arise in this process to re-specify the factor structure (Hair et al., 2006): ignore those problematic variables, deleting of variable(s) from the analysis, employing the different rotational method for better interpretation, extracting different number of factors, and changing from one extracting method to another

e) Label the factor.

Once a factor solution has obtained, including all variables have a significant loading on it, the next step is to label the factor. Variable with the highest loading is considered more important and have the highest influence for the factor. This variable is considered on the name or label selected to represent the factor.

3.2.1.7 Validation and Additional Uses of Factor Analysis

The purpose of the validation of factor analysis is to assess the generalization of result to the population and the potential respondent's impact to the overall result. The factor analysis technique can be finished with factor interpretation when the objective is simply to identify the combination of variables or better understanding in interrelationship among variables. In addition, when the objective is to determine variables for further application to other statistical techniques, the following steps can be performed:

- Selecting the variables with high factor loadings as a representation for a particular factor dimension
- Replacing the original set of variables with entirely new, smaller set of variables.

For further application, the result of factor analysis can be used as the independent variables in a regression analysis technique (Hair et al., 2006).

3.2.2 Multiple Regression Analysis

Multiple regression analysis is one of the statistical methods for analyzing relationship between a single dependent variable and several independent (predictor) variables (Hair et al., 2006). The objective of multiple regression analysis is to predict dependent variable through the independent variables whose values are known. Multiple regression procedure is for weighting the independent variables to ensure maximum prediction. In general, a multiple regression model can be expressed in following equation:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots + \beta_k x_k + \varepsilon \qquad (3.1)$$

that called multiple linear regression model with k independent variables. The parameters β_j, with j = 0,1,2,…., and k are the regression coefficient.

The ability of independent variables to predict dependent variable accurately is not only depends on its correlation to the dependent variable, but also on the correlation among independent variables. Collinearity is terminology for the correlation between two independent variables. Multicollinearity refers to the correlation among more than two independent variables in a multiple regression equation.

Options for determination of dependent and independent variables seem apparent in many times, but these three issues should be considered (Hair et al., 2006):

1) Strong theory, refers that theoretical grounds are used to determine independent and dependent variables
2) Measurement Error. Measurement error must be aware especially in determination of dependent variable. When dependent variable has substantial

measurement error, even the best independent variables may unable to predict accurately. Measurement error may be addressed by either of two approaches:

- Summated scales; multiple variables reduction is conduct into single variable as the sole representative of a concept
- Structural equation modeling; measurement error are accommodated directly to estimate the effect of independent variables in any specified dependence relationship.

Summated scales can be directly incorporate in multiple regression analysis by replacing either independents or dependent variables with the summated scales value.

3) Specification error, refers that some mistakes can occurred by inclusion of irrelevant variables or omission of relevant variables in the step of independent variables determination.

Multiple regression is widely used for two categories research problem: prediction and explanation. When it is used as prediction model, it involves the extent to which the independent variables can predict the dependent variable. As the explanation model, multiple regressions will explain relationship between dependent and independent variables in terms of their values, signs, and statistical significances.

For doing multiple regression, these three features should be considered (Hair et al., 2006):

1) Sample size; to meet the necessary levels of statistical power and statistical significance
2) Unique elements of the dependence relationship; although the relationship between independent and dependent variables is assumed to be metric and linear, but these assumptions are flexible by creating additional variables to represent the other special aspect of relationship
3) Nature of the independent variables.

In some cases, performing multiple regression analysis is faced on the problem to select appropriate independent variables from a number of possible independent variables. Sometimes a set of independent variables have exactly specified, it mean regression model uses confirmatory approach. In the other cases, independent variables selection process should be done through either sequential search method or combinatorial processes.

3.2.2.1 Statistical Test for the Model

The individual variable must meet the assumption of linearity, constant variance, independence, and normality. Researcher takes only one sample and base the model on it. With this only sample, the researcher needs to test the hypothesis that the regression model can represent the population. These statistical tests have two basic forms (Gujarati, 2004):

1) Test of the variation explained (coefficient of determination). This is the test of significance of the overall model fit. *F-ratio test* is used to test the hypothesis that the amount of variation explained by the regression model is more than the baseline prediction. By F distribution, it can make a statistical test to determine whether the ratio is different from zero (statistically significant).
2) Test of each regression coefficient. The appropriate test is the *t-test*. When the value of *t- test* greater than value in the table (agree with appropriate sample size and confidence level), it means the coefficient have statistically significant effect in the regression model.

3.2.2.2 Interpreting the Regression Variate

Interpretation of multiple regression models can be done by evaluating the estimated regression coefficient for their explanation of the dependent variable. Regression coefficient represents both the type of relationship (positive or negative) and the strength of the relationship between dependent and independent variables. The sign of coefficient represent whether the relationship is positive or negative, whereas the value of coefficient indicates the change in the dependent variables each time the independent variable changes by one unit. The regression coefficient has significant role for the objective of regression, namely, prediction and explanation.

3.2.3 Structural Equation Modeling (SEM)

Structural equation modeling (SEM) is one of the multivariate statistic analytical tools to examine relationships among variables. The main goal of use SEM is to test of a theoretical model hypothesized by a researcher. Especially, it is used to define how sets of variables establish the constructs and how relationships among these construct.

Two types of variables are used: observed variables and latent variables. The observed variables, also known as measured or indicator variables, are a set of variables that define a latent variable. The observed variables can be measured directly with field observation and data collection (test, survey, etc). Contrarily, latent variables (constructs or factors) are variables that cannot be measured directly, so it must be inferred from a set of observed variables.

3.2.3.1 Two Step Approach

SEM method introduces two step model building approach that emphasized the analysis of two basic distinct models: a measurement model then followed by the structural model (Anderson and Gerbing, 1988). The measurement model focuses on the relationship between latent variable and its underlying observed variables. The structural model determines relationships among the latent variables in the proposed model.

a) Measurement model. The relationship between the observed variables and the latent variables is expressed by a loadings factor, that provides information about the extent to which a given observed variable can measure a latent variable.

b) Structural model. Structural model specifies the extent to which a priori hypothesized relationships are supported by sample variance-covariance data.

Figure 3.2 presents the general process of model development using SEM.

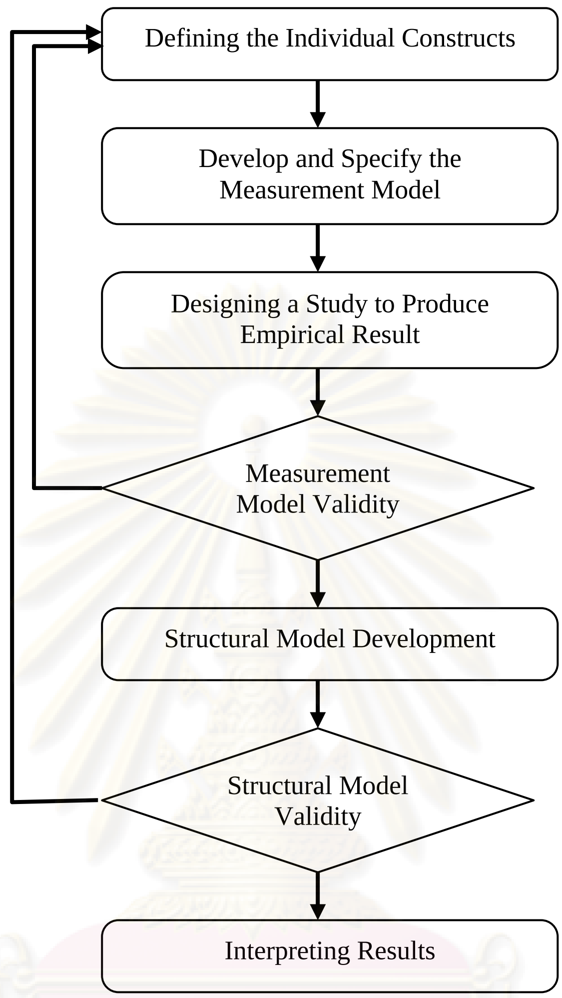


Figure 3.2 Procedures in Structural Equation Modeling

For conducting SEM analysis, following steps can be used as guideline for a better result (Byrne, 2010).

a) Model Specification

Literature review is the main task in this first step. Model specification identifies all of the available relevant researches, theories, and studies to establish a theoretical model. All of this available information is used to decide which variables to include and to eliminate in the theoretical model, and how these variables are related. Hence, researcher can determine every relationship and parameter in the model in accordance to their interest.

b) Model Identification

SEM method uses three levels of model identification that depend on the amount of information in the sample variance covariance matrix S. The three levels of model identification are as follows (Byrne, 2010):

1) Under-identified (or not identified): a model has one or more parameters may not be uniquely determined because there is not enough information in the matrix S.
2) Just-identified: a model has all of the parameters that uniquely determined because there is just enough information in the matrix S
3) Over-identified: a model has more than one way of estimating a parameter (parameters) because there is more than enough information in the matrix S.

c) Model Estimation

d) Model Testing

Have obtained the parameter estimates for a specified SEM model, the next step is to determine how well the data fit the model or to what extent is the sample data support the theoretical model. Model fit assessment can be tested through two ways. The first is fit testing of entire model, known as model fit criteria, and the second is to test the fit of individual parameters of the model.

Three main features can be considered in individual parameter assessment. The first is whether a free parameter is significantly different from zero. Parameter's standard error and parameter's estimation are obtained simultaneously. Critical value can be obtained as a ratio of the parameter estimate to the estimate standard error, which is assumed normally distributed. A parameter is significantly different from zero when the critical value exceeds the expected value at a specified α level (such as 1.96 for two tailed test at the .05 level).

The next feature is about the sign of the parameter, whether it agrees with what is expected from the theoretical model. The last feature is that parameter estimates must make sense, that is, they should be within an expected range of value. For example, variance should have positive values or correlation value should not exceed 1.0. Therefore, it can be concluded that all free parameters should agree with expected direction (sign), be statistically different from zero, and make practical sense.

e) Model Modification

When the proposed model have established, researchers can assess whether the model fit or not. If the fit of proposed model is not strong enough, then the next step is to modify the model and followed by evaluation the new modified model. Model modification is performed through altering the original proposed model for a modified model that is better fitting in some sense and yields parameters having practical significance and substantive meaning. The parameters which have no substantive meaning should be eliminated from the model.

3.2.3.2 Model Fit

As mentioned before, the main goal of SEM is to find the best fitting model to test the theories, that is, a statistically significant theoretical model that has practical and substantive meaning as well. These three following criteria can be used in judging the statistical significance and substantive meaning of a theoretical model (Byrne, 2010; Hair et al., 2006):

a) Absolute fit measures. Absolute fit indices are used to direct measure of the model. They provide basic assessment to test how well the SEM result fits the sample data. There are four tools can be used as absolute fit measures, namely, chi-square statistic (χ^2), Goodness of Fit Index (GFI), root means square residual (RMSR) and standardized root mean residual (SRMR), and Root-Mean-Square Error of Approximation (RMSEA).

b) Incremental fit indices. Incremental fit measures assess how well a specified model fits relative to some alternative baseline model. There are some examples standard output of incremental fit indices, namely Normed Fit Index (NFI), Comparative Fit Index (CFI), Tucker Lewis Index (TLI), and Relative Noncentrality Index (RNI). It should be noted that different SEM programs provide different fit statistics.

c) Parsimony fit indices. Parsimony indices refer to the information regarding which model among a set of competing models is the best, taking into account its fit relative to its complexity. The fit indices refer to parsimony fit measure such as Parsimony Goodness-of-Fit Index (PGFI) and Parsimony Normed Fit Index (PNFI).

Model fitting can not be examined through single statistical test of significance to define a correct model given the sample data. Typically, using three or four fit indices provides adequate evidence of model fit (Hair et al., 2006). Table 3.1 summarizes the model fit criteria and acceptable fit interpretation.

Table 3.1 Model Fit Criteria and Acceptable Fit Interpretation

Model fit criteria	Acceptable level	Interpretation
Chi-square	Table χ^2 value	Compares obtained χ^2 value with table value for given df
Goodness-of-Fit Index (GFI)	0 (no fit) to 1 (perfect fit)	Greater than 0.90 considered good. Close to 0.95 reflects a better model fit
Adjusted GFI (AGFI)	0 (no fit) to 1 (perfect fit)	Greater than 0.90 considered good. Closer to 0.95 indicate a better fit
Root-Mean-square Residual (RMR)	Researcher defines level	Indicates the closeness of Σ to S matrix
Root-Mean-Square Error of Approximation (RMSEA)	<0.10	Less than 0.10 is acceptable. Value less than .07 indicates a good model fit
Comparative Fit Index (CFI)	0 (no fit) to 1 (perfect fit)	Greater than 0.90 indicate good fit model
Tucker-Lewis Index (TLI)	0 (no fit) to 1 (perfect fit)	Close to .95 reflects a good fit
Normed Fit Index (NFI)	0 (no fit) to 1 (perfect fit)	Close to .95 reflects a good fit
Normed chi-square	1.0-5.0	Less than 1.0 is a poor model fit, more than 5.0 indicates a need for improvement
Parsimonious fit index	0 (no fit) to 1 (perfect fit)	Compares values in alternative models
Akaike information criterion	0 (perfect fit) to negative value (poor fit)	Compares values in alternative models

Source: (Hair et al., 2006; Schumacker and Lomax, 2004)

The formulas for the goodness-of-fit index (GFI), normed fit index (NFI), relative fit index (RFI), incremental fit index (IFI), Tucker-Lewis index (TLI), comparative fit index (CFI), model AIC, null AIC, and RMSEA can be seen respectively:

$$\mathrm{GFI} = 1 - \left(\frac{\chi^2_{model}}{\chi^2_{null}} \right) \tag{3.2}$$

$$\mathrm{NFI} = \frac{\chi^2_{null} - \chi^2_{model}}{\chi^2_{null}} \tag{3.3}$$

$$\mathrm{RFI} = 1 - \left(\frac{\chi^2_{model} / df_{model}}{\chi^2_{null} / df_{null}} \right) \tag{3.4}$$

$$\mathrm{IFI} = \frac{\chi^2_{null} - \chi^2_{model}}{\chi^2_{null} - df_{model}} \tag{3.5}$$

$$\mathrm{TLI} = \left(\frac{\chi^2_{null} / df_{null} - \chi^2_{model} / df_{model}}{\chi^2_{null} / df_{null}} \right) - 1 \tag{3.6}$$

$$\mathrm{CFI} = 1 - \left(\frac{\chi^2_{model} - df_{model}}{\chi^2_{null} - df_{null}} \right) \tag{3.7}$$

$$\text{Model AIC} = \chi^2_{model} + 2q(\text{number of free parameters}) \tag{3.8}$$

$$\text{Null AIC} = \chi^2_{null} + 2q(\text{number of free parameters}) \tag{3.9}$$

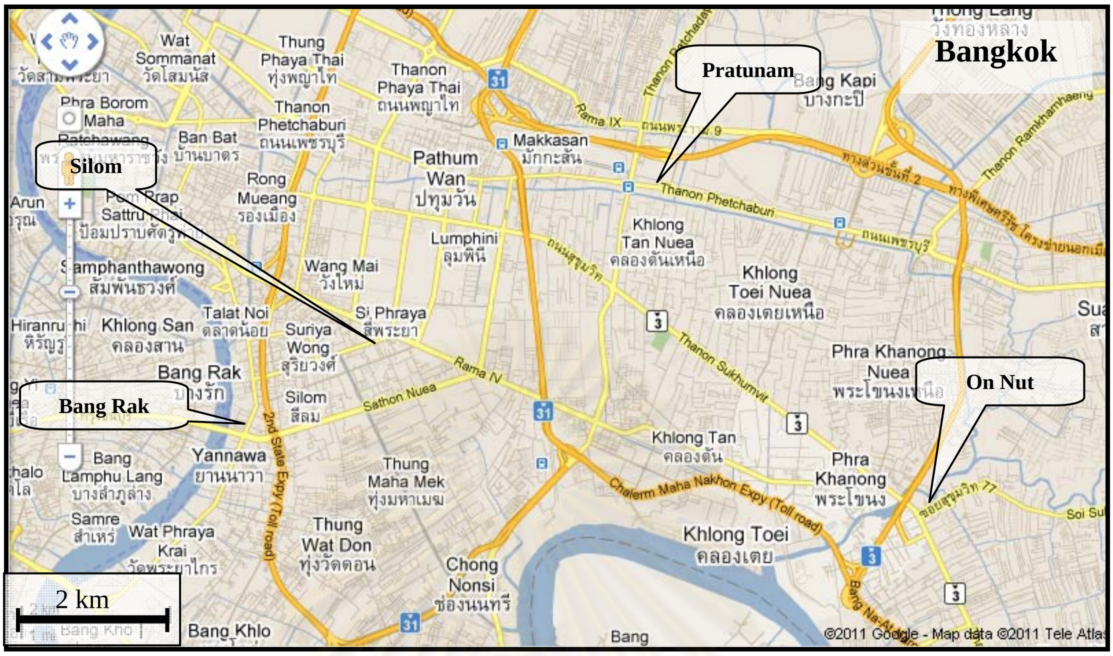
$$\mathrm{RMSEA} = \sqrt{\frac{\chi^2_{M} - df_{M}}{(N-1)df_{M}}} \tag{3.10}$$

Chapter IV
Data Collection and Preliminary Analysis

This chapter explains the data collection of the pedestrian study in two developing cities, i.e. Bangkok, Thailand; and Jakarta, Indonesia. Data was collected in the sidewalks on dense commercial area. These sidewalks were selected based on the availability of sidewalk and the presence of street vendors. The discussion would begin with the description of the general characteristics of sidewalk in the study area. Data collection process is then discussed followed by discussion of respondent's characteristics.

4.1 Study Locations

The data surveys were undertaken in a total of eight sidewalks located in commercial areas in both Bangkok and Jakarta. In Bangkok, observations were conducted in Bang Rak, Silom, On Nut, and Pratunam districts. Data collections in Jakarta were conducted in Mampang, Sabang, Jatinegara Pondok Kopi, and Jatinegara Stasiun areas (see Figure 4.1 and Figure 4.2). These locations were chosen because of the following reasons: sidewalks are available and considered feasible to observe, the volume of pedestrian is considered high, and there are street vendor activities along the sidewalk.



Source: Google Maps

Figure 4.1 Survey Locations in Bangkok

Source: Google Maps

Figure 4.2 Survey Locations in Jakarta

4.2 General Characteristics of Sidewalk under Investigation

To identify characters of the observed sidewalks, sidewalk geometry measurement and environment observation were performed. The objectives of sidewalk geometry measurement and environment observation were to measure sidewalk dimension and to identify sidewalk situation and circumstances. Observations were undertaken along the study area.

4.2.1 Bangkok's Sidewalk Characteristics

In general, sidewalks in Bangkok are partly obstructed by the physical condition and related facilities (such as pedestrian crossing bridge and traffic signals). Besides walking, some others activities exist along the sidewalk and cause obstructions to walking activities. Street vendors, telephone booths, bus stops, and pedestrians occupy the sidewalk. In Bangkok, sidewalks are used for many functions (World Bank, 2007):

- Pedestrian. Pedestrians use sidewalk as their transport infrastructure.
- Utilities. Electricity, water, telephone and television cables and pipes.
- Business. Street vendors, advertising signs.
- Others. Traffic signs, bus/taxi stops.

Negative externalities are sometimes caused by one user affecting another. For example, existence of vendors near pedestrian bridge leaves too little space for pedestrians to walk (e.g. on Pratunam). Table 4.1 and Figure 4.3 elaborate characteristics of four observed sidewalks in Bangkok.

Table 4.1 Sidewalk Characteristics in Bangkok

Items	Locations			
	Bang Rak	Pratunam	On Nut	Silom
Land use classification	commercial	commercial	commercial	commercial
Total width	2.7 m	± 3.0 – 7.0 m	3.2 m	3.0 m
Effective width	± 1.5 m	± 0.8 m	± 1.0 m	± 1.0 m
Street vendors commodities	raw food, snack, praying accessories	clothes, accessories, belts, bags	cooked/raw (take away) food, fruits, accessories, lottery	cooked foods (not take away food)

Table 4.1 Sidewalk Characteristics in Bangkok (continued)

Items	Locations			
	Bang Rak	Pratunam	On Nut	Silom
Regular obstacles (columns, electric poles, etc	Yes	Yes	Yes	Yes
Permanent non-regular obstacles (seats, rubbish bins, bus shelter, post boxes)	No	No	Yes	Yes
Street activity	very high	very high	very high	very high
Number of high rise buildings	medium	medium	many	many
Building veranda	continuous	continuous	broken	broken
Sidewalk condition	Good	Good	Good	Good
Provision for on street parking	No	Yes	No	Yes
Distance from moving vehicles	adjacent	adjacent	adjacent	adjacent
Protection from vehicles	iron fence	iron fence	iron fence	no protection

a) Bang Rak

b) Pratunam

c) On Nut

d) Silom

Figure 4.3 Typical of Observed Sidewalk in Bangkok

4.2.2 Jakarta's Sidewalk Characteristics

Generally, pedestrian (non-motorized vehicle as well) facilities in Jakarta are not sufficient compared to the length of the roadway. Besides that, not only pedestrians can use the facilities, but also various activities such as vending, illegal parking, and plantings. Furthermore, the existing sidewalk conditions vary widely in the corridor from quite good shape to narrow and badly maintained. Some kinds of obstructions exist along the sidewalk. Vendors occupy large space in the sidewalk, leads to significant sidewalk width reduction and force pedestrian into the street. Other obstructions are caused by improperly landscaping plants, car/motorcycle off-street parking, building columns, and public facilities (telephone booths, shelters, and electrical poles). Table 4.2 and Figure 4.4 present characteristics of four observed sidewalks in Jakarta.

Table 4.2 Sidewalk Characteristics in Jakarta

Items	Locations			
	Mampang	Sabang	Jatinegara Pondok Kopi	Jatinegara Stasiun
Land use classification	commercial zone	commercial zone	commercial zone	commercia l zone
Total width	± 4.0 m	2.7 m	2.5 m	3.0 m
Effective width	± 2.0 m	± 0.8 m	± 1.0 m	± 1.0 m
Street vendors commodities	cooked food (not take away), fruits, accessories	Cooked/raw food, accessories	clothes, accessories, glasses	bags, books, accessories
Regular obstacles (columns, electric poles, etc	Yes	Yes	Yes	Yes
Permanent non-regular obstacles (seats, rubbish bins, bus shelter, post boxes)	No	No	No	No
Street activity	High	High	Very high	Very high
Number of high rise buildings	medium	many	medium	medium
Building veranda	none	broken	broken	broken
Sidewalk condition	Good	Good	Good	Good
Provision for on street parking	No	No	No	Yes
Distance from moving vehicles	adjacent	not adjacent	adjacent	adjacent
Protection from vehicles	none	buffer zone	none	none

a) Mampang

b) Sabang

c) Jatinegara Pondok Kopi

d) Jatinegara Stasiun

Figure 4.4 Typical of Observed Sidewalk in Jakarta

4.2.3 Differences of Observed Sidewalk Characteristics

Previous section explains in detail on characteristics of study locations in both cities, Bangkok and Jakarta. Four selected sidewalks in Bangkok are comparable to four selected sidewalks in Jakarta concerning their specific area activities and type of street vendor. Even all observed sidewalks are located in commercial zones, they have differences on their specific main urban activities and street vendor characteristics, as can be seen in Table 4.3.

Table 4.3 Characteristic Differences among Observed Sidewalks

Items	Bang Rak – Jatinegara Stasiun	Pratunam – Jatinegara Pondok Kopi	On Nut - Mampang	Silom - Sabang
Land use classification	commercial zone			
Major activities	Shopping, traditional market	Shopping center	Shopping	Shopping center, office
Street vendor commodities	raw food, snack, accessories	clothes, fashion, accessories,	cooked/raw food (take away), mix commodities	cooked foods (outdoor restaurant)

4.2.4 Street Vendors Issues

Street vending is the informal sector and an important part of economy of the city. They are commonly found in urban area of developing countries. Bangkok, Jakarta and other cities in South-east Asian countries have a large amount of street vendors. The proportion of informal sector in urban areas increased significantly during the economic crisis in the late 1990s, when the many manufacturing and service corporations being collapse and pushed the newly unemployed into informal sector. Many people, who lost their jobs and others who could not find jobs, took street vending as main income of livelihood. In developing cities, street vending is an importance source of income for the urban poor.

There are two different opinions about street vendors. Some prefer no vendors on the sidewalk at all; some think that vendors make a walking activity more enjoyable. Although the street vendors play important role to the economy of the city, their existence are often undesirable activities by the authorities. In the name of urban order and cleanliness, there are many conflicts between urban authorities who want to keep the city and vendors who need space for their activities.

The street vendor activities can be found on the sidewalk in many streets in Bangkok, whereas in Jakarta street vendors do their activities in the sidewalks, city parks, cross walking bridges and even in the streets. They sell a wide variety of commodities, such as clothes, electronic items, curios, and cooked or raw foods.

Food vendors of Bangkok are one of the most interesting attraction to the tourist because of their cheap but nutritious fare. The number of food vendors in Bangkok increase rapidly because of three reasons (Bhowmik, 2005). Firstly, food vendor is a part of the cultural tradition of the urban population because of a tradition of eating out among the population. Secondly, dense city population as a result of urbanization and the long hours of work for low paid of urban worker often leave the urban poor with little time for cooking proper meal. Therefore, they depend on the food vendors to provide their food consumption. Thirdly, as a tourist destination, food vendors in Bangkok attract the tourists who want to look out the local variety of food.

In fact, the availability of outdoor economic activities seems to be very important for individual family economic. Study in Jakarta by Zulkifli et al. (2009) invented some reasons of the importance of presence of street vendor for Jakarta's residents, such as street vendors provide low prices goods-food (39%), approachable selling location (25%), help safety on the night (14%), and familiar with the consumer (11%).

Street vendors occupy one side or both sides on the sidewalk, their activities are not on the roadway, so they do not cause significant vehicle traffic problems (see Figure 4.5). In reality, traffic problems are caused primarily by insufficient of road space to accommodate the growing number of private vehicles.

Figure 4.5 Vendors Occupy Both Sides and One Side of the Sidewalk

The activities of street vendors in Bangkok and Jakarta should be necessary to be as close as possible to the potential costumer because the resident tends not to walk very far. Hot temperature, pollution, dirty, and heavy traffic reduce the prospect of walking activities.

4.3 Data Collection

This study conducted seven kinds of data collection including pedestrian interview, pedestrian traffic survey and walking behavior survey. Most of data collection were conducted simultaneously, start from 10 a.m. to 6 p.m.

In Bangkok, data collections were conducted two days in each location, whereas in Jakarta were conducted one day only. Data collection period in Bangkok were conducted as follows: Bang Rak: 3 and 4 November 2009; Silom: 15 and 16 June 2010; On Nut: 17 and 18 June 2010; and Pratunam: 25 June and 2 July 2010. In Jakarta, data collection period were performed as follows: Mampang and Sabang: 9 June 2010; and Jatinegara Pondok Kopi and Jatinegara Stasiun 15 June 2010.

4.3.1 Interview Survey

4.3.1.1 Questionnaire

A review of the literature was undertaken to establish questions used in the questionnaire. The questionnaire was established within two phases: pilot study and final study. The first part of the questionnaire covers measurements of current sidewalk conditions with 27 variables/questions. The scale for measuring sidewalk condition is structured around five dimensions of sidewalk condition: safety, comfort/convenience, vendor presence, accessibility, and sidewalk performance.

These dimensions were proposed so that pedestrians were able to perceive sidewalk conditions that were represented by the variables of each dimension. Table 4.4 shows the five dimensions and scale items selected for measuring the perceived sidewalk condition during the pilot study. The last variable at the bottom of Table 4.4 is a global measure. Perceived performance measures the overall feelings of sidewalk users toward the quality of sidewalk services.

From the pilot survey, some problems were found and corrected for the real data collection. The labels of dimension selected for the pilot study were changed in the final study. In order for the questions to be easily understood by respondents, some variables were changed in wording and interpretation as indicated in Table 4.5. Key information obtained from the pilot survey was not complete, while some information was not necessary and was improved. Based on the reasons mentioned above, variables Q11, Q 21, and Q 26 were removed and some new variables were added in the final study (Q1-4, Q1-5, and Q1-22). The questionnaire used in the final data collection is presented in Appendix A.

Table 4.4 Dimensions and Variables Selected for the Pilot Study

Dimensions	Variables	
Safety	Q1	I feel safe from vehicle traffic danger
	Q2	I feel safe from trips, slips and falls
	Q3	I feel safe from intimidation or physical attack
Comfort/ convenience	Q4	I think that the sidewalk is clean
	Q5	I can move freely without obstruction from physically features
	Q6	I can move freely without obstruction from other pedestrians
	Q7	I can move freely without obstruction from vendors
	Q8	I have space to avoid the obstruction without decelerating my pace
	Q9	I feel comfortable walking through the sidewalk
Vendor presence	Q10	I think that there are a large number of vendors causing the sidewalk crowded
	Q11	I think that vendors do not set their goods orderly
	Q12	I think that vendor's displays do not lead to obstruction to pedestrian movements
	Q13	I think the vendor buyers cause obstruction in pedestrian movements
	Q14	I am interest in goods sold by vendors
	Q15	I intend to buy something in street vendors
	Q16	I enjoy vendor presence
Accessibility	Q17	I think that it is easy to entry/exit to/from the sidewalk
	Q18	I think that it is easy to find bus stop from the sidewalk
Sidewalk performance	Q19	I think that there are a large number of pedestrians causing sidewalk crowded
	Q20	I think that the total width of sidewalk is wide enough
	Q21	I think that the remain sidewalk width can accommodate pedestrian flow
	Q22	I can not walk side by side with my friends
	Q23	I can choose my walking speed freely
	Q24	I can overtake other pedestrians easily
	Q25	I get many delays to walk through this sidewalk
	Q26	I enjoy walking in this sidewalk, to window shopping and it is not just walking
	Q27	Based on my perception, the sidewalk is good in serving pedestrian flow
Overall	Q28	For overall, performance of this sidewalk is ……. Give point in the range 1 to 10 for this sidewalk. Score 1 for the lowest and 10 for the highest

Table 4.5 Changes in the Variables from the Pilot Study to the Final Study

Pilot Study			Final Study		
Dimensions	Variables		Dimensions	Variables	
Safety	Q1	I feel safe from vehicle traffic danger	Safety/ Security	Q1-1	I feel safe from vehicle traffic danger
	Q2	I feel safe from trips, slips and falls		Q1-2	I feel safe from trips, slips and falls
	Q3	I feel safe from intimidation or physical attack		Q1-3	I feel safe from intimidation or physical attack
Comfort/ convenience	Q4	I think that the sidewalk is clean		Q1-4	I think that the available sidewalk width can accommodate pedestrian flow
	Q5	I can move freely without obstruction from physically features		Q1-5	I think that the sidewalk is flat enough to accommodate wheelchair users
	Q6	I can move freely without obstruction from other pedestrians	Comfort	Q1-6	I think that the street vendors keep the sidewalk clean
	Q7	I can move freely without obstruction from vendors		Q1-7	I can move freely without obstruction from physically features (phone boxes, column, bench, etc)
	Q8	I have space to avoid the obstruction without decelerating my pace		Q1-8	I am not impeded by other pedestrians
	Q9	I feel comfortable walking through the sidewalk		Q1-9	I can move freely without obstruction from vendors
Vendor presence	Q10	I think that there are a large number of vendors causing the sidewalk crowded		Q1-10	I have enough space to avoid the vendor's obstruction without decelerating my pace
	Q11	I think that vendors do not set their goods orderly		Q1-11	I feel comfortable walking through this sidewalk with the presence of on street vendors
	Q12	I think that vendor’s displays do not lead to obstruction to pedestrian movements	Vendor’s attraction	Q1-12	I am interested in goods sold by vendors along this sidewalk
	Q13	I think the vendor buyers cause obstruction in pedestrian movements		Q1-13	I intend to buy something from street vendors
	Q14	I am interest in goods sold by vendors		Q1-14	I enjoy vendor activities in this sidewalk
	Q15	I intend to buy something in street vendors		Q1-15	I think that too many street vendors occupy this sidewalk
	Q16	I enjoy vendor presence		Q1-16	I think that too many buyers cause this sidewalk crowded
Accessibility	Q17	I think that it is easy to entry/exit to/from the sidewalk		Q1-17	I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded
	Q18	I think that it is easy to find bus stop from the sidewalk	Movement easiness	Q1-18	I think that vendor’s displays do not obstruct pedestrian movements

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Table 4.5 Changes in the Variables from the Pilot Study to the Final Study (Continued)

Pilot Study			Final Study		
Dimensions	Variables		Dimensions	Variables	
Sidewalk performance	Q19	I think that there are a large number of pedestrians causing sidewalk crowded	Movement easiness	Q1-19	I think that the total width of sidewalk is wide enough
	Q20	I think that the total width of sidewalk is wide enough		Q1-20	I can choose my walking speed freely
	Q21	I think that the remain sidewalk width can accommodate pedestrian flow		Q1-21	I can overtake other pedestrians easily
	Q22	I can not walk side by side with my friends		Q1-22	At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway
	Q23	I can choose my walking speed freely	Sidewalk performance	Q1-23	I think that I can enter/exit to/from this sidewalk easily
	Q24	I can overtake other pedestrians easily		Q1-24	I can not walk side by side with my friend because the sidewalk width is too narrow
	Q25	I get many delays to walk through this sidewalk		Q1-25	If I want to access public transport, it is easy to find bus stop/BTS Station in this sidewalk
	Q26	I enjoy walking in this sidewalk, to window shopping and it is not just walking		Q1-26	I don't mind delays as long as I am comfortable
	Q27	Based on my perception, the sidewalk is good in serving pedestrian flow		Q1-27	From my opinion, this sidewalk is bad for pedestrians
Overall	Q28	For overall, performance of this sidewalk is ……. Give point in the range 1 to 10 for this sidewalk. Score 1 for the lowest and 10 for the highest	Overall	Q1-28	In overall, I would give _______ points for the performance of this sidewalk. (1 - 10 score where 1 for the lowest and 10 for the highest)

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Part 2 and Part 3 of the questionnaire were added in the final study. The second part deals with the measurement of six items about traffic and geometric condition, and twelve items about behavior and attitudes, whereas the third part refers to respondent characteristics. Contents of second part of the questionnaire are presented in Table 4.6.

Table 4.6 Second Part of the Questionnaire

Measures	Attributes	
Traffic	Q2-1	I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors
	Q2-2	I think if the vendors is prohibited, the volume of pedestrians will be higher
	Q2-3	I found delay when I walk along this sidewalk
Geometric	Q2-4	The street vendors occupy too many spaces in this sidewalk
	Q2-5	I think pedestrians with visual impairment can walk this sidewalk easily
	Q2-6	This sidewalk is too narrow to accommodate the vendors and pedestrians
Behavior/ attitudes	Q2-7	It is easy to interact with the vendors
	Q2-8	I want to look around commodities sold by vendors
	Q2-9	Walking slowly to enjoy goods from street vendors is inconvenient for other pedestrians
	Q2-10	I should walk in the sidewalk although the sidewalk is crowded by vendors
	Q2-11	I will still walk on the roadway (pavement) even when the sidewalk is very crowded
	Q2-12	In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk
	Q2-13	I will walk along this sidewalk only for shopping
	Q2-14	On street vendors make me easy to buy something
	Q2-15	I love shopping along sidewalk
	Q2-16	My friends or my relatives like to walk along this sidewalk
	Q2-17	I feel that the government should ban the vendors along the sidewalk
	Q2-18	I think the regulation of vendors along the sidewalk is not that strict

In Part 1 and Part 2 of the questionnaire, respondents were asked to indicate the perceived agreement of each attributes using a seven-point Likert scale with “one” representing strongly disagree and “seven” representing strongly agree (see Figure 4.6).

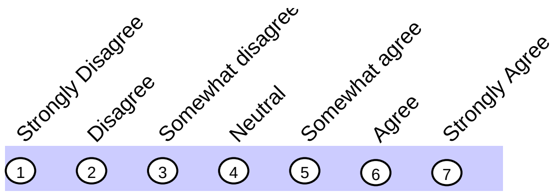

Figure 4.6 Seven-point Likert Scale

In addition to the attributes items in Table 4.5 and Table 4.6, the final study collected the respondent's profile information in the third part of the questionnaire. The selected profile variables were: gender, age, occupational status, education level, group walking, walking as main trip mode, frequency of walking, trip purpose, and monthly income. Detail of respondent's profile is described in Section 4.4.

4.3.1.2 Minimum Sample Size

The study sample size was determined by the rules-of-thumb associated with the statistical analyses selected for the data analysis phase. For factor analysis technique, the minimum sample size has to be at least five to ten observations for each variable/attribute (Hair et al., 2006). Table 4.5 and Table 4.6 show 45 variables, making the minimum sample size 450 (45 x 10). For multiple regression analysis, the consensus for a minimum sample size has to be at least 15 to 20 times the number of independent variables in the analysis (Hair et al., 2006). There are at least ten independent variables selected for regression analysis, making the minimum sample size 200 responses (10 x 20). For structural equation modeling, the required sample sizes should be greater than 200 (Hair et al., 2006; Kline, 2005). The largest number obtained using all rules-of-thumb is 450 responses, making the minimum sample size 450 respondents.

In total, 1474 and 567 responses were gathered during data collection in Bangkok and Jakarta, respectively. Because of incomplete or missing data, some observations could not be used. In Bangkok, 1381 responses could be used (93 responses were rejected), whereas out of 567 responses in Jakarta, 523 usable samples were obtained (44 responses were eliminated).

4.3.1.3 Data Editing

After data collection, editing of the data was performed in order to ensure the omission, completeness, and consistency of the data. Editing was considered as part of the data processing and analysis stage. This study included all respondents in the analysis process who completed at least 75% of the questionnaire answer (Sekaran, 2000), whereas those with more than 25% unanswered questions were excluded. As a result, 93 surveys (6.31%) were excluded for Bangkok, and 44 (7.76%) surveys were eliminated for Jakarta. Any missing data had been considered missing value and discussed below.

4.3.1.4 Treatment of Missing Data

As the first stage in the data analysis, screening for missing data was performed. Missing data commonly occurs when obtaining data sets (Hair et al., 2006). Missing data usually occurs when a respondent fails to answer one or more survey questions. Tabachnick and Fidel (2007) recommends two ways to evaluate the degree to which there are missing data, namely, to evaluate the amount of missing data, and to evaluate what data are missing (the pattern). However, Tabachnick and Fidel (2007) stated that assessing the pattern of missing data may be more essential than to evaluate the amount of missing data, though the latter is still necessary. The reason is because investigating the pattern of missing data has an advantage in determining whether or not the missing data occur randomly or is related to specific items. Tabachnick and Fidel (2007) revealed that the pattern of missing data should be randomly distributed among the questionnaires, otherwise the missing data will lead to biased estimates of results.

The screening of the data in SPSS indicated that there was no variable that have more than 5% of missing data. Therefore, there was no requirement to assess the pattern of missing data because less than 5% of missing data was considered acceptable (Churchill, 1995). Nonetheless, to ensure that there was no systematic error (the missing data are randomly distributed) in the responses, the randomness of missing data was assessed (Hair et al., 2006). An analysis of the pattern of missing data using SPSS indicated only random occurrences. According to Tabachnick and

Fidel (2007), there was no problem with the data and the analysis could be continued further.

As missing data was considered minimal and distributed randomly, the missing values were decided to be replaced with the variable mean responses for each variable. This method was believed to be most acceptable for two reasons. First, this method is widely used, because it is based on valid responses that make the mean the best single replacement of missing data (Hair et al., 2006). Second, since the variables in this study will be grouped in factors, elimination of the variables with missing data would result in a loss of the overall sample size (Tabachnick and Fidel, 2007).

4.3.2 Pedestrian Traffic Survey and Walking Behavior

Pedestrian traffic surveys included pedestrian volume count that conducted to calculate the number of pedestrian who pass in the sidewalk on both directions. Counting was separated in 5 minutes interval. Observations were performed eight hours in each day, start from 10 a.m. to 6 p.m.

Activities of vendors in the sidewalk could affect to pedestrian traffic flows. Some pedestrians stopped in front of vendor shops to look around or to buy something on vendor’s commodities. Various goods were sold by vendors, such as clothes, cooked or raw foods, and accessories. Vendor’s activities reduced the capacity of the sidewalk, and in some situation push pedestrians walk outside the sidewalk because of either obstruction or too large volume of walkers. Hence, the volume of pedestrians who walk outside the sidewalk was counted in this study as well. Data collection procedures in this study are detailed in Table 4.7. The result of data collection can be seen in Appendix B.

Table 4.7 Data Collection Procedures

No	Surveys	Objectives	Output	Location Setting	Time
1.	Sidewalk geometric and environment	a. To measure sidewalk dimensions b. To identify sidewalk situation and circumstance	Sketch of sidewalks lay-out	Along study area	Before sidewalks activities are started
2.	Pedestrian volume count	To count the number of pedestrians passing the sidewalks in both direction	The number of pedestrians passing the sidewalk. Counting was in 5 minutes interval	In a point within 10 m segment observed in travel time survey.	10 am – 6 pm
3.	Pedestrian travel time	To measure pedestrian travel time to pass 10 m length of sidewalk	a. Several measurements of pedestrian travel time. b. Measurements are in 5 minutes interval c. To calculate pedestrian speed	In 10 m length segment of sidewalk within study area.	10 am – 6 pm
4.	Vendor's characteristic	a. To measure space/ dimension used by vendors in sidewalk b. To determine type of goods sold by vendors	a. Sketch of sidewalk completed with vendors situation b. To determine effective width	Similar to (3)	During and after vendors activities are started
5.	Interview	a. To identify pedestrian perceptions b. To identify pedestrian characteristics	Pedestrian's perceptions	Along study area but outside the (2), (3) and (4)	10 am – 6 pm
6.	Number of pedestrians stop at vendors	To count the number of pedestrians stop in vendors	The number of pedestrian stop in vendors. Measurement was in 5 minutes interval	Similar to (3)	10 am – 6 pm
7.	Number of pedestrians do not walk in sidewalk	To count the number of pedestrians do not walk in sidewalk	The number of pedestrian who not walk in sidewalk. Calculation is in 5 minutes interval	Similar to (3)	10 am – 6 pm

4.4 Descriptive of Questionnaires Data

4.4.1 Descriptive Statistics Bangkok and Jakarta Data

Table 4.8 elaborates the respondent's response on safety variables. It shows the percentage of seven-point Likert scale, mean, and standard deviation value for five safety statements. The respondents were asked to indicate "how safe" from vehicle traffic, trips, falls, slips, or physical attack when they were walking on the sidewalk.

The results from the survey showed that respondents in Bangkok moderately feel safe when walking on the sidewalk. The average score of five items is around 4.0. The distributions of the scores across five items are concentrated on 4 (neutral point), 3, and 5 categories. On the other hand, respondents in Jakarta have rather different feeling of safety. On the three first items, respondents expressed their slightly positive feeling on safety, providing an average score of items in range of 4.40 to 4.65 and distribution centered on 5 and 6. The score's distributions of the last two items concentrated mainly on 3 and 2 categories, indeed extremely negative score of the last item ("I think that the sidewalk is flat enough to accommodate wheelchair user") was quite high (17.4%). The mean value of the last item in Jakarta was considerable low compare to Bangkok (3.82 vs. 2.71). In fact, even sidewalks in Jakarta flat enough, but they are not continuous, so the discontinuity makes difficulties for disable person to access the sidewalk.

Table 4.8 Percentage, Mean, and Standard Deviation of Safety Perception

Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
	1	2	3	4	5	6	7		
Bangkok									
Q1_1	1.67	13.32	15.71	30.99	26.00	11.80	0.51	4.04	1.27
Q1_2	1.30	10.93	19.70	37.44	21.80	8.33	0.51	3.94	1.16
Q1_3	1.88	11.30	22.52	29.91	24.19	9.20	1.01	3.95	1.24
Q1_4	3.11	13.25	22.45	27.44	24.98	8.54	0.22	3.84	1.27
Q1_5	4.78	14.05	21.87	24.04	24.76	10.07	0.43	3.82	1.37
Jakarta									
Q1-1	1.91	17.40	8.03	7.46	17.59	46.85	0.76	4.65	1.63
Q1-2	0.38	15.68	10.71	7.84	25.43	38.05	1.91	4.64	1.52
Q1-3	3.25	18.16	12.43	7.46	20.27	36.71	1.72	4.40	1.68
Q1-4	2.29	32.70	20.46	5.93	21.41	16.83	0.38	3.63	1.58
Q1-5	17.40	46.46	15.11	1.72	7.84	11.09	0.38	2.71	1.57

Six items were designed to assess directly perception on feeling of comfort. These items reflected cleanness, obstructions, and feeling on vendors presence were presented in a scale from 1 to 7. Table 4.9 shows the full description of results. As showed in Table 4.9, people in Bangkok had moderate feeling of comfort, providing an average score of items in range of 3.88 to 4.10. The respondents who rated comfort when walking on the sidewalk as moderate and slightly positive feeling (score 4.0-5.0) were dominant, compromising more than a half of the sample. The sample showed only small proportion of respondents (less than 10 %) has strongly agree/disagree toward comfort feeling across six items. Respondents in Jakarta had negative feeling of comfort. It can be seen that the average score of items in the range of 3.16 to 4.03 as a result of more than half of respondents scored their comfort feeling mainly on 2.0 and 3.0 categories. Similar to Bangkok sample, only small proportion of respondents had strongly agree/disagree toward comfort feeling across six items. On item Q1-6 ("I think that the street vendors keep the sidewalk clean"), mean value of Jakarta was very low compare to Bangkok (3.16 vs. 4.10). Jakarta's respondents agreed that most of street vendor activities contributed to the feeling of sidewalk dirtiness. Because of low of law enforcement, vendors did not keep the cleanliness of the sidewalks during and after their activities.

Table 4.9 Percentage, Mean, and Standard Deviation of Comfort Perception

Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
	1	2	3	4	5	6	7		
Bangkok									
Q1_6	2.10	8.98	20.85	27.15	27.37	12.89	0.65	4.10	1.26
Q1_7	2.53	11.22	19.19	29.04	23.24	13.69	1.09	4.05	1.32
Q1_8	3.40	11.51	21.65	25.42	24.40	12.38	1.23	3.98	1.35
Q1_9	2.61	11.30	20.78	26.94	24.19	12.96	1.23	4.03	1.33
Q1_10	1.96	10.14	24.26	26.72	24.26	11.37	1.30	4.01	1.28
Q1_11	2.32	12.45	22.38	31.86	20.49	9.99	0.51	3.88	1.25
Jakarta									
Q1-6	4.40	35.37	30.40	8.41	13.38	7.27	0.76	3.16	1.38
Q1-7	4.40	29.83	25.43	13.00	17.40	9.18	0.76	3.40	1.45
Q1-8	1.53	16.83	26.77	11.85	18.55	23.14	1.15	4.03	1.52
Q1-9	3.06	34.80	27.34	10.71	13.77	9.56	0.76	3.29	1.42
Q1-10	2.87	36.33	30.21	8.80	12.43	8.60	0.76	3.20	1.39
Q1-11	3.63	31.93	25.81	9.18	13.19	15.68	0.57	3.46	1.54

Vendor's attraction is defined as the interaction between vendors and pedestrians when pedestrians are interest with vendor's activities, such as look around commodities sold by vendors. The concept was assessed by six items to measure pedestrian feeling in correlation with vendor activities along the sidewalk. The results of assessment are shown in Table 4.10. Respondents in Bangkok had moderate feeling of vendor activities, it can be seen that average score of items in range of 4.03 to 4.31 and the distribution of score center on neutral (4.0) point. On the other hand, respondents in Jakarta had positive feeling of vendor activities. The score across six items concentrated mainly on 5.0 and 6.0 point, as a result the average score of items fell in the range 3.91 to 5.01.

Table 4.10 Percentage, Mean, and Standard Deviation of Vendor Attraction Perception

Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
	1	2	3	4	5	6	7		
Bangkok									
Q1_12	1.23	11.22	17.81	31.35	25.63	11.66	1.09	4.08	1.25
Q1_13	1.16	11.59	19.91	31.21	24.11	10.64	1.38	4.03	1.25
Q1_14	1.38	10.50	20.20	30.56	24.11	11.88	1.38	4.07	1.26
Q1_15	1.30	8.83	18.32	30.20	23.75	15.35	2.24	4.21	1.29
Q1_16	1.09	7.24	18.75	29.25	23.10	17.16	3.40	4.31	1.30
Q1_17	0.80	7.75	21.22	28.39	24.48	14.34	3.04	4.23	1.28
Jakarta									
Q1_12	1.15	14.15	16.25	14.91	33.65	18.93	0.96	4.26	1.39
Q1_13	0.38	15.11	17.97	16.83	28.68	20.27	0.76	4.22	1.39
Q1_14	0.96	14.72	24.28	13.38	22.56	22.94	1.15	4.15	1.46
Q1_15	0.38	6.31	11.66	10.71	22.75	40.73	7.46	5.01	1.38
Q1_16	0.19	5.35	14.34	14.72	30.59	32.31	2.49	4.77	1.27
Q1_17	1.91	12.62	31.36	17.59	21.03	14.34	1.15	3.91	1.37

Movement easiness is defined as pedestrian feeling of easiness to walk, freely to choose their speed along the sidewalk. The construct was measured by five items. As listed in Table 4.11, the scores across five items were quite similar. Bangkok's samples show that score's distribution of five items concentrated mainly on neutral point (4.0), accounting for almost one-third of respondents. In Jakarta, more than a half of the respondents expressed their negative feeling. Most of the respondents scored their feeling on 2.0 and 3.0 point and resulted average of the score were on the range 3.59 to 3.90.

Table 4.11 Percentage, Mean, and Standard Deviation of Movement Easiness Perception

Item No.	Strongly disagree	⟶					Strongly agree	Mean	Std. Dev.
	1	2	3	4	5	6	7		
Bangkok									
Q1_18	3.26	10.14	18.90	28.75	25.63	12.24	1.09	4.04	1.32
Q1_19	3.33	10.28	20.78	29.69	24.84	10.14	0.94	3.97	1.29
Q1_20	3.11	11.08	19.48	30.70	22.45	12.60	0.58	3.98	1.30
Q1_21	2.97	11.37	20.20	28.46	24.48	11.88	0.65	3.98	1.31
Q1_22	1.81	10.21	20.35	29.98	23.97	12.67	1.01	4.06	1.27
Jakarta									
Q1_18	1.72	25.43	25.05	12.05	19.50	15.11	1.15	3.72	1.50
Q1_19	4.78	27.72	17.97	9.94	18.36	19.69	1.53	3.75	1.66
Q1_20	1.72	16.83	38.05	12.62	18.36	10.52	1.91	3.68	1.37
Q1_21	2.49	21.03	33.46	12.62	18.93	10.90	0.57	3.59	1.38
Q1_22	0.96	24.47	20.08	16.25	14.91	22.75	0.57	3.90	1.54

Pedestrian feelings of sidewalk performance were assessed by five items that were regarded to accessibility of sidewalk, obstructions, and overall serviceability to the walker. Table 4.12 presents full description of the assessment. As the results shown, the results from the survey in Bangkok showed that people in the area were moderately in sidewalk serviceability feeling. The average score of five items were around 4.0. The distributions of the scores across five items were concentrated on 4.0 (neutral point), 3.0, and 5.0 categories. Results from survey in Jakarta showed that respondents had positive feeling of sidewalk performance. The average score were in the range 4.04 to 4.77 as a result of more than a half of respondents scored their positive feeling of sidewalk performance on 5 and 6 point.

Table 4.12 Percentage, Mean, and Standard Deviation of Sidewalk Performance

Item No.	Strongly disagree →					Strongly agree		Mean	Std. Dev.
	1	2	3	4	5	6	7		
Bangkok									
Q1_23	1.88	10.86	20.35	29.04	26.86	10.35	0.65	4.02	1.24
Q1_24	3.19	12.74	20.56	28.67	21.29	10.93	2.61	3.95	1.37
Q1_25	2.03	9.34	18.46	29.98	26.72	11.22	2.24	4.13	1.28
Q1_26	2.03	10.14	20.71	33.02	24.19	8.04	1.88	3.99	1.24
Q1_27	3.11	16.22	19.99	30.92	19.04	8.25	2.46	3.81	1.36
Jakarta									
Q1_23	1.72	8.99	22.56	9.18	27.34	28.68	1.53	4.44	1.45
Q1_24	1.53	8.60	14.15	6.88	27.15	39.01	2.68	4.77	1.45
Q1_25	4.02	9.37	10.13	7.46	32.31	34.61	2.10	4.67	1.51
Q1_26	1.72	18.36	21.99	11.85	25.81	19.12	1.15	4.04	1.50
Q1_27	1.53	11.85	16.25	9.75	22.94	30.78	6.88	4.61	1.58

Six items were developed in order to measure pedestrian feeling on pedestrian traffic and sidewalk geometry condition. These items reflected pedestrian volume condition, delay faced by walker, and sidewalk geometry to accommodate vendor and walker. As shown in Table 4.13, respondents in Bangkok had moderate feeling of traffic and geometry, providing an average score of items in range of 3.46 to 4.67. The respondents who rated traffic and geometry condition when walking on the sidewalk as moderate and slightly positive/negative feeling (score 3-5) were dominant, more than two-third of the sample. The sample showed only small proportion of respondents (less than 10 %) had strongly agree/disagree toward traffic and geometry feeling across six items. In Jakarta, respondents had rather different on traffic and geometry feeling. On the two first items, respondents expressed their slightly negative feeling of traffic, providing an average score of items in the range 3.32 to 3.75. Next two items, the range of average score was 4.63 to 4.88 that refer the slightly positive feeling of respondents. Extremely negative feeling on geometry could be seen on item Q2-5 ("I think pedestrian with visual impairment can walk this sidewalk easily") that more than a half of respondents score were on 1 and 2 point.

Bangkok respondents expressed their slightly negative feeling on item Q2-5, but Jakarta respondents felt that person with visual impairment would face difficulties to pass the sidewalk (mean value 3.46 vs. 2.20). Most of sidewalks in Bangkok were completed with special texture in the surface along the sidewalk as guidance for people with visual impairment. Such tools provided in Jakarta, but pedestrian with disabilities found difficulties to pass discontinuity sidewalk and improper display of vendor commodities.

Table 4.13 Percentage, Mean, and Standard Deviation of Traffic and Geometry

Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
	1	2	3	4	5	6	7		
Bangkok									
Q2_1	2.10	17.23	11.51	35.41	19.33	13.54	0.87	3.97	1.34
Q2_2	1.74	6.08	25.63	31.86	25.78	8.04	0.87	4.01	1.15
Q2_3	0.65	10.57	14.63	31.64	28.46	11.15	2.90	4.22	1.25
Q2_4	1.67	6.95	21.43	27.81	25.71	12.60	3.84	4.22	1.30
Q2_5	16.80	17.09	13.47	20.42	21.29	10.43	0.51	3.46	1.65
Q2_6	0.87	3.04	8.04	30.56	33.74	20.93	2.82	4.67	1.12
Jakarta									
Q2_1	5.74	23.52	30.40	20.65	13.77	4.78	1.15	3.32	1.32
Q2_2	1.72	16.44	28.68	24.09	18.55	8.60	1.91	3.75	1.32
Q2_3	0.96	5.74	12.81	12.05	48.18	19.31	0.96	4.63	1.18
Q2_4	1.15	10.33	8.80	6.69	28.49	41.11	3.44	4.88	1.44
Q2_5	30.21	45.51	11.85	3.82	4.02	4.40	0.19	2.20	1.28
Q2_6	0.96	8.60	10.52	7.27	18.74	48.37	5.54	5.02	1.46

Twelve items were designed to assess directly perception on pedestrian behavior relating to existence of vendor activities. The respondents were asked to indicate their willingness to interact with vendor, their anticipation from problems may arise caused by vendor activities, and what of their opinion regarding vendor regulation. The result from the survey, as can be seen in Table 4.14, shows that respondents in Bangkok and Jakarta were moderately and slightly positive in behavior on presence of vendors feeling when walking on the sidewalk. In Bangkok, distributions of the scores across twelve items were concentrated on 4.0 (neutral point) and 5.0 categories. The average score of twelve items were in the range 3.83 to 4.50. Distributions of the scores in Jakarta were dispersed on 2, 5, and 6 point and the average score range is between 3.51 and 5.23.

Table 4.14 Percentage, Mean, and Standard Deviation of Behavior

Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
	1	2	3	4	5	6	7		
Bangkok									
Q2_7	0.72	4.13	12.31	32.87	34.18	14.55	1.23	4.44	1.09
Q2_8	0.87	5.50	15.57	29.04	32.30	15.13	1.59	4.38	1.18
Q2_9	0.65	7.60	15.28	23.46	28.82	20.20	3.98	4.49	1.32
Q2_10	0.87	6.66	16.08	24.19	27.59	18.97	5.65	4.50	1.34
Q2_11	5.87	11.59	16.36	23.10	26.43	15.28	1.38	4.04	1.47
Q2_12	5.72	13.11	17.74	24.84	23.82	13.76	1.01	3.93	1.45
Q2_13	1.16	10.43	16.58	28.67	28.75	13.40	1.01	4.18	1.25
Q2_14	1.30	6.66	18.61	27.73	31.06	13.76	0.87	4.25	1.20
Q2_15	1.52	7.89	15.57	31.21	28.39	14.41	1.01	4.24	1.23
Q2_16	1.30	6.95	16.29	30.27	28.82	15.28	1.09	4.29	1.21
Q2_17	4.06	18.83	17.16	25.05	20.78	13.03	1.09	3.83	1.45
Q2_18	4.34	15.93	17.67	26.57	20.85	12.53	2.10	3.90	1.45
Jakarta									
Q2_7	0.38	9.94	7.84	7.07	38.43	34.99	1.15	4.84	1.32
Q2_8	0.57	12.24	19.12	14.53	31.36	20.84	1.34	4.32	1.38
Q2_9	0.19	4.21	10.33	9.94	31.55	39.39	4.40	5.04	1.22
Q2_10	0.76	14.15	19.69	8.22	18.93	36.71	1.53	4.47	1.55
Q2_11	4.02	28.30	15.87	6.31	20.46	24.47	0.57	3.87	1.70
Q2_12	3.82	31.17	19.69	13.38	19.89	11.09	0.96	3.51	1.51
Q2_13	3.06	16.63	23.71	19.31	20.84	16.06	0.19	3.88	1.44
Q2_14	0.76	16.06	14.72	13.38	35.37	18.36	1.34	4.27	1.41
Q2_15	1.15	22.75	17.40	16.25	23.14	18.74	0.57	3.96	1.49
Q2_16	1.72	20.46	24.09	15.68	21.41	15.49	1.15	3.86	1.46
Q2_17	1.91	11.47	17.59	28.49	18.93	16.63	4.97	4.21	1.44
Q2_18	0.19	4.40	5.35	18.93	15.11	45.32	10.71	5.23	1.29

4.4.2 Summary of Respondent's Characteristics

Table 4.15, Table 4.16 and Figure 4.8 through Figure 4.10 summarize respondent's characteristics obtained from main data collections in Bangkok and

Jakarta. Pearson chi-square statistic was used to test whether the sample profile in two cities are different. Statistical differences were found for all attributes at 95 percent confidence, indicating that the characteristics of the respondents in two cities are quite different.

From Table 4.15, the proportion of female respondents was larger than male in Bangkok (57.0% vs. 43.0%), whereas proportion of male respondents was larger than female in Jakarta (69.4% vs. 30.6%). The majority of age of the respondents in Bangkok and Jakarta was in the range 19 to 30 years (44.9% vs. 44.6%), followed by 31 to 60 years (35.4% vs. 41.2%).

Table 4.15 Respondent’s Profile

Attributes	Parameters	Bangkok n = 1381	Jakarta n = 523
Gender	n	1378	520
	Male	43.0%	69.4%
	Female	57.0%	30.6%
Age	n	1369	522
	Average	32.0	30.3
	Min	8	9
	Max	88	70
	≤ 18	14.8%	12.8%
	19-30	44.9%	44.6%
	31-60	35.4%	41.2%
	≥61	4.9%	1.3%

Figure 4.7 through Figure 4.9 show respondent’s socioeconomic characteristics. Figure 4.7 presents the distribution of the monthly income. It can be seen that the proportion of the lowest grade of income was dominant in both cities. In terms of education, Figure 4.8 shows the majority of respondents in Bangkok had undergraduate level (52.4%), whereas those in Jakarta were dominated by high school level (51.2%). Figure 4.9 shows occupation of the respondents. It can be seen that most of the respondents in both cities were workers in private offices, factories, or government (35.2% vs. 42.2%), followed by students (31.5% vs. 23.7%).

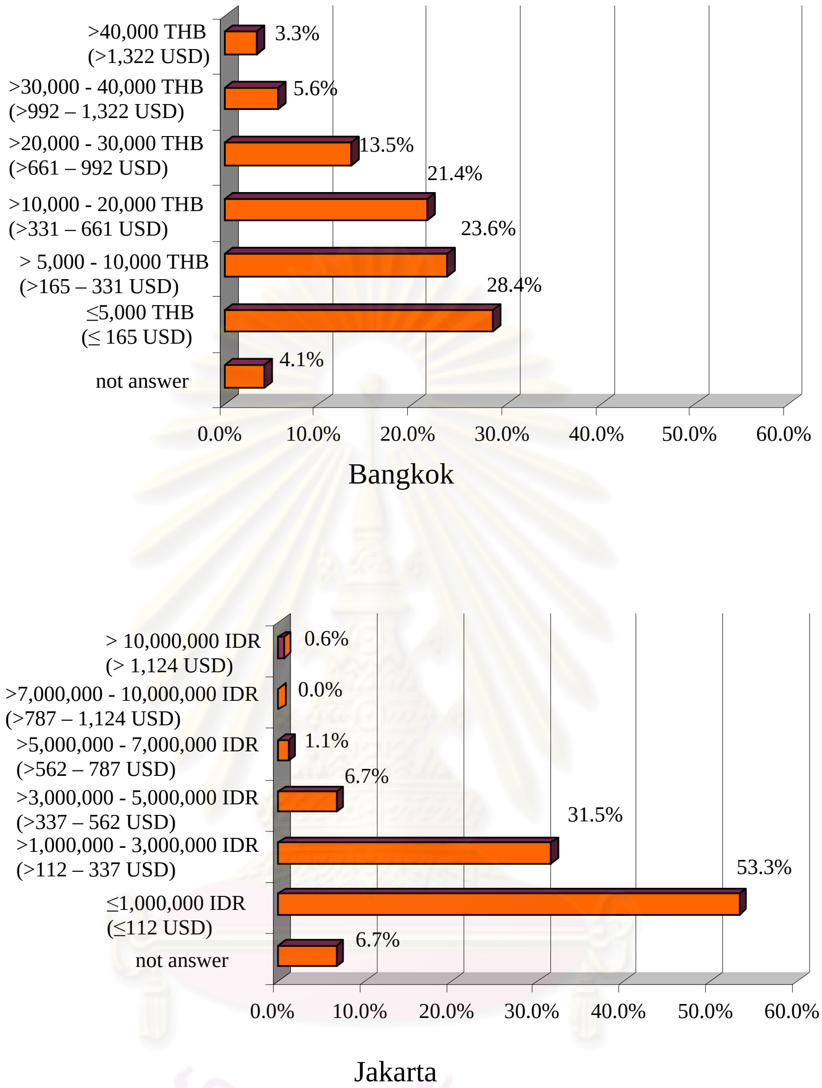

Figure 4.7 Summary of Monthly Income

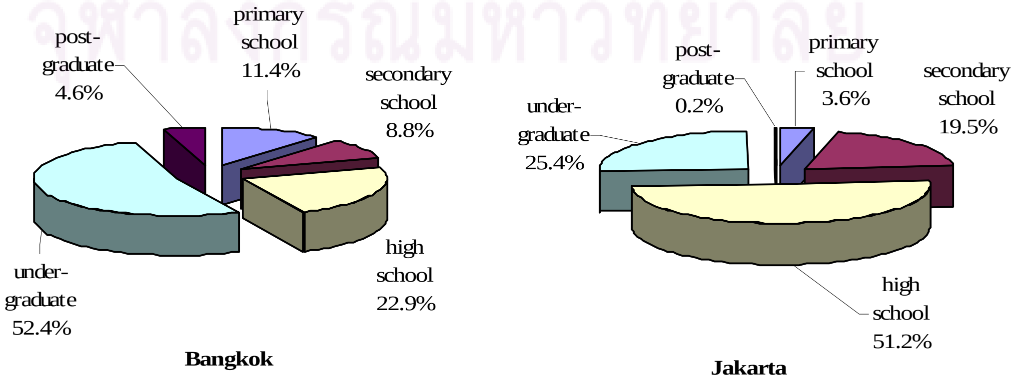

Figure 4.8 Summary of Education

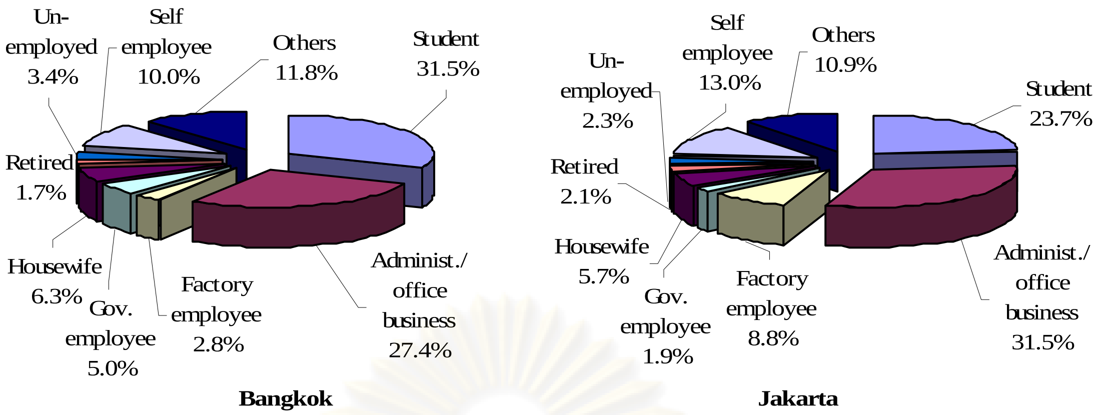

Figure 4.9 Summary of Occupation

Table 4.16 and Figure 4.10 summarize the trip characteristics obtained from the survey. Table 4.16 summarizes that daily walker was dominant for walking frequency on the observed sidewalk in both Bangkok and Jakarta (52.4% vs. 57.4%), presumably the commuters. The next high of walking frequency proportion was rarely (36.4% vs. 30.2%). Regarding pedestrians walk in a group or not, most of the walkers walked without group, which was recorded 59.7% and 57.5% for Bangkok and Jakarta, respectively; followed by walking in 2 persons group (26.0% vs. 18.1%).

From Figure 4.10, the majority of the trip purpose of the respondents was "go to/from work", which accounted for 31.5% for Bangkok and 40.9% for Jakarta; and followed by "shopping" with the proportion 26.8% and 17.6% for Bangkok and Jakarta, respectively.

Table 4.16 Respondent's Trip Characteristics

Attributes	Parameters	Bangkok n = 1381	Jakarta n = 523
Walking frequency	n	1352	486
	rarely	36.4%	30.2%
	1/week	0.9%	0.0%
	2/week	3.9%	2.1%
	3/week	3.8%	3.7%
	4/week	1.5%	2.3%
	5/week	1.0%	4.3%
	6/week	0.1%	0.0%
	daily	52.4%	57.4%
Walking in group	n	1331	513
	alone	59.7%	57.5%
	2 people/group	26.0%	18.1%
	3 people/group	8.6%	12.5%
	>3 people/group	5.6%	11.9%

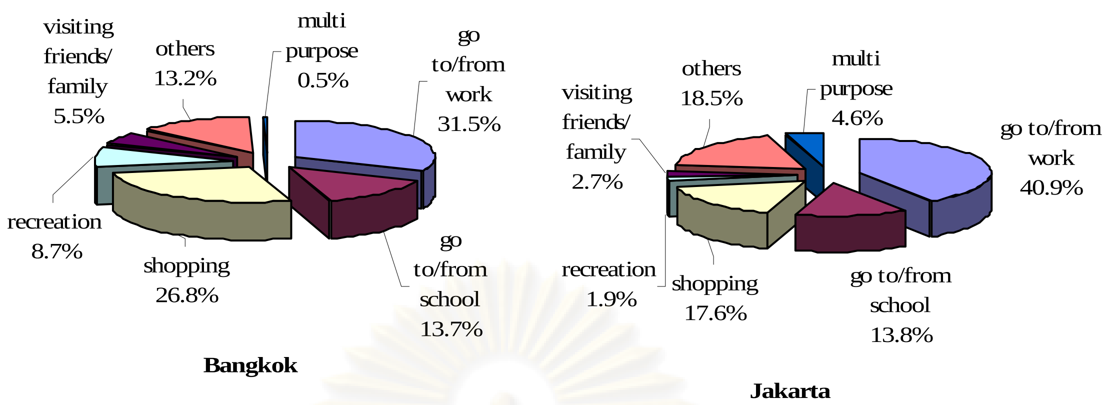

Figure 4.10 Summary of Trip Purpose

4.4.3 Respondent's Profile Differences in Sidewalk Perception

The participants were asked to indicate their perceptions regarding sidewalk condition using 47 statements in the questionnaire. For each indicator, respondents were asked to rate their agreement. Pearson chi-square analyses were used to test whether the sample profile were different in gender, age, walking frequency, and cities. For the analyses, age were categorized as young (≤ 30 years) and old (31 years and above), whereas walking frequency were categorized into two groups as daily (daily to one time per week frequency) and rarely. Table 4.17 and Table 4.18 show the results of χ^2-test of the data samples.

Table 4.17 elaborates result of chi-square test of the samples by cities, gender, age, and walking frequency. There were reported significantly differences of respondents in the group of city, age, and walking frequency; whereas reported no significant differences in gender.

Table 4.18 presents the following sample characteristics by cities: gender, age, and walking frequency. The observed frequencies of the age could be concluded that there was no evidence that categorization samples by age would establish different results between Bangkok and Jakarta. However, categorization the samples by gender and walking frequency would make different result between Bangkok and Jakarta.

Table 4.17 Respondent's Profile Differences

Items		N	χ^2	df	α
Cities		1861	365.700	1	.000
	Bangkok	1343			
	Jakarta	518			
Gender		1861	0.336	1	.562
	Male	943			
	Female	918			
Age		1861	61.026	1	.000
	Young	1099			
	Old	762			
Walking frequency		1861	194.090	1	.000
	Daily	1231			
	Rarely	630			

Table 4.18 Cities Differences in Demographics (n = 1861)

Items		Bangkok	Jakarta	χ^2	df	α
Gender	• Male	585 (31.4%)	359 (19.3%	99.706	1	.000
	• Femal	759 (40.8%)	159 (8.5%)			
Age	• Youn	803 (43.1%)	296 (15.9%)	1.085	1	.298
	• Old	540 (29.0%)	222 (11.9%)			
Walking Frequency	• Daily	858 (46.1%)	373 (20.0%)	11.009	1	.001
	• Rarely	485 (26.1%)	145 (7.8%)			

Chapter V
Development of Sidewalk Performance Model

5.1 Important Factors Affecting Walking

This study was started with the investigation of important factors relating sidewalk performance based on pedestrian perceptions. Exploratory factor analysis technique and reliability test of the variables were performed in the first step of the study. Factor loadings of variables were extracted in relationship with factors, and then Cronbach's alphas were calculated for the most reliable variables. The factor loadings and Cronbach'a alpha were used to indicate the suitability of the variables in describing the factors selected. Those variables with low factor loadings or have cross-loadings on other factors should be eliminated (Hair et al., 2006).

5.1.1 Important Factors for Bangkok based on Pedestrian Perceptions

5.1.1.1 Factor Analysis of Bangkok Data

The factor analysis (FA) and reliability test were conducted firstly for the variables within the factor. The appropriateness of conducting FA procedure was checked by a number of methods such as Bartlett test for presence of nonzero correlations, or test of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO-MSA) (Hair et al., 2006).

The exploratory factor analysis was employed on the 45 items of sidewalk current conditions (Parts 1 and 2 of the questionnaire) in order to extract dimensions of pedestrian perceptions. The KMO test resulted in a value of 0.913, which was greater than 0.5, so the factor analysis was justified (Field, 2005; Hair et al., 2006). The result also indicated that Bartlett test was significant at 0.001. Using the method of principal component extraction with VARIMAX rotation, eight factors were identified as important and labeled on the basis of the attributed covered (see Table 5.1). Variables with a factor loading greater than 0.5, were chosen (Hair et al., 2006). Therefore, nine items with a factor loading less than 0.5 had been eliminated -

namely, Q2-10, Q2-5, Q2-2, Q2-9, Q2-8, Q2-4, Q2-3, Q2-7, and Q2-6. The eight factors explained 62.393% of total variance. Inspection of the output confirms that the eight-factor structures made conceptual sense and that each factor accounted for a substantial portion of the overall variance.

The resulting factor structures are presented in Table 5.1. These eight factors are arbitrarily named as **comfort**, **vendor's attraction**, **vendor problems**, **safety**, **vendor regulation**, **sidewalk interaction**, **space availability**, and **sidewalk condition**. A factor analysis for the dimensions involves 36 variables, in which eight variables are regarded to comfort, seven variables are categorized as sidewalk interaction, six variables are grouped as space availability, four items are grouped as sidewalk condition, two variables are classified as vendor regulation, and three variables each for factors of vendor's attraction, vendor problems, and safety. Factor loadings of variables, explained variance and Cronbach's alpha of the factors are summarized in Table 5.1.

Factor 1, labeled '**comfort'**, comprises eight items and covers 27.609% of the total variance. This factor refers to the existence of obstructions along the sidewalk, such as physical features, vendors and other pedestrian obstructions. In addition, the available sidewalk width can accommodate walking and vendor activities. Also, sidewalks cleanliness increases comfortable feelings. Factor 2, labeled '**vendor's attraction**', comprises three items and accounts for 4.588% of the total variance. This factor refers to the existence of street vendors along the sidewalks, and pedestrian intention to look around and to buy something on street vendor's commodities. Factor 3, named '**vendor problems**', contains three items and accounts for 3.603% of the total variance. This factor refers to some problems that may arise because of street vendor activities on the sidewalk. Factor 4, named '**safety**', includes three items and covers 3.265% of the total variance. This factor includes items that assess pedestrian perceptions regarding vehicle traffic danger, sidewalk surface conditions, and the possibility of criminal activities. Factor 5, called '**vendor regulation**', comprises two items and accounts for 2.982% of the total variance. This factor contains items of pedestrian perception on vendor regulation and its reinforcement. Factor 6, named '**sidewalk interaction**', includes seven items and account 10.471% of the total variance. This factor refers to pedestrian behavior when they face vendor activities at the sidewalk. Factor 7 labeled '**space availability**', includes six items and covered 5.788% of the total variance. This factor refers to space availability for walking movement. Factor 8, named '**sidewalk condition**, comprises four items and accounts for 4.087% of the total variance. Basically, this factor includes items that assess pedestrian perception about easiness to access public transport, availability of sidewalk width, and sidewalk performance.

Table 5.1 Factor Loading, Explained Variance, and Cronbach's Alpha of Bangkok Data

Variables		Factor 1 (Comfort)	Factor 2 (Vendor attraction)	Factor 3 (Vendor problems)	Factor 4 (Safety)
Q1-8	I am not impeded by other pedestrians	0.750			
Q1-9	I can move freely without obstruction from vendors	0.736			
Q1-7	I can move freely without obstruction from physically features (phone boxes, column, bench, etc)	0.686			
Q1-10	I have enough space to avoid the vendor's obstruction without decelerating my pace	0.684			
Q1-5	I think that the sidewalk is flat enough to accommodate wheelchair users	0.673			
Q1-4	I think that the available sidewalk width can accommodate pedestrian flow	0.649			
Q1-6	I think that the street vendors keep the sidewalk clean	0.642			
Q1-11	I feel comfortable walking through this sidewalk with the presence of on street vendors	0.537			
Q1-13	I intend to buy something from street vendors		0.778		
Q1-12	I am interested in goods sold by vendors along this sidewalk		0.743		
Q1-14	I enjoy vendor activities in this sidewalk		0.701		
Q1-17	I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded			0.793	
Q1-16	I think that too many buyers cause this sidewalk crowded			0.784	
Q1-15	I think that too many street vendors occupy this sidewalk			0.642	
Q1-2	I feel safe from trips, slips and falls				0.830
Q1-1	I feel safe from vehicle traffic danger				0.826
Q1-3	I feel safe from intimidation or physical attack				0.592
Cronbach's alpha		0.874	0.814	0.766	0.724
Variance explained (%)		27.609	4.588	3.603	3.265
Cumulative variance explained (%)		27.609	32.197	35.800	39.065
MSA = 0.913; Bartlett test < 0.001					

Table 5.1. Factor Loading, Explained Variance, and Cronbach's Alpha of Bangkok Dataset (continued)

Variables		Factor 5 (Vendor regulation)	Factor 6 (Sidewalk interaction)	Factor 7 (Space availability)	Factor 8 (Sidewalk condition)
Q2-18	I think the regulation of vendors along the sidewalk is not that strict	0.816			
Q2-17	I feel that the government should ban the vendors along the sidewalk	0.792			
Q2-14	On street vendors make me easy to buy something		0.763		
Q2-15	I love shopping along sidewalk		0.742		
Q2-13	I will walk along this sidewalk only for shopping		0.730		
Q2-16	My friends or my relatives like to walk along this sidewalk		0.688		
Q2-12	In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk		0.640		
Q2-11	I will still walk on the roadway (pavement) even when the sidewalk is very crowded		0.590		
Q2-1	I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors		0.532		
Q1-21	I can overtake other pedestrians easily			0.762	
Q1-20	I can choose my walking speed freely			0.735	
Q1-22	At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway			0.684	
Q1-19	I think that the total width of sidewalk is wide enough			0.652	
Q1-23	I think that I can enter/exit to/from this sidewalk easily			0.620	
Q1-18	I think that vendor's displays do not obstruct pedestrian movements			0.528	
Q1-27	From my opinion, this sidewalk is bad for pedestrians				0.776
Q1-26	I don't mind delays as long as I am comfortable				0.627
Q1-24	I can not walk side by side with my friend because the sidewalk width is too narrow				0.541
Q1-25	If I want to access public transport, it is easy to find bus stop/BTS Station in this sidewalk				0.518
Cronbach's alpha		0.846	0.840	0.849	0.718
Variance explained (%)		2.982	10.471	5.788	4.087
Cumulative variance explained (%)		42.047	52.518	58.306	62.393
MSA = 0.913; Bartlett test < 0.001					

5.1.1.2 Reliability Test of Bangkok Data

Reliability test was used to measure the consistency of a questionnaire. The internal consistency was examined to ensure at a certain level that the scale (1–7) for measuring the relative significance of the questionnaire would get the same result over time. Cronbach's alpha test was performed to test the internal consistency of the scale and value greater than 0.7 indicated an acceptable value (Field, 2005). Table 5.1 presents the result of Cronbach's alpha test. It can be observed that all values are greater than 0.7, indicating acceptable and good internal consistency and reliability of the questionnaire.

5.1.2 Important Factor for Jakarta based on Pedestrian Perceptions

5.1.2.1 Factor Analysis of Jakarta Data

The exploratory factor analysis with a VARIMAX rotation was conducted on the 45 items. Table 5.2 presents the summary of exploratory factor analysis and reliability test of Jakarta sample. It can be seen that the KMO-MSA test results in a value of 0.874, which was greater than 0.5, and the Bartlett test resulted in a value <0.001. This indicates that the factor analysis procedure was justified. Inspection of the scree plots and the eigenvalues initially suggested a six-factor solution. Items that have communalities below 0.50 or did not have loadings factor of at least 0.50 on any scale were dropped individually from the data set, until a final solution was achieved (Hair et al., 2006). Therefore, seventeen items had been eliminated.

The proposed solution has six factors, and is accounted for 64.925% of the total variance. Inspection of the output confirms that the six-factor structures made conceptual sense and that each factor accounted for a substantial portion of the overall variance. The resulting factor structure is presented in Table 5.2. The six factors were arbitrarily named as **comfort**, **vendor's attraction**, **vendor problems**, **safety**, **vendor regulation,** and **walking path**. Factor 1, **comfort** (8 items, variance = 10.308%), refers to walking comfort, which is related to the impact of obstructions and the available space for walking, minimize obstructions at the sidewalk, such as physical features, vendors and other pedestrians obstructions. Factor 2, **vendor's attraction** (9 items, variance = 30.535%), refers to street vendors existence in the sidewalks, intention to look around and buy something on street vendor's commodities. Factor 3, **vendor problems** (3 items, variance = 5.709%), comprises any matters arising from street vendor activities. Factor 4, **safety** (3 items, variance = 7.908%), includes items that assess pedestrian perceptions regarding vehicle traffic danger, sidewalk surface conditions, and crime attacking. Factor 5, **vendor regulation** (2 items, variance =

4.153%), refers to pedestrian perception when vendors are prohibited. Factor 6, **walking path** (3 items, variance = 6.312%), refers to pedestrian perception for choosing walking path when sidewalk is crowded as a result of vendor activities.

Table 5.2 Factor Loading, Explained Variance, and Cronbach's Alpha of Jakarta Data

Variables		Factor 1 (Comfort)	Factor 2 (Vendor attraction)	Factor 3 (Vendor problems)
Q1-19	I think that the total width of sidewalk is wide enough	0.748		
Q1-4	I think that the available sidewalk width can accommodate pedestrian flow	0.723		
Q1-20	I can choose my walking speed freely	0.709		
Q1-21	I can overtake other pedestrians easily	0.689		
Q1-10	I have enough space to avoid the vendor's obstruction without decelerating my pace	0.686		
Q1-9	I can move freely without obstruction from vendors	0.673		
Q1-7	I can move freely without obstruction from physically features (phone boxes, column, bench, etc)	0.663		
Q1-8	I am not impeded by other pedestrians	0.660		
Q2-8	I want to look around commodities sold by vendors		0.824	
Q1-13	I intend to buy something from street vendors		0.812	
Q2-15	I love shopping along sidewalk		0.793	
Q1-12	I am interested in goods sold by vendors along this sidewalk		0.773	
Q2-14	On street vendors make me easy to buy something		0.749	
Q2-13	On street vendors make me easy to buy something		0.741	
Q1-14	I enjoy vendor activities in this sidewalk		0.727	
Q1-26	I don't mind delays as long as I am comfortable		0.702	
Q2-16	My friends or my relatives like to walk along this sidewalk		0.698	
Q1-17	I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded			0.709
Q1-16	I think that too many buyers cause this sidewalk crowded			0.668
Q1-15	I think that too many street vendors occupy this sidewalk			0.567
Cronbach's alpha		0.866	0.928	0.562
Variance explained (%)		10.308	30.535	5.709
Cumulative variance explained (%)		10.308	40.843	46.552
MSA = 0.874; Bartlett test < 0.001				

Table 5.2 Factor Loading, Explained Variance, and Cronbach's Alpha of Jakarta Data (Continued)

Variables		Factor 4 (Safety)	Factor 5 (Vendor regulation)	Factor 6 (Walking path)
Q1-2	I feel safe from trips, slips and falls	0.885		
Q1-1	I feel safe from vehicle traffic danger	0.863		
Q1-3	I feel safe from intimidation or physical attack	0.835		
Q2-2	I think if the vendors is prohibited, the volume of pedestrians will be higher		0.802	
Q2-17	I feel that the government should ban the vendors along the sidewalk		0.755	
Q2-11	I will still walk on the roadway (pavement) even when the sidewalk is very crowded			-0.81
Q2-10	I should walk in the sidewalk although the sidewalk is crowded by vendors			0.772
Q2-12	In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk			-0.756
Cronbach's alpha		0.887	0.618	0.778
Variance explained (%)		7.908	4.153	6.312
Cumulative variance explained (%)		54.46	58.613	64.925
MSA = 0.874; Bartlett test < 0.001				

5.1.2.2 Reliability Test of Jakarta Data

Reliability test was used to measure the consistency of a questionnaire. The internal consistency was examined to ensure at a certain level that the scale (1–7) for measuring the relative significance of the questionnaire would get the same result over time. Cronbach's alpha test was performed to investigate the internal consistency of the scale and value greater than 0.7 indicated an acceptable value (Field, 2005). The last part of Table 5.2 presents the result of Cronbach's alpha test. It can be seen that alpha value of four factors are greater than 0.7, indicating acceptable and good internal consistency and reliability of questionnaire. The alpha value of '**vendor problems**' and '**vendor regulation**' are considered within the acceptable range (α = 0.6) though it quite low (George and Mallery, 2010; Gliem and Gliem, 2003; Hair et al., 2006; Zhang, 2006).

5.1.3 Important Factors Based on Respondent's Characteristics

5.1.3.1 Important Factors Based on Gender

The KMO test resulted in a value of 0.855 (male) and 0.875 (female), which was greater than 0.5. The result also indicated that Bartlett test was significant at

0.001. Using the method of principal component extraction with VARIMAX rotation, eight (male) and seven (female) factors were identified as important and labeled on the basis of the attributed covered (see Table 5.3). Variables with a factor loading greater than 0.5, were chosen (Hair et al., 2006). These factors were arbitrarily named as **sidewalk interaction**, **comfort**, **space availability**, **safety**, **vendor problems**, **walking path**, **vendor regulation**, and **vendor's attraction**. Factor loadings of variables, explained variance and Cronbach's alpha of the factors are summarized in Table 5.3.

Factor 1, named '**sidewalk interaction**', refers to pedestrian's intention when they face vendor activities at the sidewalk and their feelings on vendor presence. Factor 2, labeled '**comfort'**, refers to the existence of obstructions along the sidewalk, such as physical features, vendors and other pedestrian obstructions. In addition, the available sidewalk width can accommodate walking and vendor activities. Also, sidewalks cleanliness increases comfortable feelings. Factor 3, called '**space availability**', indicates movement easiness, sidewalk accessibility and space availability for walking movement. Factor 4, named '**safety**', includes items that assess pedestrian perceptions regarding vehicle traffic danger, sidewalk surface conditions, and the possibility of criminal activities. Factor 5, named '**vendor problems**', implies some problems that may arise because of street vendor activities on the sidewalk. Factor 6, called '**walking path**', implies pedestrian's choice of walking path when the sidewalk is crowded. Factor 7, labeled '**vendor regulation**', contains items of pedestrian perceptions on regulation and the enforcement. Factor 8 (arise for male only), labeled '**vendor's attraction**', refers to the existence of street vendors along the sidewalks, and pedestrian intention to look around and to buy something on street vendor's commodities.

Table 5.3 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Gender

Variables	Male KMO-MSA: 0.855; Bartlett test: <0.001			Female KMO-MSA: 0.875; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 1: Sidewalk interaction (FA-1)		***23.834***	***0.844***		***11.215***	***0.846***
Q2-15 I love shopping along sidewalk	0.764			0.782		
Q2-13 I will walk along this sidewalk only for shopping	0.763			0.677		
Q2-14 On street vendors make me easy to buy something	0.729			0.783		
Q2-16 My friends or my relatives like to walk along this sidewalk	0.708			0.747		
Q2-8 I want to look around commodities sold by vendors	0.644			0.552		
Q2-1 I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors	0.549					
Q1-13 I intend to buy something from street vendors				0.586		
Q1-12 I am interested in goods sold by vendors along this sidewalk				0.567		
Factor 2: Comfort (FA-2)		***10.725***	***0.819***		***26.706***	***0.861***
Q1-10 I have enough space to avoid the vendor's obstruction without decelerating my pace	0.713			0.657		
Q1-9 I can move freely without obstruction from vendors	0.713			0.736		
Q1-6 I think that the street vendors keep the sidewalk clean	0.700			0.693		
Q1-7 I can move freely without obstruction from physically features (phone boxes, column, bench, etc)	0.673			0.700		
Q1-8 I am not impeded by other pedestrians	0.615			0.698		
Q1-5 I think that the sidewalk is flat enough to accommodate wheelchair users	0.571			0.692		
Q1-4 I think that the available sidewalk width can accommodate pedestrian flow				0.598		

Table 5.3 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Gender (continued)

Variables	Male KMO-MSA: 0.855; Bartlett test: <0.001			Female KMO-MSA: 0.875; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 3: Space Availability (FA-3)		***7.321***	***0.797***		***6.553***	***0.837***
Q1-22 At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway	0.756			0.739		
Q1-21 I can overtake other pedestrians easily	0.664			0.752		
Q1-23 I think that I can enter/exit to/from this sidewalk easily	0.663			0.700		
Q1-19 I think that the total width of sidewalk is wide enough	0.615			0.660		
Q1-20 I can choose my walking speed freely	0.597			0.722		
Factor 4: Safety (FA-4)		***6.902***	***0.832***		***6.118***	***0.767***
Q1-2 I feel safe from trips, slips and falls	0.889			0.827		
Q1-1 I feel safe from vehicle traffic danger	0.845			0.834		
Q1-3 I feel safe from intimidation or physical attack	0.794			0.646		
Factor 5: Vendor Problems (FA-5)		***4.519***	***0.698***		***5.350***	***0.706***
Q1-17 I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded	0.785			0.599		
Q1-16 I think that too many buyers cause this sidewalk crowded	0.770			0.836		
Q1-15 I think that too many street vendors occupy this sidewalk	0.705			0.810		
Factor 6: Walking Path (FA-6)		***4.026***	***0.739***		***3.621***	***0.769***
Q2-12 In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk	0.867			0.817		
Q2-11 I will still walk on the roadway (pavement) even when the sidewalk is very crowded	0.845			0.796		

Table 5.3 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Gender (continued)

Variables	Male KMO-MSA: 0.855; Bartlett test: <0.001			Female KMO-MSA: 0.875; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 7: Vendor Regulation (FA-7)		***3.544***	***0.690***		***4.300***	***0.840***
Q2-18 I think the regulation of vendors along the sidewalk is not that strict	0.789			0.861		
Q2-17 I feel that the government should ban the vendors along the sidewalk	0.781			0.882		
Factor 8: Vendor's Attraction (FA-8)		***5.255***	***0.849***			
Q1-13 I intend to buy something from street vendors	0.833					
Q1-12 I am interested in goods sold by vendors along this sidewalk	0.795					
Q1-14 I enjoy vendor activities in this sidewalk	0.704					

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5.1.3.2 Important Factors Based on Age

Table 5.4 presents the summary the results of exploratory factor analysis and reliability test based on respondent's age. Note that respondent's ages were divided into two groups, namely, young (≤ 30 years) and old (> 30 years). It can be seen that the KMO-MSA test resulted in a value of 0.865 (young) and 0.883 (old), which was greater than 0.5, and the Bartlett test resulted in a value <0.001. This indicated that the factor analysis procedure was justified.

The proposed solution has nine (young) and seven (old) factors. Inspection of the output confirms that the factor structures make conceptual sense and that each factor accounts for a substantial portion of the overall variance. The resulting factor structure is presented in Table 5.4. The factors are arbitrarily named as **comfort**, **sidewalk interaction**, **safety, vendor's attraction**, **vendor problems**, **vendor regulation**, **walking path**, **space availability,** and **sidewalk condition**. Factor 1, **comfort**, refers to feeling of movement easiness, sufficiency of space for walking, and presences of obstructions at the sidewalk, such as physical features, vendors and other pedestrian obstructions. Also, sidewalks cleanness increases comfortable feelings. Factor 2, **sidewalk interaction**, contains items of pedestrian intention to interact with vendors. Factor 3, **safety**, includes items that assess pedestrian perceptions regarding vehicle traffic danger, sidewalk surface conditions, and crime attacking. Factor 4, **vendor's attractions**, refers to street vendors existence in the sidewalks, intention to look around and buy something on street vendor's commodities. Factor 5, **vendor problems**, comprises any matters arising from street vendor activities. Factor 6, **vendor regulation**, includes perception of vendor regulation and its implementation/enforcement. Factor 7, **walking path**, refers to pedestrian's choice of walking path when the sidewalk is crowded. Factor 8 (arise for young only), **space availability**, refers to some items relating to availability of space on the sidewalk for walking movement. Factor 9 (arise for young only), **sidewalk condition**, includes items that assess pedestrian perception about easiness to access public transport and sidewalk performance.

Table 5.4 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Age

Variables	Young KMO-MSA: 0.865; Bartlett test: <0.001			Old KMO-MSA: 0.883; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 1: Comfort (FA-1)		***23.755***	***0.847***		***23.771***	***0.897***
Q1-9 I can move freely without obstruction from vendors	0.750			0.741		
Q1-8 I am not impeded by other pedestrians	0.716			0.680		
Q1-10 I have enough space to avoid the vendor's obstruction without decelerating my pace	0.689			0.761		
Q1-7 I can move freely without obstruction from physically features (phone boxes, column, bench, etc)	0.680			0.690		
Q1-6 I think that the street vendors keep the sidewalk clean	0.676					
Q1-5 I think that the sidewalk is flat enough to accommodate wheelchair users	0.603					
Q1-4 I think that the available sidewalk width can accommodate pedestrian flow	0.597			0.640		
Q1-20 I can choose my walking speed freely				0.764		
Q1-21 I can overtake other pedestrians easily				0.762		
Q1-19 I think that the total width of sidewalk is wide enough				0.728		
Q1-22 At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway				0.632		
Q1-11 I feel comfortable walking through this sidewalk with the presence of on street vendors				0.586		
Factor 2: Sidewalk interaction (FA-2)		***9.290***	***0.833***		***13.138***	***0.852***
Q2-15 I love shopping along sidewalk	0.769			0.786		
Q2-14 On street vendors make me easy to buy something	0.749			0.743		
Q2-16 My friends or my relatives like to walk along this sidewalk	0.746			0.735		

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Table 5.4 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Age (continued)

Variables		Young KMO-MSA: 0.865; Bartlett test: <0.001			Old KMO-MSA: 0.883; Bartlett test: <0.001		
		Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Q2-13	I will walk along this sidewalk only for shopping	0.701			0.744		
Q2-1	I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors	0.583					
Q2-8	I want to look around commodities sold by vendors				0.644		
Q2-10	I should walk in the sidewalk although the sidewalk is crowded by vendors				0.564		
Factor 3: Safety (FA-3)			***5.727***	***0.801***		***6.527***	***0.812***
Q1-2	I feel safe from trips, slips and falls	0.861			0.872		
Q1-1	I feel safe from vehicle traffic danger	0.839			0.863		
Q1-3	I feel safe from intimidation or physical attack	0.715			0.745		
Factor 4: Vendor's Attraction (FA-4)			***5.369***	***0.816***		***4.421***	***0.845***
Q1-13	I intend to buy something from street vendors	0.810			0.720		
Q1-12	I am interested in goods sold by vendors along this sidewalk	0.782			0.689		
Q1-14	I enjoy vendor activities in this sidewalk	0.696			0.660		
Factor 5: Vendor Problems (FA-5)			***4.236***	***0.669***		***7.808***	***0.782***
Q1-16	I think that too many buyers cause this sidewalk crowded	0.788			0.755		
Q1-17	I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded	0.766			0.710		
Q1-15	I think that too many street vendors occupy this sidewalk	0.680			0.691		
Q2-9	Walking slowly to enjoy goods from street vendors is inconvenient for other pedestrians				0.623		
Q2-3	I found delay when I walk along this sidewalk				0.591		
Q2-2	I think if the vendors is prohibited, the volume of pedestrians will be higher				0.554		

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Table 5.4 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Age (continued)

Variables		Young KMO-MSA: 0.865; Bartlett test: <0.001			Old KMO-MSA: 0.883; Bartlett test: <0.001		
		Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 6: Vendor Regulation (FA-6)			***3.728***	***0.781***		***3.141***	***0.747***
Q2-18	I think the regulation of vendors along the sidewalk is not that strict	0.858			0.801		
Q2-17	I feel that the government should ban the vendors along the sidewalk	0.819			0.729		
Factor 7: Walking Path (FA-7)			***3.521***	***0.728***		***4.080***	***0.696***
Q2-12	In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk	0.824			0.787		
Q2-11	I will still walk on the roadway (pavement) even when the sidewalk is very crowded	0.807			0.807		
Q2-6	This sidewalk is too narrow to accommodate the vendors and pedestrians				0.507		
Factor 8: Space Availability (FA-8)			***6.709***	***0.807***			
Q1-21	I can overtake other pedestrians easily	0.758					
Q1-20	I can choose my walking speed freely	0.725					
Q1-22	At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway	0.698					
Q1-23	I think that I can enter/exit to/from this sidewalk easily	0.633					
Q1-19	I think that the total width of sidewalk is wide enough	0.609					
Factor 9: Sidewalk Condition (FA-9)			***3.183***	***0.535***			
Q1-25	If I want to access public transport, it is easy to find bus stop/BTS Station in this sidewalk	0.784					
Q1-27	From my opinion, this sidewalk is bad for pedestrians	0.636					
Q1-26	I don't mind delays as long as I am comfortable	0.548					

5.1.3.3 Important Factors Based on Walking Frequency

Walking frequency was divided into two groups, namely, “daily walking” that represent respondent who walk on the observed sidewalk daily to one time per week and rarely walking” that refers to respondent who walk less than one time per week in frequency. The KMO-MSA test for daily and rarely group were 0.886 and 0.845, respectively; and the Bartlett test resulted in a value <0.001, so the factor analysis procedure was appropriate. The principal component extraction with VARIMAX rotation resulted in eight factors for each daily and rarely, and they were arbitrarily labeled based on the attributed covered as in Table 5.5. Only variables with factor loadings greater than 0.5 were chosen (Hair et al., 2006).

The first factor (**Comfort**) refers to walking comfort, which is related to the impact of street vendors and the available space for walking, the existence of obstructions along the sidewalk, such as physical features, vendors and other pedestrian obstructions. In addition, the available sidewalk width can accommodate walking and vendor activities. Also, sidewalks cleanliness increases comfortable feelings. The second factor (**Sidewalk Interaction**) includes some items relating to pedestrian intention to interact with vendors. The third factor (**Space Availability**) signifies movement easiness, sidewalk accessibility and space availability for walking movement. The fourth factor (**Safety**) presents pedestrian perceptions regarding vehicle traffic danger, sidewalk surface conditions, and crime attacking. The fifth factor (**Vendor’s Attraction**) signifies the existence of street vendors along the sidewalks, and pedestrian’s intention to look around and buy products from street vendor’s commodities. The sixth factor (**Vendor Problems**) represents potential walking movement problems caused by street vendor activities, which may come from the vendors, buyers, or pedestrians. The seventh factor (**Walking Path**) contains two items regarding pedestrian action when sidewalk is crowded. The eighth factor (**Vendor Regulation**) includes two items relating to implement of vendor regulation and the enforcement.

Table 5.5 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Walking Frequency

Variables	Daily KMO-MSA: 0.886; Bartlett test: <0.001			Rarely KMO-MSA: 0.845; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 1: Comfort (FA-1)		***25.590***	***0.859***		***10.297***	***0.842***
Q1-10 I have enough space to avoid the vendor's obstruction without decelerating my pace	0.724			0.689		
Q1-9 I can move freely without obstruction from vendors	0.723			0.786		
Q1-6 I think that the street vendors keep the sidewalk clean	0.698			0.612		
Q1-7 I can move freely without obstruction from physically features (phone boxes, column, bench, etc)	0.656			0.734		
Q1-5 I think that the sidewalk is flat enough to accommodate wheelchair users	0.655					
Q1-8 I am not impeded by other pedestrians	0.601			0.766		
Q1-4 I think that the available sidewalk width can accommodate pedestrian flow	0.592					
Q1-11 I feel comfortable walking through this sidewalk with the presence of on street vendors	0.581					
Factor 2: Sidewalk interaction (FA-2)		***10.446***	***0.850***		***24.718***	***0.831***
Q2-15 I love shopping along sidewalk	0.777			0.773		
Q2-16 My friends or my relatives like to walk along this sidewalk	0.755			0.699		
Q2-13 I will walk along this sidewalk only for shopping	0.740			0.724		
Q2-14 On street vendors make me easy to buy something	0.739			0.760		
Q2-8 I want to look around commodities sold by vendors	0.625			0.622		
Q2-1 I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors	0.560					
Q2-10 I should walk in the sidewalk although the sidewalk is crowded by vendors				0.543		

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Table 5.5 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Walking Frequency (Continued)

Variables	Daily KMO-MSA: 0.886; Bartlett test: <0.001			Rarely KMO-MSA: 0.845; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 3: Space Availability (FA-3)		***6.448***	***0.824***		***7.245***	***0.801***
Q1-22 At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway	0.762			0.716		
Q1-23 I think that I can enter/exit to/from this sidewalk easily	0.698			0.613		
Q1-21 I can overtake other pedestrians easily	0.688			0.748		
Q1-20 I can choose my walking speed freely	0.600			0.738		
Q1-19 I think that the total width of sidewalk is wide enough	0.588					
Factor 4: Safety (FA-4)		***6.351***	***0.812***		***5.853***	***0.792***
Q1-2 I feel safe from trips, slips and falls	0.871			0.858		
Q1-1 I feel safe from vehicle traffic danger	0.842			0.848		
Q1-3 I feel safe from intimidation or physical attack	0.746			0.743		
Factor 5: Vendor's Attraction (FA-5)		***4.958***	***0.825***		***6.396***	***0.834***
Q1-12 I am interested in goods sold by vendors along this sidewalk	0.768			0.774		
Q1-13 I intend to buy something from street vendors	0.756			0.839		
Q1-14 I enjoy vendor activities in this sidewalk	0.652			0.749		
Factor 6: Vendor Problems (FA-6)		***4.120***	***0.690***		***4.836***	***0.720***
Q1-16 I think that too many buyers cause this sidewalk crowded	0.796			0.835		
Q1-15 I think that too many street vendors occupy this sidewalk	0.739			0.676		
Q1-17 I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded	0.737			0.792		

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Table 5.5 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Walking Frequency (Continued)

Variables	Daily KMO-MSA: 0.886; Bartlett test: <0.001			Rarely KMO-MSA: 0.845; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 7: Walking Path (FA-7)		***3.630***	***0.737***		***3.904***	***0.785***
Q2-12 In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk	0.841			0.833		
Q2-11 I will still walk on the roadway (pavement) even when the sidewalk is very crowded	0.828			0.845		
Factor 8: Vendor Regulation (FA-8)		***3.340***	***0.750***		***4.120***	***0.795***
Q2-18 I think the regulation of vendors along the sidewalk is not that strict	0.863			0.871		
Q2-17 I feel that the government should ban the vendors along the sidewalk	0.816			0.840		

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5.1.3.4 Important Factors Based on Trip Purpose

Table 5.6 presents summary results of exploratory factor analysis and reliability test based on respondent's trip purposes. Note that trip purposes were divided into two groups: work/school and recreational groups. Work/school group categorized pedestrian that their purpose was to go to/from work or school, whereas recreational was the group for pedestrian that their trip purpose is to shopping, sightseeing, visiting friend/family and others. It can be seen that the KMO-MSA test resulted in a value of 0.868 (work/school) and 0.877 (recreational), which was greater than 0.5, and the Bartlett test resulted in a value <0.001. This indicated that the factor analysis procedure was justified.

The proposed solution has eight factors for both work/school and recreational groups. Inspection of the output confirms that the factor structures make conceptual sense and that each factor accounts for a substantial portion of the overall variance. The resulting factor structure is presented in Table 5.6. The factors were arbitrarily named as **comfort**, **sidewalk interaction**, **space availability, safety**, **vendor's attraction**, **vendor problems**, **vendor regulation**, **and walking path**. Factor 1, **comfort**, refers to feeling of movement easiness, sufficiency of space for walking, and presences of obstructions at the sidewalk, such as physical features, vendors and other pedestrian obstructions. Also, sidewalks cleanness increases comfortable feelings. Factor 2, **sidewalk interaction**, contains items of pedestrian intention to interact with vendors. Factor 3, **space availability**, refers to some items relating to availability of space on the sidewalk for walking movement. Factor 4, **safety**, includes items that assess pedestrian perceptions regarding vehicle traffic danger, sidewalk surface conditions, and crime attacking. Factor 5, **vendor's attractions**, refers to street vendors existence in the sidewalks, pedestrian intention to look around and buy something on street vendor's commodities. Factor 6, **vendor problems**, comprises any matters arising from street vendor activities. Factor 7, **vendor regulation**, includes perception of vendor regulation and its implementation/enforcement. Factor 8, **walking path**, refers to pedestrian's choice of walking path when the sidewalk is crowded.

Table 5.6 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Trip Purpose

Variables		Work/school KMO-MSA: 0.868; Bartlett test: <0.001			Recreational KMO-MSA: 0.877; Bartlett test: <0.001		
		Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 1: Comfort (FA-1)			***25.195***	***0.853***		***26.578***	***0.871***
Q1-9	I can move freely without obstruction from vendors	0.731			0.729		
Q1-10	I have enough space to avoid the vendor's obstruction without decelerating my pace	0.721			0.681		
Q1-6	I think that the street vendors keep the sidewalk clean	0.691			0.710		
Q1-7	I can move freely without obstruction from physically features (phone boxes, column, bench, etc)	0.660			0.706		
Q1-5	I think that the sidewalk is flat enough to accommodate wheelchair users	0.647			0.656		
Q1-8	I am not impeded by other pedestrians	0.629			0.675		
Q1-11	I feel comfortable walking through this sidewalk with the presence of on street vendors	0.563			0.545		
Q1-4	I think that the available sidewalk width can accommodate pedestrian flow	0.558			0.626		
Factor 2: Sidewalk interaction (FA-2)			***9.804***	***0.856***		***6.690***	***0.848***
Q2-15	I love shopping along sidewalk	0.785			0.805		
Q2-16	My friends or my relatives like to walk along this sidewalk	0.755			0.771		
Q2-14	On street vendors make me easy to buy something	0.745			0.776		
Q2-13	I will walk along this sidewalk only for shopping	0.731			0.710		
Q2-8	I want to look around commodities sold by vendors	0.673					

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Table 5.6 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Trip Purpose (continued)

Variables		Work/school KMO-MSA: 0.868; Bartlett test: <0.001			Recreational KMO-MSA: 0.877; Bartlett test: <0.001		
		Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 3: Space Availability (FA-3)			***6.928***	***0.808***		***10.774***	***0.825***
Q1-22	At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway	0.739			0.757		
Q1-21	I can overtake other pedestrians easily	0.700			0.692		
Q1-23	I think that I can enter/exit to/from this sidewalk easily	0.657			0.700		
Q1-20	I can choose my walking speed freely	0.621			0.663		
Q1-19	I think that the total width of sidewalk is wide enough	0.606			0.643		
Factor 4: Safety (FA-4)			***6.513***	***0.826***		***5.690***	***0.786***
Q1-2	I feel safe from trips, slips and falls	0.888			0.858		
Q1-1	I feel safe from vehicle traffic danger	0.847			0.854		
Q1-3	I feel safe from intimidation or physical attack	0.757			0.716		
Factor 5: Vendor Attraction (FA-5)			***5.434***	***0.819***		***6.005***	***0.839***
Q1-12	I am interested in goods sold by vendors along this sidewalk	0.784			0.776		
Q1-13	I intend to buy something from street vendors	0.778			0.818		
Q1-14	I enjoy vendor activities in this sidewalk	0.683			0.748		
Factor 6: Vendor Problems (FA-6)			***4.404***	***0.695***		***4.150***	***0.717***
Q1-16	I think that too many buyers cause this sidewalk crowded	0.813			0.829		
Q1-17	I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded	0.731			0.814		
Q1-15	I think that too many street vendors occupy this sidewalk	0.730			0.664		

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Table 5.6 Factor Loading, Explained Variance, and Cronbach's Alpha Based on Trip Purpose (continued)

Variables	Work/school KMO-MSA: 0.868; Bartlett test: <0.001			Recreational KMO-MSA: 0.877; Bartlett test: <0.001		
	Factor Loadings	Variance Explained (%)	Cronbach's Alpha	Factor Loadings	Variance Explained (%)	Cronbach's Alpha
Factor 7: Vendor Regulation (FA-7)		***3.679***	***0.747***		***3.653***	***0.798***
Q2-18 I think the regulation of vendors along the sidewalk is not that strict	0.867			0.860		
Q2-17 I feel that the government should ban the vendors along the sidewalk	0.823			0.823		
Factor 8: Walking Path (FA-8)		***3.360***	***0.739***		***3.428***	***0.776***
Q2-12 In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk	0.866			0.827		
Q2-11 I will still walk on the roadway (pavement) even when the sidewalk is very crowded	0.844			0.843		

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5.2 Model Development with Regression Analysis

5.2.1 Ratings of Level of Service Values

Sidewalk segments were also surveyed in this study. The contents included pedestrian performance questionnaire survey, pedestrian volume survey, the number of pedestrians that interact with vendors, and the number of pedestrian that walk outside the sidewalk. Among these surveys, pedestrian interview covers 1904 respondents. Respondents were asked to give real time assessment of the sidewalk. Respondents were asked to give a score from one to ten, where one represents the lowest and ten represents the highest rating.

A ratings scale is modified from a model proposed by Jaskiewicz (2000). A scale of 1 to 10 is sufficient to accurately cover the range of sidewalk performance. Table 5.7 shows the level of service categories based on the score of assessment.

Table 5.7 Level of Service Categories

Pedestrian LOS	Model score
A	9.0 < LOS
B	7.0 < LOS ≤ 9.0
C	5.0 < LOS ≤ 7.0
D	3.0 < LOS ≤ 5.0
E	2.0 < LOS ≤ 3.0
F	LOS ≤ 2.0

The distribution of the pedestrian LOS can be seen in Figure 5.1. The horizontal axis is the assessing grades and the vertical axis is the percentage of each grades. It can be seen that pedestrian LOS C is the peak of the LOS distribution and the percentage values decrease gradually from the peak toward both sides. Grade C occupies the largest proportion, followed by grades D and B, whereas grades A, E, and F are smaller.

From Figure 5.1, most of pedestrians feel the sidewalk environment is acceptable, whereas, the perceptions of good and poor conditions of sidewalk are few. It means that when the pedestrians assess the LOS, the result converges on middle grade and very little of pedestrians assess the extreme good and poor of sidewalk condition.

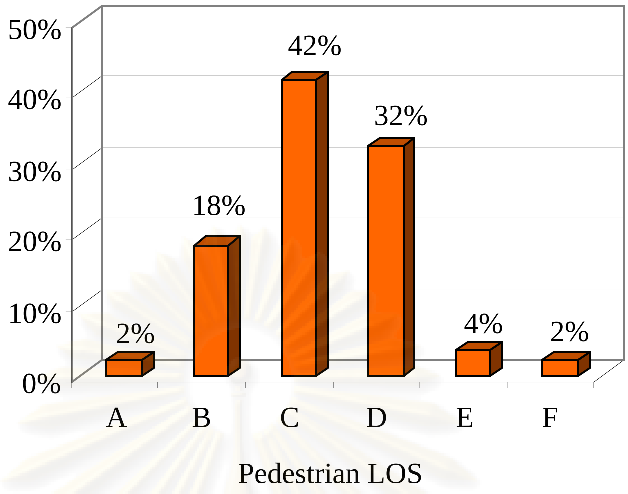

Figure 5.1 Pedestrian LOS distribution

5.2.2 Development of Pedestrian LOS Model

The data surveys for developing the model were undertaken in a total of eight sidewalks located in commercial areas in both Bangkok and Jakarta. In Bangkok, observations were conducted in Bang Rak, Silom, On Nut, and Pratunam districts. Data collections in Jakarta were conducted in Mampang, Sabang, Jatinegara Pondok Kopi, and Jatinegara Stasiun areas. These locations were chosen because of the following reasons: sidewalks are available and considered feasible to observe, the volume of pedestrian is considered high, and there are street vendor activities along the sidewalk. Observations were conducted during daytime start from 10.00 a.m. to 6 p.m. Since the vendor characteristics were different between daytime and night-time in some locations, the proposed model in this study may be feasible when applied in daytime or in the sidewalk with similar vendor characteristics.

Multiple regression method was conducted to analyze all data being proposed as dependent and independent variables. The independent variables comprise of the qualitative variables considered important concerning walking condition based on pedestrian perception, and the measured variables relating to pedestrian traffic and the amount of pedestrian who contact with vendors as well.

Pedestrian volume is considered one of the important independent variable. Most of previous studies proposed pedestrian volume in their level of service model

(Huang and Chiun, 2007; Landis et al., 2001; Tan et al., 2007; TRB, 2000). Pedestrian volume is found to have negative relationship on sidewalk performance, increasing in pedestrian volume will reduce sidewalk performance. The worst performance of sidewalk is occurred when total volume is greater than sidewalk capacity. When it is occurred, pedestrian find difficulties to pass through the sidewalk, then they are forced to walk on the roadway. Besides pedestrian population, another reason why people tend to walk outside the sidewalk is because of vendor activities, that set up their commodities improperly, so sidewalk width reduced significantly. Therefore, the number of pedestrian who walk outside the sidewalk is considered as one of the independent variable. Vendor activities reduce capacity of the sidewalk because people who stop in front of vendor's stalls for buying and selling activities cause obstruction for pedestrian flow. This study tries to portrait pedestrian behavior related to effect caused by vendor activities, so the number of people who contact or interact with vendors is considered as independent variable. Other variables considered important for the model are factors based on pedestrian perception. As revealed in previous studies, evaluation of sidewalk performance is not only take into account volume and geometry aspect, but also important to consider qualitative aspect (Byrd and Sisiopiku, 2006; Jaskiewicz, 2000). This study reveals four factors considered important on sidewalk performance that can be used as qualitative independent variables, namely, comfort, vendor's attraction, vendor problems, and safety. Therefore, to establish the level of service model using multiple regression analysis, this study propose sidewalk performance score as dependent variable and seven variables as independent variables, namely, (a) FA-1: Comfort, (b) FA-2: vendor's attraction, (c) FA-3: vendor problems, (d) FA-4: safety, (e) pedestrian volume, (f) the number of pedestrian who walk outside the sidewalk, and (g) the number of pedestrian who interact with street vendors.

Several variable transformations and combinations of the factor are analyzed to build eleven final models. The models are established based on source data that elaborated by considering sidewalk locations, cities, and combination of all-data, as can be seen in Table 5.8.

Table 5.8 Basis of the Proposed Models

Model	Source data	∑ Respondents	Model	Source data	∑ Respondents
1	Combined all-data	1904	7	Mampang	59
2	Jakarta	523	8	Bang Rak	351
3	Bangkok	1381	9	Pratunam	276
4	Sabang	135	10	Silom	375
5	Jatinegara Pondok Kopi	173	11	On Nut	379
6	Jatinegara Stasiun	164			

Table 5.9 displays results of multiple regression analysis including coefficient of regressions, t-statistics, F-statistic, R^2, and *adjusted* R^2 for the eleven models. Variables show in the table are only which statistically significant.

For comparing the models, *F-test* is performed since it is most useful for comparing models that differ by more than one independent variable. In this regard, the F-test is conducted to test the null and alternative hypotheses as follows:

H_0 : all $B_k = 0$

H_1 : all $B_k \neq 0$

Then, the formula of F test is as follows:

$$F = \frac{\dfrac{SSE_R - SSE_F}{df_R - df_F}}{\dfrac{SSE_F}{df_F}} \approx F\,(1\text{-}\alpha;\, df_R - df_F,\, df_F) \qquad (5.1)$$

where,

SSE_R = Sum of Square Error from the all-data model

SSE_F = Sum of Square Error from the sum of SSE_s from the separated models

Df_F = $\sum n_i - p_F$; $\sum n_i$: sum of sample size from separated models; p_F : sum of variables from separated models

df_R = $n_T - p_R$; n_T: sample size total; p_R: the number of variables in all-data model

Table 5.9 Estimated Regression Coefficients

Variables	Model 1 Combined	Model 2 Jakarta	Model 3 Bangkok	Model 4 Sabang	Model 5 Jatinegara Pondok Kopi	Model 6 Jatinegara Stasiun	Model 7 Mampang	Model 8 Bang Rak	Model 9 Pratunam	Model 10 Silom	Model 11 On Nut
Constant	4.723* (7.15)	5.884* (8.287)	3.083* (3.296)	10.404* (12.512)	4.344* (13.127)	2.74* (4.58)	4.327* (8.597)	7.648* (5.188)	2.486*** (1.886)	0.79 (0.636)	4.788* (1.842)
FA-1 (Comfort)	0.495* (4.677)	0.37* (3.462)	1.338* (6.316)			0.843* (4.409)		1.727* (3.946)	1.024* (3.075)		
FA-2 (Vendor's attraction)			-0.545** (-2.334)					-0.99* (-3.811)			
FA-3 (Vendor problems)	-0.174*** (-1.818)	-0.329* (-2.971)		-1.004* (-5.371)							-0.898 (-1.647)
FA-4 (Safety)										1.355* (4.04)	
Pedestrian volume (ped/15 min/m)	0.001* (2.604)				0.011* (4.122)		0.105* (3.83)	-0.001** (-2.182)			
Walking outside sidewalk (ped / 15 min)							-0.04* (-4.27)				
The number of interact with vendors (ped/15 min)	-0.007*** (-1.783)										
F test	9.947*	14.275*	20.166*	28.848*	16.994*	19.435*	12.51*	7.966*	9.459*	16.319*	1.3000
R^2	0.245	0.211	0.270	0.507	0.395	0.437	0.532	0.603	0.259	0.386	0.302
adj. R^2	0.221	0.196	0.257	0.490	0.372	0.415	0.490	0.527	0.232	0.362	0.07

Note: **p<0.01 **p<0.05 ***p<0.1*

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Firstly, comparison model based on sidewalk location is undertaken. The model of all Jakarta data is compared to the models for each sidewalk located in Jakarta (Model 2 vs. Models 4-7). Typically, the models for each location and Jakarta combined model can be shown by following equations:

$$Y_{Jakarta} = B_{2,1} + B_{2,1}X_{2,1} + B_{2,2}X_{2,2} + B_{2,3}X_{2,3} + ... + B_{2,k}X_{2,k}$$

$$Y_4 = B_{4,1} + B_{4,1}X_{4,1} + B_{4,2}X_{4,2} + B_{4,3}X_{4,3} + ... + B_{4,k}X_{4,k}$$

$$Y_5 = B_{5,1} + B_{5,1}X_{5,1} + B_{5,2}X_{5,2} + B_{5,3}X_{5,3} + ... + B_{5,k}X_{5,k}$$

$$Y_6 = B_{6,1} + B_{6,1}X_{6,1} + B_{6,2}X_{6,2} + B_{6,3}X_{6,3} + ... + B_{6,k}X_{6,k}$$

$$Y_7 = B_{7,1} + B_{7,1}X_{7,1} + B_{7,2}X_{7,2} + B_{7,3}X_{7,3} + ... + B_{7,k}X_{7,k}$$

Hypothesis:

$H_0 : B_{4,1} = B_{5,1} = B_{6,1} = B_{7,1}; \ldots\ldots\ldots; B_{4,k} = B_{5,k} = B_{6,k} = B_{7,k}$

H_1 : not H_0

The result of calculation yields F_{test} = 22.8481057, then compare to the value in F distribution table with $\alpha = 0.05$ (F_{table} = 2.60). Since $F_{test} \geq F_{table}$, then reject H_0, it means that separated model (based on sidewalk location) is better than all Jakarta data model.

Similar procedures are performed to compare the model of all Bangkok data to the models for each sidewalk located in Bangkok (Model 3 vs. Models 8-11). The result of calculation generate F_{test} = 22.5787652, then compare to the value in F distribution table with $\alpha = 0.05$ (F_{table} = 2.37). Since $F_{test} \geq F_{table}$, then reject H_0, it means that separated model (based on sidewalk location) is better than all Bangkok data model.

Then, the F-test procedures are conducted to compare the models on the basis of cities. Models for all Jakarta data and Bangkok data are compared to combination of all data accepted (Model 1 vs. Model 2-3) to test following hypotheses:

$$Y_{combined} = B_{1,1} + B_{1,1}X_{1,1} + B_{1,2}X_{1,2} + B_{1,3}X_{1,3} + ... + B_{1,k}X_{1,k}$$

$$Y_{Jakarta} = B_{2,1} + B_{2,1}X_{2,1} + B_{2,2}X_{2,2} + B_{2,3}X_{2,3} + ... + B_{2,k}X_{2,k}$$

$$Y_{Bangkok} = B_{3,1} + B_{3,1}X_{3,1} + B_{3,2}X_{3,2} + B_{3,3}X_{3,3} + ... + B_{3,k}X_{3,k}$$

To test following hypotheses:

$H_0 : B_{2,1} = B_{3,1}; \ldots\ldots; B_{2,k} = B_{3,k}$

H_1 : not H_0

The result of calculation yields F_{test} = 14.8153495, then compare to the value in F distribution table with α = 0.05 (F_{table} = 3.84). Since $F_{test} \geq F_{table}$, then reject H_0, it means that separated model (models based on cities) is better than combined model.

Lastly, similar procedures are performed to compare the model of combination all-data to the models for each sidewalk (Model 1 vs. Models 4-11).

$Y_{combined} = B_{1,1} + B_{1,1}X_{1,1} + B_{1,2}X_{1,2} + B_{1,3}X_{1,3} + ... + B_{1,k}X_{1,k}$

$Y_4 = B_{4,1} + B_{4,1}X_{4,1} + B_{4,2}X_{4,2} + B_{4,3}X_{4,3} + ... + B_{4,k}X_{4,k}$

$Y_5 = B_{5,1} + B_{5,1}X_{5,1} + B_{5,2}X_{5,2} + B_{5,3}X_{5,3} + ... + B_{5,k}X_{5,k}$

……………………………..

$Y_{11} = B_{11,1} + B_{11,1}X_{11,1} + B_{11,2}X_{11,2} + B_{11,3}X_{11,3} + ... + B_{11,k}X_{11,k}$

Hypothesis:

$H_0 : B_{4,1} = B_{5,1} = ….. = B_{11,1}; …….; B_{4,k} = B_{5,k} = …. = B_{11,k}$

H_1 : not H_0

The result of calculation generate F_{test} = 22. 52189, then compare to the value in F distribution table with α = 0.05 (F_{table} = 2.37). Since $F_{test} \geq F_{table}$, then reject H_0, it means that separated model (based on sidewalk location) is better than combined model.

According to *F-test* of all the eleven models established, it can be concluded that pedestrian level of service model based on the sidewalk locations is better than combined model. Therefore, to find the best PLOS model, it can be selected among models 4 to 11. By comparing among eight individual models in Table 5.9, Model 8 has the largest *adjusted* R^2 value that indicate it is the best model. Model 8 can be shown as follows:

$$Y = 7.648 + 1.727X_1 - 0.990X_2 - 0.001X_3 \quad (5.2)$$

β *(0.786)* *(-0.588)* *(-0.401)*

where,

Y = Pedestrian LOS (score of sidewalk's performance by pedestrian)

X_1 = FA-1 (Comfort, pedestrian’s perception about sidewalk comfort)

X_2 = FA-2 (Vendor’s attraction, refers to street vendors existence in the sidewalks, pedestrian intention to look around and buy something on street vendor’s commodities)

X_3 = Pedestrian volume (the number of pedestrian passing in the sidewalk per 15 minutes per 1 meter width, ped/15 min/m)

To compare among independent variables, it is important to convert all variables into standard unit, and multiple regression analysis provides standardized data termed beta (β) coefficient. Standardization converts variables to a common scale and zero variability, with a mean of zero (0.0) and standard deviation of one (1.0). According to beta (β) coefficient values, as can be seen in equation (5.2), comfort has the most impact. This agrees with accepted practice, that pedestrians need a comfortable sidewalk to support their walking activities (Jaskiewicz, 2000; Rahaman et al., 2005; Sarkar, 2003). In fact, pedestrian comfort is a problematic aspect of sidewalks with various vendor activities. Comfort is the first impression they have about the sidewalk and influence their feeling of evaluation of the sidewalk as a whole. Vendor's attraction is the next important component. Because of vendor existences, pedestrian give more attention in selling/buying and other vendor activities. Their intention to interact with vendors influences overall sidewalk performance. Negative coefficient indicates more contact between pedestrians and vendors cause decreasing in sidewalk performance value. Although that seems contrary to accepted practice, it is found that the lowest importance variable of the pedestrian volume, when compared to the other components.

This study focuses on establishing pedestrian level of service for sidewalk segment in the commercial area with street vendor activities. Considering pedestrian perceptions, pedestrian traffic, and pedestrian behavior toward vendor's activities as affected variables, pedestrian level of service model is proposed by analyzing the relationship among pedestrian level of service and these variables. Finally, a pedestrian LOS is found with three significant independent variables. The three variables include both qualitative and quantitative variables. In association with pedestrian perceptions, two variables that are significantly influence the pedestrian LOS are comfort and pedestrian intention to interact with vendor's activities. Another independent variable is associated with pedestrian volume.

Different with previous developed pedestrian LOS model that consider traditional variables traffic and geometry (Huang and Chiun, 2007; Landis et al., 2001; TRB, 2000) or environment variables (Jaskiewicz, 2000; Sarkar, 2003), our developed model provides different point of view in evaluation of sidewalk performance by incorporating pedestrian feelings of walking condition. Also, by considering street vendor activities, this model is useful for evaluation of the sidewalk in the commercial districts in developing cities. Street vendor activity is one of the unique sidewalk characteristic that is found mostly in the developing cities only. Their obstructions in walking movement are not taken into account in the previous pedestrian LOS model that came from developed countries.

5.3 Model Development with SEM

Structural equation modeling (SEM) was used to test the proposed models and hypothesized the interaction between variables. In order to structure the causal relationships between 46 variables (part 1 and 2 of questionnaire) which were selected as being the key measures and the indicators of sidewalk performance, four latent variables were estimated, namely, “pedestrian perception of traffic”, “pedestrian perception of interaction”, “pedestrian perceptions of sidewalk condition”, and “pedestrian perception of sidewalk performance”. The data collected from 1381 and 523 respondents of Bangkok and Jakarta were analyzed by using SEM software package called AMOS 7 (Analysis of Moment Structures) to test the measurements and structural model based on maximum likelihood method of estimation (Byrne, 2010).

In this section of the thesis, the analysis of Bangkok sample data is presented first, followed by the sample data from Jakarta. In each part, after testing the validity of the measurement model, the analysis of the structural model is presented.

5.3.1 SEM Model for Bangkok

5.3.1.1 Validity of the Performance Measures and the Indicator

The aim of testing the construct validity of performance measurement variables is to examine the degree to which a latent variable measures what it intends to measure. Construct validity testing is consisted of several sub-dimensions, all of which should be satisfied to achieve construct validity. These sub-dimensions include: scale reliability, convergent validity, and discriminant validity.

A. Scale reliability testing of performance measures

The scale reliability is the internal consistency of a latent variable and is quantified most commonly using Cronbach's alpha coefficient. The objective of testing the reliability of a construct is to figure out how each measured/observed variable represents its correspondent latent variable.

Table 5.10 shows the reliability test results of latent variables according to the SPSS software package analysis. Cronbach's alpha values are 0.829 for "pedestrian perception of traffic", 0.749 for "pedestrian perception of interaction", and 0.672 for "pedestrian perceptions of sidewalk condition". These reliability values are satisfactory since the Cronbach's alpha coefficients are all greater than 0.70, the minimum value recommended by Field (2005). The alpha value of "pedestrian perception of sidewalk condition" is considered within the acceptable range ($\alpha = 0.6$) though it quite low (George and Mallery, 2010; Gliem and Gliem, 2003; Hair et al., 2006; Zhang, 2006).

Table 5.10 Latent Variables, Measurement Variables and Cronbach's Alpha Coefficients of Bangkok Data

Latent variables	Measurement variables	Cronbach's α
Pedestrian perception of traffic	FA-7: Space Availability Q2-1: I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors Q2-2: I think if the vendors is prohibited, the volume of pedestrians will be higher Q2-3: I found delay when I walk along this sidewalk Q2-4: The street vendors occupy too many spaces in this sidewalk Q2-5 :I think pedestrians with visual impairment can walk this sidewalk easily Q2-6: This sidewalk is too narrow to accommodate the vendors and pedestrians Q1-9: I can move freely without obstruction from vendors Q1-10: I have enough space to avoid the vendor's obstruction without decelerating my pace Q1-20: I can choose my walking speed freely Q1-21: I can overtake other pedestrians easily	0.829

Table 5.10 Latent Variables, Measurement Variables and Cronbach's Alpha Coefficients of Bangkok Data (continued)

Latent variables	Measurement variables	Cronbach's α
Pedestrian perception of interaction	FA-5: Vendor regulation FA-6: Sidewalk interaction Q1-12: I am interested in goods sold by vendors along this sidewalk Q1-14: I enjoy vendor activities in this sidewalk Q2-7: It is easy to interact with the vendors Q2-8: I want to look around commodities sold by vendors Q2-9: Walking slowly to enjoy goods from street vendors is inconvenient for other pedestrians Q2-10: I should walk in the sidewalk although the sidewalk is crowded by vendors	0.749
Pedestrian perceptions of sidewalk condition	FA-1: Comfort FA-3: Vendor problems FA-4: Safety FA-8: Sidewalk Condition	0.672
Pedestrian perception of sidewalk performance	In overall, I would give _______ points for the performance of this sidewalk. (1 - 10 score where 1 for the lowest and 10 for the highest)	

B. Convergent validity testing of performance measures

The purpose of convergent validity testing is to measure the correlation between latent variable and its corresponding items (observed variables). Ideally, convergent validity is examined by determining whether the items in a scale converge or load together on a single construct in the measurement model. However, if the factor loadings are statistically significant, then the convergent validity exist (Dunn et al., 1994). As sample size and statistical power have substantial effect on the significance test, this statement needs expanding. In addition, assessing convergent validity should also examine the overall fit of the measurement model, and the magnitude, direction, and statistical significance of the estimated parameters between latent variable and their indicators.

Table 5.11 **s**ummarizes the model parameters assessed and all factor loadings are found to be significant at $\alpha = 0.001$. An assessment of the overall fit of the measurement model is going to be performed after presenting the final model.

Table 5.11 Latent Variables and Their Indicators with Factor Loadings of Bangkok Data

Latent variables	Indicators	Factor loadings
Pedestrian perception of traffic	FA-7: Space Availability	0.999
	Q2-1: I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors	-0.602
	Q2-2: I think if the vendors is prohibited, the volume of pedestrians will be higher	0.505
	Q2-3: I found delay when I walk along this sidewalk	0.465
	Q2-4: The street vendors occupy too many spaces in this sidewalk	-1.260
	Q2-5 :I think pedestrians with visual impairment can walk this sidewalk easily	0.481
	Q2-6: This sidewalk is too narrow to accommodate the vendors and pedestrians	0.108
	Q1-9: I can move freely without obstruction from vendors	0.468
	Q1-10: I have enough space to avoid the vendor's obstruction without decelerating my pace	0.531
	Q1-20: I can choose my walking speed freely	0.811
	Q1-21: I can overtake other pedestrians easily	0.794
Pedestrian perception of interaction	FA-5: Vendor regulation	0.418
	FA-6: Sidewalk interaction	0.811
	Q1-12: I am interested in goods sold by vendors along this sidewalk	0.392
	Q1-14: I enjoy vendor activities in this sidewalk	0.429
	Q2-7: It is easy to interact with the vendors	0.400
	Q2-8: I want to look around commodities sold by vendors	0.573
	Q2-9: Walking slowly to enjoy goods from street vendors is inconvenient for other pedestrians	0.519
	Q2-10: I should walk in the sidewalk although the sidewalk is crowded by vendors	0.469
Pedestrian perceptions of sidewalk condition	FA-1: Comfort	0.621
	FA-3: Vendor problems	0.375
	FA-4: Safety	0.361
	FA-8: Sidewalk Condition	0.576
Pedestrian perception of sidewalk performance	In overall, I would give _______ points for the performance of this sidewalk. (1 - 10 score where 1 for the lowest and 10 for the highest)	

C. Discriminant validity testing of performance measures

Discriminant validity testing is used to measure the extent to which the items representing a latent variable discriminate that construct from other items representing other latent variables. For this test, we need to verify that scales developed to measure different construct are indeed measuring different construct. This is particularly important when constructs are highly correlated and similar in nature. In essence, items from one scale should not load or converge too closely with items from different scale. Different latent variables that correlate too highly may indeed be measuring the same construct rather than different constructs. The presence of discriminant validity is denoted by relatively low correlations among variables (constructs). Table 5.12 through Table 5.14 show the inter-correlation matrices for the items of each observed variable.

Table 5.12 Inter-correlations for the Variables of "Pedestrian Perception of Traffic"

	FA-7	Q2_1	Q2_2	Q2_3	Q2_4	Q2_5	Q2_6	Q1_9	Q1_10	Q1_20	Q1_21
FA-7	1.000										
Q2_1	0.420	1.000									
Q2_2	0.311	0.571	1.000								
Q2_3	0.289	0.520	0.505	1.000							
Q2_4	0.227	0.459	0.496	0.627	1.000						
Q2_5	0.405	0.451	0.326	0.273	0.330	1.000					
Q2_6	0.005	0.208	0.262	0.207	0.247	0.160	1.000				
Q1_9	0.493	0.281	0.214	0.217	0.139	0.244	-0.025	1.000			
Q1_10	0.528	0.275	0.213	0.197	0.169	0.291	-0.042	0.651	1.000		
Q1_20	0.809	0.278	0.202	0.189	0.127	0.293	-0.049	0.383	0.423	1.000	
Q1_21	0.802	0.286	0.198	0.181	0.123	0.325	0.000	0.368	0.389	0.680	1.000

Note: FA-7: Space Availability

Table 5.13 Inter-correlations for the Variables of "Pedestrian Perception of Interaction"

	FA-6	FA-5	Q1_12	Q1_14	Q2_7	Q2_8	Q2_9	Q2_10
FA-6	1.000							
FA-5	0.453	1.000						
Q1_12	0.356	0.061	1.000					
Q1_14	0.382	0.034	0.500	1.000				
Q2_7	0.405	0.178	0.121	0.185	1.000			
Q2_8	0.507	0.231	0.218	0.238	0.445	1.000		
Q2_9	0.441	0.254	0.165	0.177	0.235	0.415	1.000	
Q2_10	0.408	0.247	0.173	0.171	0.178	0.251	0.537	1.000

Note: FA-2: Sidewalk Interaction; FA-8: Vendor Regulation

Table 5.14 Inter-correlations for the Variables of “Pedestrian Perception of Sidewalk Condition”

	FA-1	**FA-3**	**FA-4**	**FA-8**
FA-1	1.000			
FA-3	0.291	1.000		
FA-4	0.433	0.217	1.000	
FA-8	0.416	0.424	0.267	1.000

Note: FA-1: Comfort; FA-3: Vendor Problems; FA-4: Safety; FA-8: Sidewalk Condition

From those matrices above, it can be seen that all inter-correlation calculated for all constructs are below 0.90, indicating that multicollinearity do not exist but implying that the constructs have discriminant validity (Hair et al., 2006). The inter-correlation in Table 5.12 through Table 5.14 provide evidence that the variables are different from each other and that they are complementary.

5.3.1.2 Analysis of the Structural Performance Model with SEM

This study applies structural equation modeling (SEM) method consistent with the structure of the hypothesized model that is consisted of a number of direct and indirect interdependencies between dependent and independent variables.

Basically, the procedural steps of SEM can be conducted with two main tasks: specification of the model and evaluation of the model fit.

A. Specification of the model

The proposed model was established based on a series of literature reviews. Each construct was developed to take into account the correlating previous researches. Relationships among behavior, traffic, perception, and level of service had been investigated in transportation research. Although several past studies did not investigate them under pedestrian context, it is apparent that pedestrian behavior influence pedestrian perceptions to some extent. Walking environments establish a set of conditions for behavior. Once exposed in the public environment, pedestrians experience a variety sensation related to comfort or stimulation and they have to make a series of judgments and decisions while navigating the environment (Zacharias, 2001). Observing pedestrian attitudes, Tan et al. (2007) found relationships between pedestrian behavior and level of service that sidewalk obstructions and traffic condition influenced level of service. Hence, it can be implied that traffic condition influenced pedestrian perceptions.

From literature, relationships between pedestrian perceptions and level of service have been proposed. For example, based on a variation of traffic and roadway variables, Landis et al. (2001) revealed that perceptions about safety and comfort were considered a significant factor for assessing level of service. Variables affecting pedestrian’s sense of safety and comfort included lateral separation of sidewalk-roadway, vehicle traffic, vehicle speed, and driveway access frequency and volume. These variables were generated and then tested with stepwise regression, forming into a model to assess pedestrian level of service. In a similar vein, Jaskiewiz (2000) proposed a method for evaluating pedestrian LOS based on trip quality derived from pedestrian perceptions. Nine specific items were used to classify the characteristics or features that contribute to positive pedestrian experiences. These measures included enclosure/definition, complexity of path network, building articulations, complexity of spaces, transparencies, buffers, shades, trees, overhangs/awnings/varied roof lines, and physical components/conditions. The research revealed that pedestrian level of service needs variables more than volumes and capacities (Jaskiewicz, 2000).

The hypotheses were stated in the form of a structural equation model. Based on the extent literature related to pedestrian level of service and its influencing variables, a conceptual relationship model with four latent constructs was proposed in Figure 5.2.

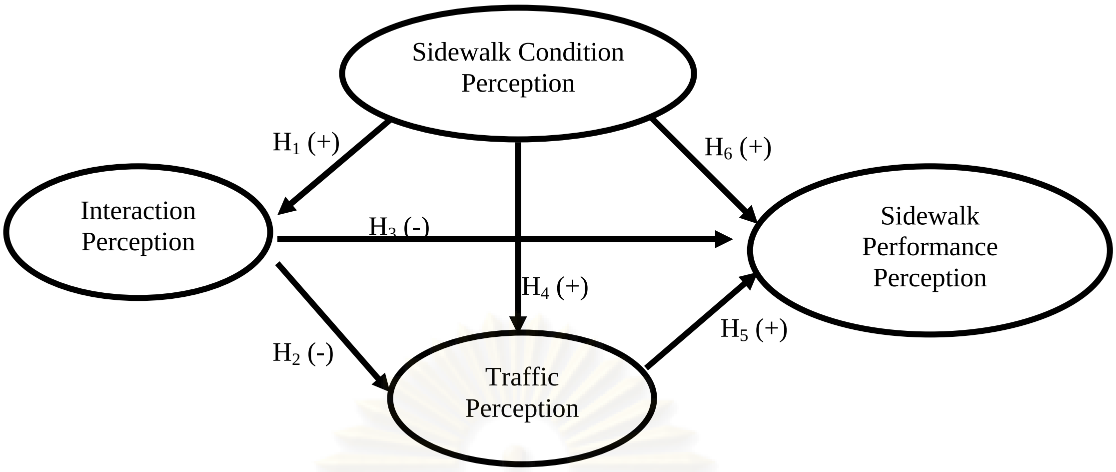


Figure 5.2 Proposed Hypothetical Model

In Figure 5.2, the four latent variables consist of pedestrian perception of sidewalk condition (*Sidewalk Condition Perception*), perception of traffic and movement (*Traffic Perception*), perception of interaction between pedestrians and street vendors (*Interaction Perception*), and perception of sidewalk performance (*Sidewalk Performance Perception*). Pedestrian opinions are empirically assessed toward their behaviors when they are encountered at the sidewalk with street vendors. The perception of interaction between pedestrians and vendors is formed when pedestrians walk along the sidewalk and have to interact with street vendors. Similarly, while walking along the sidewalk, perceptions of traffic movement and sidewalk condition are formed. These perceptions are believed to affect the sidewalk performance.

According to the proposed model, the following hypotheses among the latent variables are to be tested:

H_1: Pedestrian perception of sidewalk condition has a direct and positive effect on the pedestrian perception of the interaction between pedestrians and street vendors

H_2: Pedestrian perception of the interaction between pedestrians and street vendors has a direct and negative effect on the pedestrian perception of traffic and movement

H_3: Pedestrian perception of the interaction between pedestrians and street vendors has a direct and negative effect on the sidewalk performance

H_4: Pedestrian perception of sidewalk condition has a direct and positive effect on the pedestrian perception of traffic and movement

H_5: Pedestrian perception of traffic and movement has a direct and positive effect on the sidewalk performance

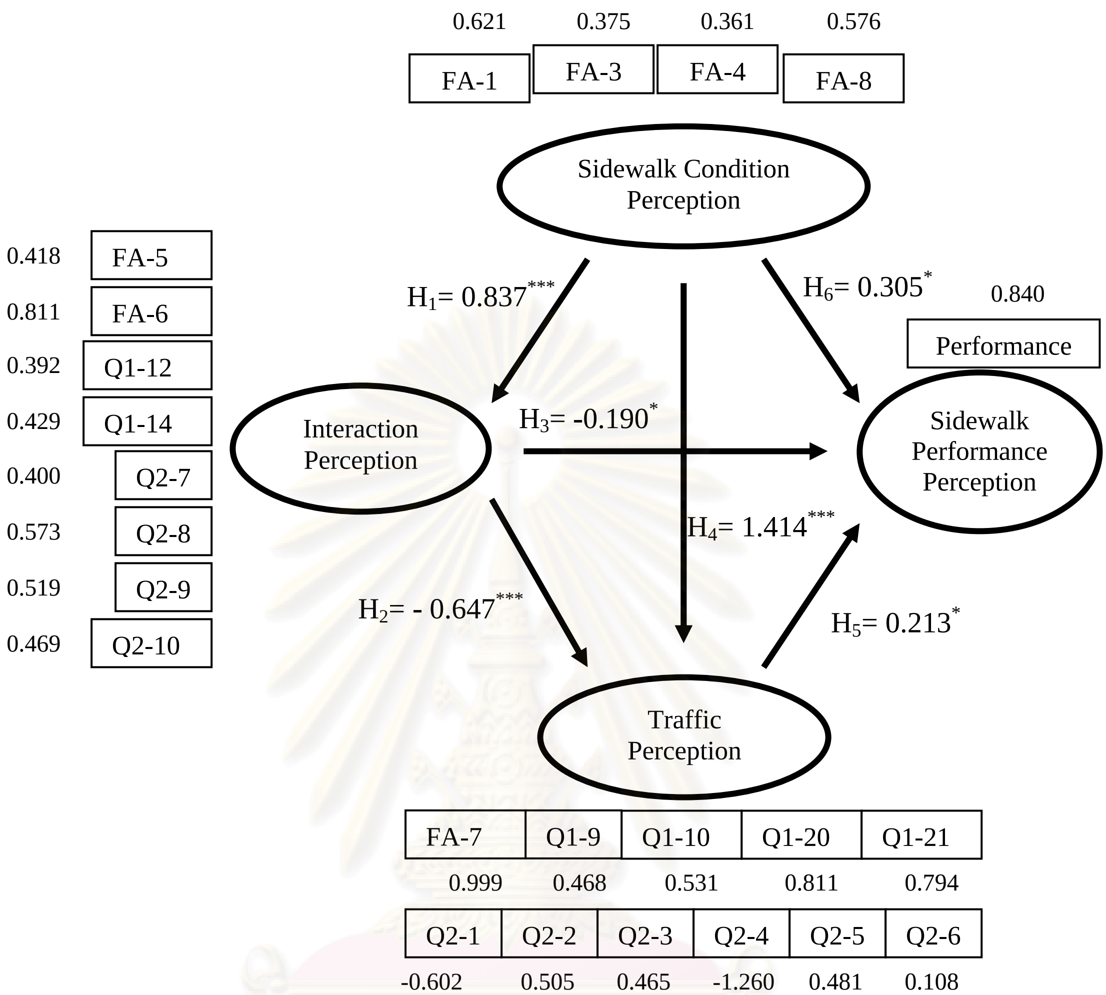
H_6: Pedestrian perception of sidewalk condition has a direct and positive effect on the sidewalk performance

B. Evaluation of the model fit

The purpose of model fit evaluation is to determine how well the hypothesized model as a whole explains the data. Once it is determined that the fit of a structural equation model to the data is adequate, performance measurement model is completed. The concept model presented in the Figure 5.2 is analyzed. Table 5.15 and Figure 5.3 present the result of SEM analysis for Bangkok dataset. This study examines some fit indices for the overall model as listed in Table 5.16. Results generally indicate a good fit for the proposed structural relationships.

Table 5.15 Path Coefficients among Latent Variables of Bangkok SEM Result

Paths	Path Coefficients
Sidewalk condition perception → Interaction perception	0.837
Interaction perception → Traffic perception	-0.647
Interaction perception → Sidewalk performance perception	-0.190
Sidewalk condition perception → Traffic perception	1.414
Traffic perception → Sidewalk performance perception	0.213
Sidewalk condition perception → Sidewalk performance perception	0.305



Note: **** p<0.001, ** p<0.01, * p<0.05*
FA-1: Comfort; FA-3: Vendor Problems; FA-4: Safety; FA-8: Sidewalk Condition;
FA-5: Vendor Regulation; FA-6: Sidewalk Interaction; FA-7: Space Availability

Figure 5.3 SEM Results for Bangkok

Table 5.16 Model Fit Indices for SEM of Bangkok

Indices	Results	Remarks
Degree of Freedom (df)	176	
Chi-Square (χ^2)	1019.277 (p<0.000)	
Goodness of Fit Index (GFI)	0.940	Good fit model
Adjusted Goodness of Fit Index (AGFI)	0.897	Good fit model
Root Mean square Residual (RMR)	0.108	Good fit model
Normed Fit Index (NFI)	0.936	Good fit model
Comparative Fit Index (CFI)	0.946	Good fit model
Root Mean Square Error of Approximation (RMSEA)	0.059	Good fit model

The overall model fit indices listed in Table 5.16 indicates a good fit of the data since all findings are within the acceptable ranges (see Table 3.1). The path coefficients denoted on the arrows in Figure 5.3 can be understood similar to regression coefficients that explain the linear relationships between two latent variables (Hair et al., 2006; Matt and Dean, 1993). In terms of statistical significance, it can be observed that the model follows postulated hypotheses in all causal paths. All postulated causal paths are statistically significant at $\alpha = 0.05$.

5.3.2 SEM Model for Jakarta

5.3.2.1 Validity of the Performance Measures and the Indicator

A. Scale reliability testing of performance measures

It should be noted that due to the internal consistency of items, some questions were discarded for Jakarta model. Table 5.17 shows the reliability test results of latent variables according to the SPSS software package analysis. Cronbach's alpha values are 0.567 for "pedestrian perception of traffic", 0.631 for "pedestrian perception of interaction", and 0.715 for "pedestrian perceptions of sidewalk condition". It can be seen that reliability value of one latent variables are greater than 0.7, indicating acceptable and good internal consistency reliability of questionnaire (Field, 2005). The alpha value of "pedestrian perception of traffic" and "pedestrian perception of interaction" are considered within the acceptable range ($\alpha = 0.6$) though it quite low (George and Mallery, 2010; Gliem and Gliem, 2003; Hair et al., 2006; Zhang, 2006).

B. Convergent validity testing of performance measures

Model parameters assessed and all factor loadings are found to be significant at $\alpha = 0.001$, as can be seen in Table 5.18. An assessment of the overall fit of the measurement model is going to be performed after presenting the final model.

Table 5.17 Latent Variables, Measurement Variables and Cronbach's alpha Coefficients of Jakarta Data

Latent variable	Measurement variable	Cronbach's α
Pedestrian perception of traffic	Q1-18: I think that vendor's displays do not obstruct pedestrian movements Q1-20: I can choose my walking speed freely Q1-21: I can overtake other pedestrians easily Q2-1: I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors Q2-5: I think pedestrians with visual impairment can walk this sidewalk easily	0.567
Pedestrian perception of interaction	Q1-12: I am interested in goods sold by vendors along this sidewalk Q1-14: I enjoy vendor activities in this sidewalk Q2-7: It is easy to interact with the vendors	0.631
Pedestrian perceptions of sidewalk condition	FA-1: Comfort FA-4: Safety Q1-5: I think that the sidewalk is flat enough to accommodate wheelchair users Q1-6: I think that the street vendors keep the sidewalk clean Q1-11: I feel comfortable walking through this sidewalk with the presence of on street vendors Q1-22: At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway Q1-23: I think that I can enter/exit to/from this sidewalk easily	0.715
Pedestrian perception of sidewalk performance	In overall, I would give _______ points for the performance of this sidewalk. (1 - 10 score where 1 for the lowest and 10 for the highest)	

Table 5.18 Latent Variables and Their Indicators with Factor Loadings of Jakarta Data

Latent variable	Indicators	Factor Loadings
Pedestrian perception of traffic	Q1-18: I think that vendor's displays do not obstruct pedestrian movements	0.485
	Q1-20: I can choose my walking speed freely	1.035
	Q1-21: I can overtake other pedestrians easily	0.996
	Q2-1: I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors	0.396
	Q2-5: I think pedestrians with visual impairment can walk this sidewalk easily	0.314

Table 5.18 Latent Variables and Their Indicators with Factor Loadings of Jakarta Data (continued)

Latent variable	Indicators	Factor Loadings
Pedestrian perception of interaction	Q1-12: I am interested in goods sold by vendors along this sidewalk	0.681
	Q1-14: I enjoy vendor activities in this sidewalk	0.835
	Q2-7: It is easy to interact with the vendors	0.382
Pedestrian perceptions of sidewalk condition	FA-1: Comfort	0.829
	FA-4: Safety	0.398
	Q1-5: I think that the sidewalk is flat enough to accommodate wheelchair users	0.342
	Q1-6: I think that the street vendors keep the sidewalk clean	0.542
	Q1-11: I feel comfortable walking through this sidewalk with the presence of on street vendors	0.606
	Q1-22: At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway	0.345
	Q1-23: I think that I can enter/exit to/from this sidewalk easily	0.463
Pedestrian perception of sidewalk performance	In overall, I would give _______ points for the performance of this sidewalk. (1 - 10 score where 1 for the lowest and 10 for the highest)	

C. Discriminant validity testing of performance measures

Relatively low correlations among variables represent the presence of discriminant validity. Inter-correlation matrices for the items of each measured variable can be seen in Table 5.19 through Table 5.21.

Table 5.19 Inter-correlations for the Variables of “Pedestrian Perception of Traffic”

	Q1_18	**Q1_20**	**Q1_21**	**Q2_1**	**Q2_5**
Q1_18	1.000				
Q1_20	0.185	1.000			
Q1_21	0.183	0.637	1.000		
Q2_1	0.287	0.146	0.023	1.000	
Q2_5	0.119	0.267	0.208	-0.004	1.000

Table 5.20 Inter-correlations for the Variables of "Pedestrian Perception of Interaction"

	Q1_12	**Q1_14**	**Q2_7**
Q1_12	1.000		
Q1_14	0.573	1.000	
Q2_7	0.151	0.345	1.000

Table 5.21 Inter-correlations for the Variables of "Pedestrian Perception of Sidewalk Condition"

	FA-1	**FA-4**	**Q1_5**	**Q1_6**	**Q1_11**	**Q1_22**	**Q1_23**
FA-1	1.000						
FA-4	0.229	1.000					
Q1_5	0.189	0.249	1.000				
Q1_6	0.466	0.274	0.271	1.000			
Q1_11	0.530	0.242	0.121	0.416	1.000		
Q1_22	0.458	0.155	-0.016	0.162	0.154	1.000	
Q1_23	0.442	0.364	0.162	0.259	0.251	0.515	1.000

Note: FA-1: Comfort; FA-4: Safety

All inter-correlation calculated for all constructs are below 0.90, indicating that multicollinearity do not exist but implying that the constructs have discriminant validity (Hair et al., 2006). The inter-correlation in Table 5.19 through Table 5.21 provides evidence that the variables are different from each other and they are complementary.

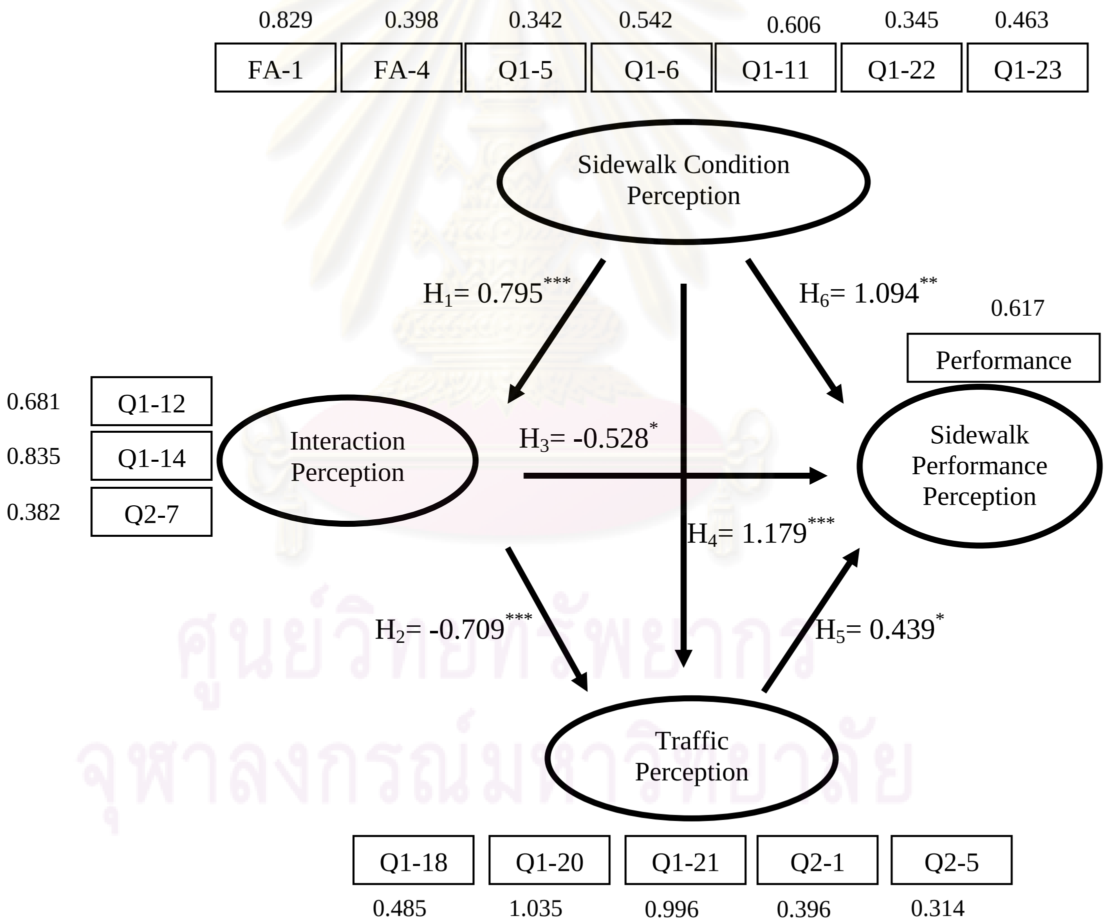
5.3.2.2 Analysis of the Structural Performance Model with SEM

For the first step, specification of the model, the hypothesized model and hypotheses of structural relationships among latent variables are similar to the concept model which is presented in Bangkok data set or Section 5.3.1.2 (see Figure 5.2).

For evaluation of the model fit step, the analyses of the hypothesized structural model are undertaken by testing the hypothesized model, which specified the six casual relationships in Figure 5.2. In testing the hypothesized model of Jakarta dataset, the results are presented in Table 5.22 and Figure 5.4. Table 5.23 indicates a good fit for the proposed structural relationships.

Table 5.22 Path Coefficients among Latent Variables of Jakarta SEM Result

Paths	Path Coefficients
Sidewalk condition perception → Interaction perception	0.795
Interaction perception → Traffic perception	-0.709
Interaction perception → Sidewalk performance perception	-0.528
Sidewalk condition perception → Traffic perception	1.179
Traffic perception → Sidewalk performance perception	0.439
Sidewalk condition perception → Sidewalk performance perception	1.094



Note: *** *p<0.001*, ** *p<0.01*, * *p<0.05*
FA-1: Comfort; FA-4: Safety

Figure 5.4 SEM Results for Jakarta

Table 5.23 Model Fit Indices for SEM of Jakarta

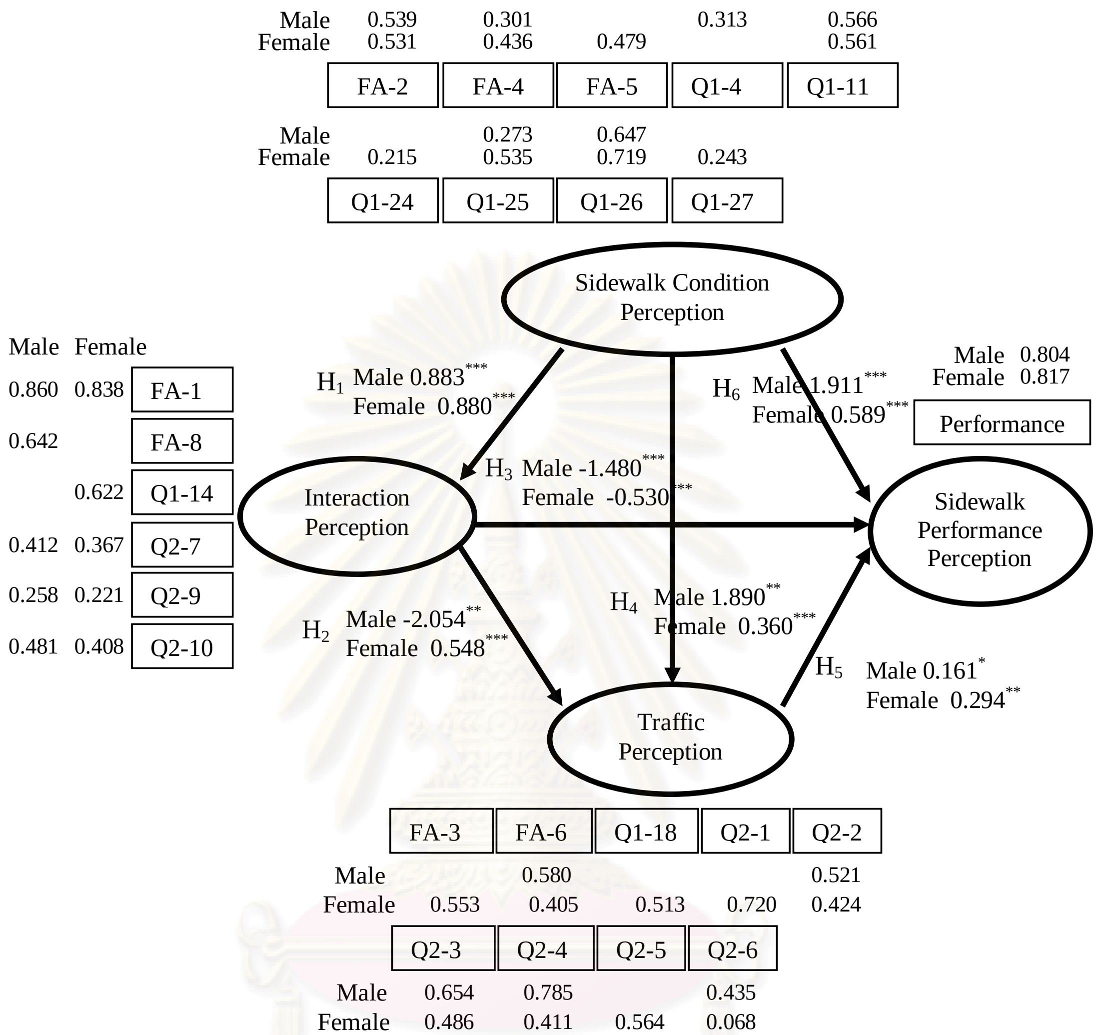
Indices	Results	Remarks
Degree of Freedom (df)	73	
Chi-Square (χ^2)	318.810 ($p<0.000$)	
χ^2/df	4.367	Good fit model
Goodness of Fit Index (GFI)	0.932	Good fit model
Adjusted Goodness of Fit Index (AGFI)	0.873	Good fit model
Root Mean square Residual (RMR)	0.109	Good fit model
Normed Fit Index (NFI)	0.891	Good fit model
Comparative Fit Index (CFI)	0.912	Good fit model
Root Mean Square Error of Approximation (RMSEA)	0.080	Good fit model

Table 5.23 implies a good fit of the data. The χ^2/df ratios are 4.367, which indicate reasonable model fit since the ratio falls between 2.0 and 5.0 (Hair et al., 2006; Shook et al., 2004). The path coefficients denoted on the arrows in Figure 5.4 can be read similar to regression coefficients that explain the linear relationships between two latent variables (Hair et al., 2006; Matt and Dean, 1993). Regarding statistical significance, the model agree with postulated hypotheses since all postulated causal paths are statistically significant at $\alpha = 0.05$.

5.3.3 SEM Model Based on Respondent's Characteristics

5.3.3.1 SEM Model Based on Gender

Figure 5.5 present the result of SEM analysis based on the respondent's gender. This study examined some fit indices for the overall model as listed in Table 5.24. Results generally indicate a good fit for the proposed structural relationships.



Note: **** p<0.001, ** p<0.01, * p<0.05*
FA-1: Sidewalk Interaction; FA-8: Vendor Attraction;
FA-2: Comfort; FA-4: Safety; FA-5: Vendor Problems;
FA-3: Space Availability; FA-6: Walking Path

Figure 5.5 SEM Results Based on Gender

The overall model fit indices listed in Table 5.24 indicates a good fit of the data since all findings are within the acceptable ranges (see Table 3.1). The χ^2/df ratios are 4.948 and 4.916, which indicate reasonable model fit since the ratio falls between 2.0 and 5.0 (Hair et al., 2006; Shook et al., 2004). In terms of statistical significance, it can be observed that the model follows postulated hypotheses in all causal paths. All postulated causal paths are statistically significant at $\alpha = 0.05$.

Table 5.24 Model Fit Indices for SEM Based on Gender

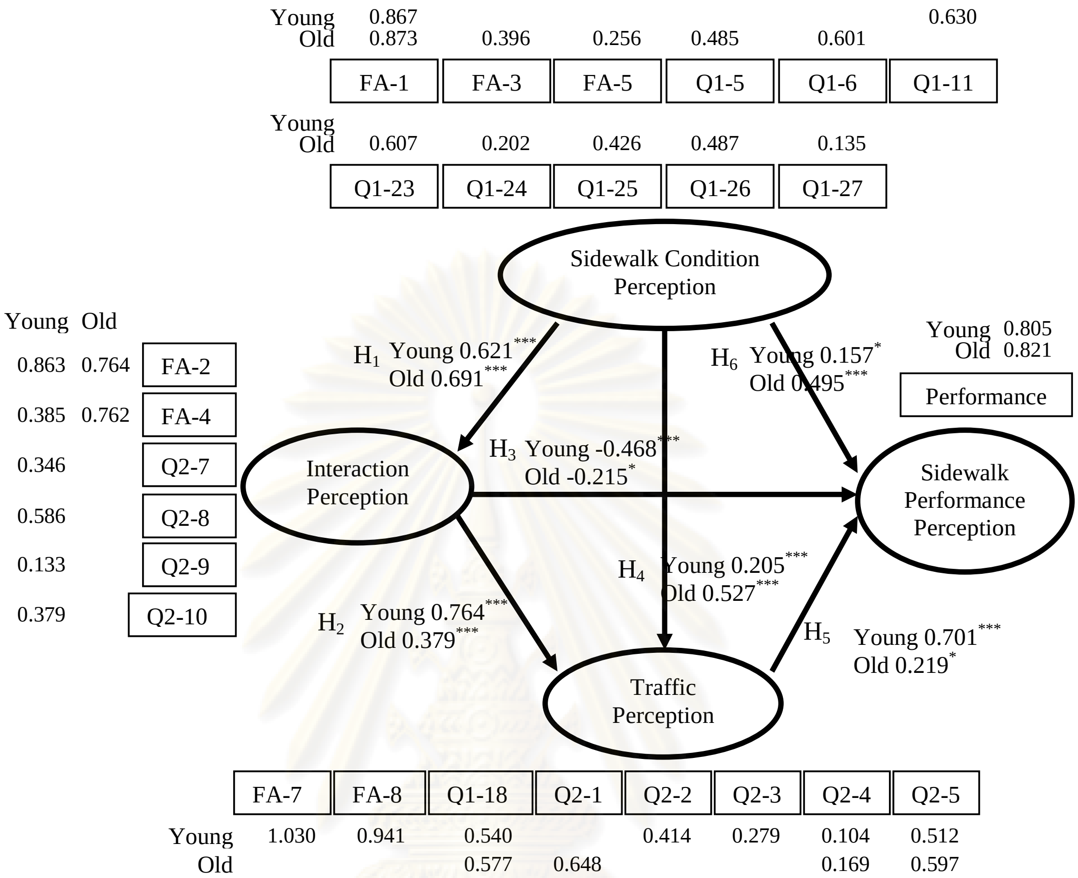
Indices	Genders		Remarks
	Male	Female	
Degree of Freedom (df)	70	167	
Chi-Square (χ^2)	346.352 ($p<0.000$)	821.051 ($p<0.000$)	
χ^2/df	4.948	4.916	Good fit model
Goodness of Fit Index (GFI)	0.961	0.924	Good fit model
Adjusted Goodness of Fit Index (AGFI)	0.914	0.874	Good fit model
Normed Fit Index (NFI)	0.920	0.884	Good fit model
Comparative Fit Index (CFI)	0.934	0.904	Good fit model
Root Mean Square Error of Approximation (RMSEA)	0.064	0.064	Good fit model

5.3.3.2 SEM Model Based on Age

In testing the hypothesized model based on respondent's age, the results are presented in Figure 5.6. Table 5.25 summarizes the result of goodness of fit test and it can be seen that the results indicate a good fit for the proposed structural relationships.

Table 5.25 Model Fit Indices for SEM Based on Age

Indices	Ages		Remarks
	Young	Old	
Degree of Freedom (df)	60	91	
Chi-Square (χ^2)	267.908 ($p<0.000$)	493.260 ($p<0.000$)	
Goodness of Fit Index (GFI)	0.971	0.932	Good fit model
Adjusted Goodness of Fit Index (AGFI)	0.935	0.872	Good fit model
Normed Fit Index (NFI)	0.942	0.899	Good fit model
Comparative Fit Index (CFI)	0.954	0.915	Good fit model
Root Mean Square Error of Approximation (RMSEA)	0.056	0.076	Good fit model



Note: **** p<0.001, ** p<0.01, * p<0.05*

FA-1: Comfort; FA-3: Safety; FA-5: Vendor Problems

FA-2: Sidewalk Interaction; FA-4: Vendor Attraction

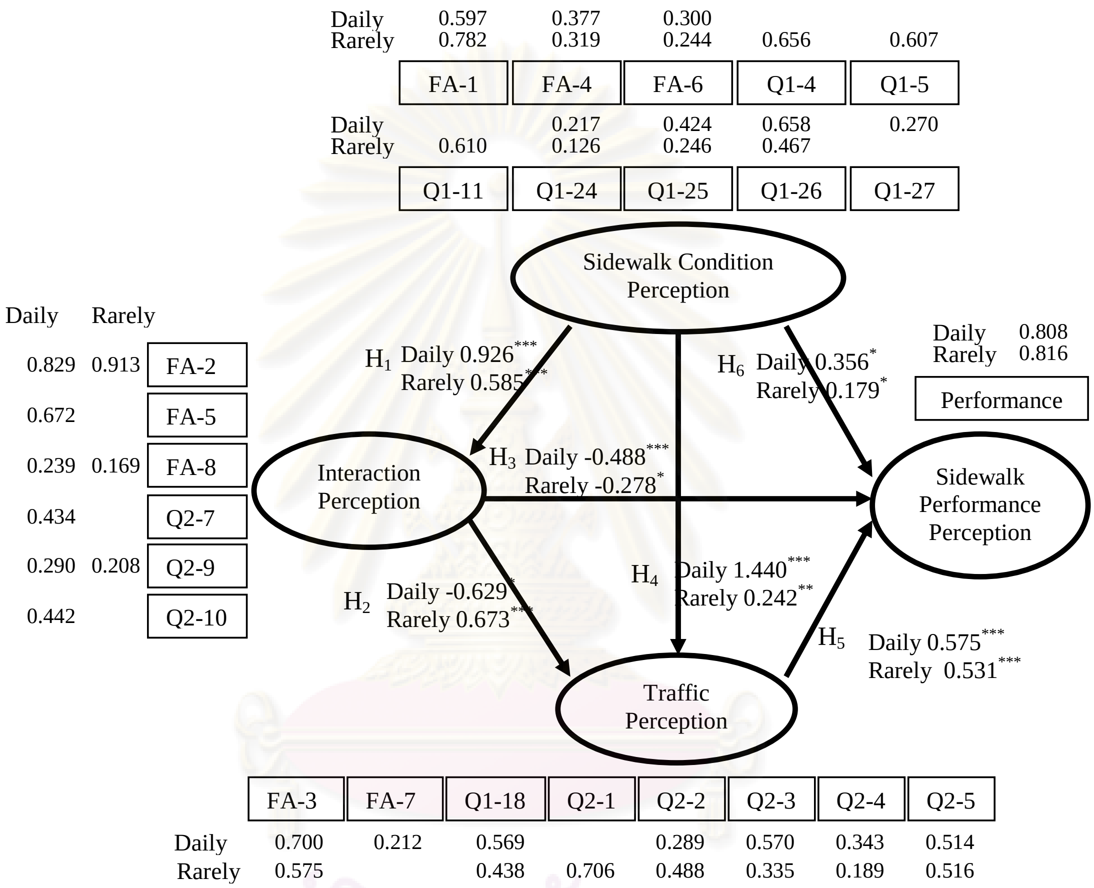
FA-7: Walking Path; FA-8: Space Availability

Figure 5.6 SEM Results Based on Age

The overall model fit indices listed in Table 5.25 show a good fit of the data since all findings are within the acceptable ranges (see Table 3.1). The path coefficients denoted on the arrows in Figure 5.6 can be understood similar to regression coefficients that explain the linear relationships between two latent variables (Hair et al., 2006; Matt and Dean, 1993). In terms of statistical significance, it can be observed that the model follows postulated hypotheses in all causal paths. All postulated causal paths are statistically significant at $\alpha = 0.05$.

5.3.3.3 SEM Model Based on Walking Frequency

Results of testing the hypothesized model based on walking frequency are detailed in Figure 5.7. Table 5.26 shows model fit indices and results indicate a good fit for the proposed structural relationships.



Note: *** *p<0.001*, ** *p<0.01*, * *p<0.05*

FA-1: Comfort; FA-4: Safety; FA-6: Vendor Problems

FA-2: Sidewalk Interaction; FA-5: Vendor Attraction; FA-8: Vendor Regulation

FA-3: Space Availability; FA-7: Walking Path

Figure 5.7 SEM Results Based on Walking Frequency

The overall model fit indices listed in Table 5.26 show a good fit of the data since all findings are within the acceptable ranges (see Table 3.1). In terms of statistical significance, it can be observed that the model follows postulated hypotheses in all causal paths. All postulated causal paths are statistically significant at $\alpha = 0.05$.

Table 5.26 Model Fit Indices for SEM Based on Walking Frequency

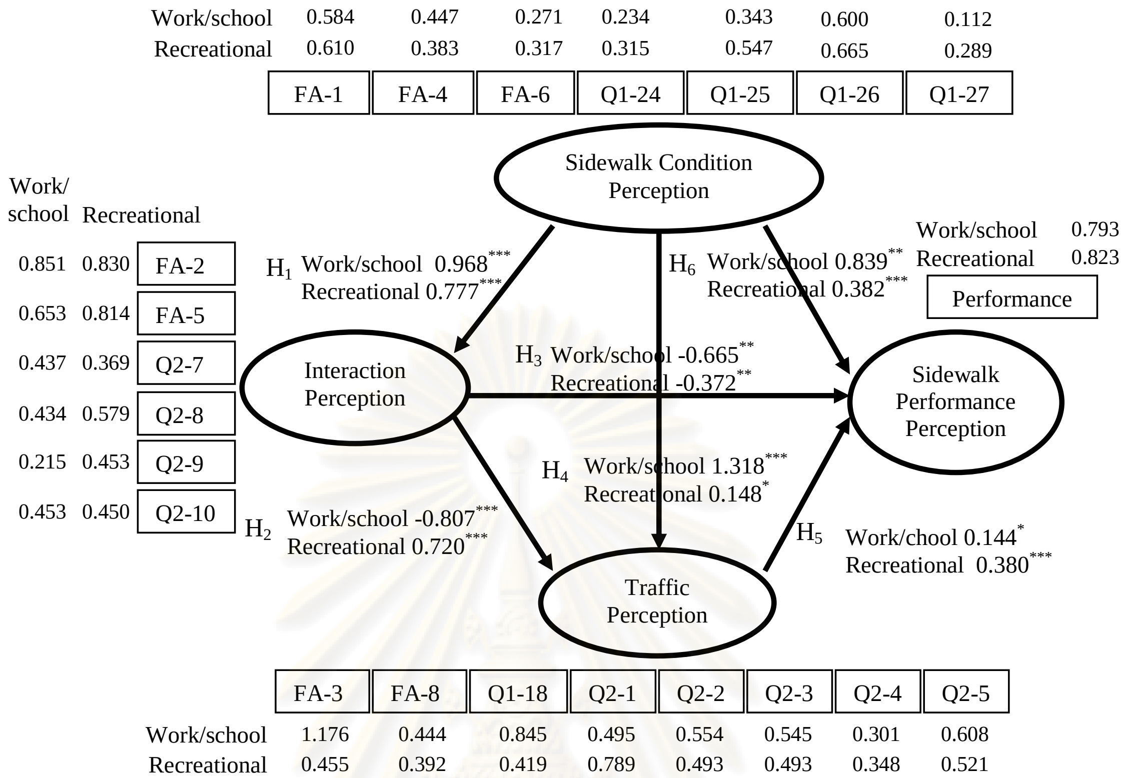
Indices	Walking Frequencies		Remarks
	Daily	Rarely	
Degree of Freedom (df)	115	140	
Chi-Square (χ^2)	1014.218 ($p<0.000$)	587.444 ($p<0.000$)	
Goodness of Fit Index (GFI)	0.925	0.912	Good fit model
Adjusted Goodness of Fit Index (AGFI)	0.850	0.855	Good fit model
Normed Fit Index (NFI)	0.867	0.857	Good fit model
Comparative Fit Index (CFI)	0.879	0.885	Good fit model
Root Mean Square Error of Approximation (RMSEA)	0.079	0.071	Good fit model

5.3.3.4 SEM Model Based on Trip Purpose

Result of SEM analysis based on respondent's trip purposes is illustrated in Figure 5.8, and then some fit indices for overall model are listed in Table 5.27. The results indicate a good fit for the proposed structural relationships since all findings are within the acceptable ranges (see Table 3.1). All causal paths are statistically significant at $\alpha = 0.05$.

Table 5.27 Model Fit Indices for SEM Based on Trip Purpose

Indices	Trip Purposes		Remarks
	Work/school	Recreational	
Degree of Freedom (df)	126	139	
Chi-Square (χ^2)	742.678 ($p<0.000$)	654.044 ($p<0.000$)	
Goodness of Fit Index (GFI)	0.926	0.939	Good fit model
Adjusted Goodness of Fit Index (AGFI)	0.865	0.888	Good fit model
Normed Fit Index (NFI)	0.864	0.902	Good fit model
Comparative Fit Index (CFI)	0.883	0.920	Good fit model
Root Mean Square Error of Approximation (RMSEA)	0.074	0.063	Good fit model



Note: *** *p<0.001, ** p<0.01, * p<0.05*

FA-1: Comfort; FA-4: Safety; FA-6: Vendor Problems

FA-2: Sidewalk Interaction; FA-5: Vendor Attraction;

FA-3: Space Availability; FA-8: Walking Path

Figure 5.8 SEM Results Based on Trip Purpose

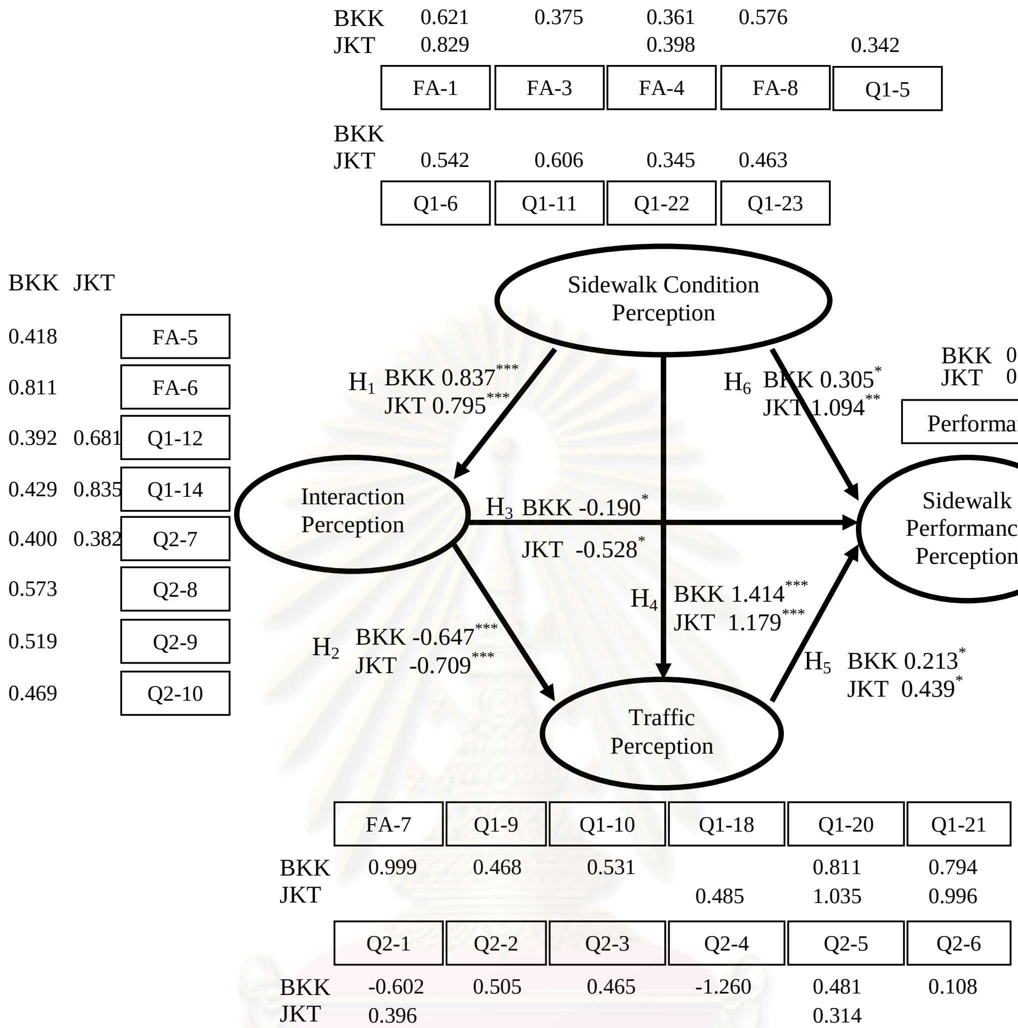
Chapter VI
Discussion

In this chapter, major findings of the study are investigated and discussed in comparison with the findings of the similar previous researchers. In this study, a SEM technique was used to distinguish variables that affect the sidewalk performance directly or indirectly. Results of testing the hypothesized model for Bangkok and Jakarta data set, shown in Figure 6.1 (incorporation of Figure 5.3 and Figure 5.4), indicate the suitability of the sidewalk performance model for each path based on several factors.

6.1 SEM Model for Bangkok and Jakarta

6.1.1 Effect of Interaction Perception on Traffic Perception

From Figure 6.1, it can be seen that based on the p-values all of the causal paths can be statistically accepted. The effect of pedestrian interactions with street vendors is reported to have a significant negative effect on pedestrian perception of traffic in Bangkok and Jakarta, which conformed to our hypothesis. Street vendor activities on the sidewalk profoundly change the environment of walking space. Although the wider size of sidewalk is available, effective width to be used for walking movement decrease significantly. Studied by Zulkifli et al. (2009) revealed that presences of other activities in the sidewalk leave less than 35 percent of the space for walking movement. The pedestrian traffic flow also changed, when they face many obstacles on their paths, they tend to move at a slightly slower speed and make maneuvers to avoid the obstacles, as a result they need time longer than normal condition.



Note: **** p<0.001, ** p<0.01, * p<0.05*

FA-1: Comfort; FA-3: Vendor Problems; FA-4: Safety; FA-8: Sidewalk Condition

FA-5: Vendor Regulation; FA-6: Sidewalk Interaction;

FA-7: Space Availability

Figure 6.1 SEM Results of Bangkok and Jakarta Dataset

6.1.2 Effect of Sidewalk Condition Perception on Interaction Perception

From the model estimation results, pedestrian perception of sidewalk condition is found to have a positive influence on respondent's interaction with vendors and other pedestrians. This agreed with a former study by Zacharias (2001) where he found that once walking along the sidewalk with specific environment/activities, pedestrians feel a variety of sensation relating to the actual conditions. Then, they would make a series of judgments and decisions to adopt and navigate the environment. When walking in commercial districts, pedestrians would anticipate certain activities and situations that they face during their walking trip along the sidewalk.

In terms of interaction aspect, wider size and better condition of the sidewalk will attract more people activities. Depend on characteristics of culture, some Southeast Asian countries have unique sidewalk function. The roads role is not only for walking or cycling, but also as a place for people activities in related with economic and social purposes, such as speaking to friends, sitting for eating, shopping, and sightseeing. Therefore, establishing policies and management to control street vendors and other activities on the sidewalk is good starting point in order to encourage walking activities. More advantages can be accepted with the planning of integration of these activities, so the sidewalks can attract more economic and profitable activities without neglecting walking activities.

6.1.3 Effect of Interaction Perception on Sidewalk Performance Perception

Consistent in both Bangkok and Jakarta data, pedestrian interaction is found to have a negative and significant effect on sidewalk performance. This finding is in line with our hypothesized. Since most of the respondents are commuters who go to/from work or school, they do not feel comfortable with the existence of street vendors along the sidewalk. Thus, they would perceive street vendors as an impediment that reduces sidewalk service level. As a reference, a study by Kim et al. (2008) revealed that the larger the dimensions of the street furniture, the greater the impact on pedestrian level of service. Vending often generates more activities by attracting pedestrians to contact with vendors, such as waiting for service. The vendor impact significantly reduces the sidewalk performance by decreasing the level of service, as measured by area per pedestrian and flow rate (Kim et al., 2008). In our study, pedestrians in Jakarta have a stronger negative effect than those in Bangkok, primarily because vendor activities occupy larger space on the sidewalk and they remain only narrow space for walking movements.

6.1.4 Effect of Sidewalk Condition Perception on Traffic Perception

Figure 6.1 shows that pedestrian perception of sidewalk condition has a positive significant effect on pedestrian perception of traffic. This finding is agree with studied by Zulkifli et al (2009) that mentioned where sidewalks are narrow or broken and many obstacles exist, it would influence the pattern of pedestrian traffic movement such as avoid the obstacles by walking in the road shoulder or roadway which is very risk for both pedestrians and drivers. Even the sidewalks have sufficient space, but their capacity is reduced because part of the space has been used to accommodate facilities. Also, the discontinuity of the sidewalks result inconveniently for walking (Pamanikabud and Pichittanapanya, 2003).

6.1.5 Effect of Traffic Perception on Sidewalk Performance Perception

From our model, pedestrian perception of traffic has a positive and significant effect on pedestrian perception of sidewalk performance. From literatures, pedestrian traffic is considered an important factor to assess sidewalk performance (Huang and Chiun, 2007; Tan et al., 2007; TRB, 2000). As indicated in our SEM results, good sidewalk traffic condition can raise pedestrian perception of performance. One of the indicator of pedestrian level of service in some methods is pedestrian traffic (Huang and Chiun, 2007; Landis et al., 2001; Tan et al., 2007; TRB, 2000). Higher level of service represents better performance of the sidewalk and stated with better traffic condition such as higher speed, lower density, and higher volume.

6.1.6 Effect of Sidewalk Condition Perception on Sidewalk Performance Perception

Similarly, pedestrian perception of sidewalk condition is found to have a positive impact on sidewalk performance. According to Sarkar (2003), a comfortable environment would make walking trip more pleasant and enjoyable, and the key attributes of comfort could be used to qualitatively grade the physical, physiological, and psychological comfort levels of sidewalk. Also, Zulkifli et al. (2009) revealed that the tendency of satisfaction level is consistent with the condition of location, pedestrian in ‘good’ sidewalk condition are more satisfied compared to pedestrian in 'bad' area. It can be stated that the availability of facilities is parallel with the satisfaction level. Jaskiewicz (2000) suggested that attention should be paid to pedestrian comfort and safety in order to encourage walking as an alternative form of transportation mode. Through SEM analysis in this study, it can be seen that the effect of sidewalk condition is found to be stronger in Jakarta than Bangkok. Most of sidewalk conditions in Jakarta are crowded by non walking activities, such as parking and vendors, improper plants, and improper public facilities like phone booths and electrical/phone poles that can make walking inconvenient. This is one of the reasons why walking is not popular travel mode in Jakarta in comparing to vehicle base mode.

6.2 Overall Discussion on the Structural Relations among the Variables

Given the strong path coefficients, the hypothesis set forward in this study appears to hold true. Not only "interaction perception", "sidewalk condition perception" and "traffic perception" have direct affect on sidewalk performance, but "interaction perception" and "sidewalk condition perception" also appeared to have an indirect impact on sidewalk performance.

Table 6.1 summarizes the direct and indirect effects of latent variables on sidewalk performance model. The results show that "interaction perception", "traffic perception", and "sidewalk condition perception" have direct effects on sidewalk performance perception. However, "interaction perception" and "sidewalk condition perception" have indirect effect on sidewalk performance perception as well.

The total effect of pedestrian perception of interaction between pedestrians and street vendors on sidewalk performance, which is the sum of indirect and direct effects, is found to be -0.328 and -0.839 for Bangkok and Jakarta, respectively. The total effect of pedestrian perception of sidewalk condition on sidewalk performance is found to be 0.332 and 0.944 for Bangkok and Jakarta, respectively, while the total effect of pedestrian perception of traffic on sidewalk performance is found to be 0.213 for Bangkok and 0.439 for Jakarta.

Table 6.1 Estimates of Direct and Indirect Effect on Sidewalk Performance

Causal Paths	Effects	Bangkok	Jakarta
Interaction → sidewalk performance	Indirect effect	-0.138	-0.311
	Direct effect	-0.190	-0.528
	Total effect	**-0.328**	**-0.839**
Sidewalk Condition → sidewalk performance	Indirect effect	0.027	-0.150
	Direct effect	0.305	1.094
	Total effect	***0.332***	***0.944***
Traffic → sidewalk performance	Direct effect	**0.213**	**0.439**

These results indicate that the most important determinant for sidewalk performance in Bangkok and Jakarta are pedestrian perception of sidewalk condition. In some commercial areas in Bangkok, most of sidewalk widths are not sufficient to accommodate sidewalk user's activities. Even supporting facilities are established, such as pedestrian bridge and lighting, pedestrians argue that the most important aspect in considering performance appears to be sidewalk condition. This finding agrees with several previous researchers that sidewalk environment is an important aspect to assess comfort, convenient, and safety requirements (Jaskiewicz, 2000; Rahaman et al., 2005; Sarkar, 2003; Zulkifli et al., 2009). On the other hand, Jakarta still has a problem with sidewalk infrastructure and law enforcement. Most of the sidewalks currently do not have supporting facilities for pedestrians; thus, pedestrians perceive that the development of sidewalk environment is the most urgent action to enhance sidewalk performance. The biggest problems on factor affecting walking preference in Jakarta are discontinuity and narrow of sidewalk, and unsafe distance with vehicle traffic (Zulkifli et al., 2009). For future planning purposes, encouraging walking activities may be accomplished by increasing safety and comfort, in addition to volume and capacity factors (Jaskiewicz, 2000).

Walking activities can be improved by identifying factors that would encourage people to walking more often. Based on these identified factors, some effort should be done to improve sidewalk condition. The condition of location is strongly influence the satisfaction level for pedestrians (Zulkifli et al., 2009). Therefore, improvement of existing sidewalk infrastructure will encourage people for walking more often.

The findings implied that this study has introduced a method to measure sidewalk performance in subjective (qualitative) terms. The strong paths coefficients among the constructs of the model are an indication that qualitative dimensions of sidewalk performance have been proven to be effective as the traditional objective dimensions.

6.3 Important Variables Based on Respondent's Characteristics

In analyzing SEM model based on the respondent's characteristics, as depicted in Figure 5.5 through Figure 5.8, it can be seen that based on the p-values of the all causal paths can be statistically accepted. Four criterions of characteristics were investigated in order to identify differences of the proposed model, namely gender, age, walking frequency, and trip purpose.

SEM model based on gender, walking frequency, and trip purpose found to have difference sign with the proposed model. The effect of pedestrian perception of interaction is reported to have a significant negative effect on pedestrian perception of traffic in male, daily, and work/school groups, which is conformed to our hypothesis, but such effect is found to be positive for female, rarely, and recreational respondents. This findings are make sense that the female, lower frequency of walking, and recreational purposes groups tend to enjoy their walking by look around and sightseeing or enjoy to shopping, so they less care in traffic situation. Also, studied by Zulkifli et al. (2009) revealed that people with lower frequency of walking are more satisfied in comparison with peoples with higher frequency of walking per week.

Differences with hypothesized model are found in SEM model based on age, as well. Both of younger and older group perceptions on interaction are reported to have a positive effect on pedestrian perception of traffic. Relating to the characteristic of the culture, road function is not only for walking, but also for the activities in related with economic and social purposes such as speaking to friends, sitting for eating, and shopping (Zulkifli et al., 2009). The older group more consider their safety and more cautious behavior when facing a specific traffic situation like in commercial area (Bernhoft and Carstensen, 2008). Even the younger group generally finds to state that it important to move as fast as possible and directly in traffic, they can make various maneuver to avoid the obstructions, whereas the older group takes into account the sidewalk real condition (Zacharias, 2001) and they are feel convenience even facing stop and go situation during their walking movement along the sidewalk.

Table 6.2 through Table 6.5 summarize the direct and indirect effects of latent variables on sidewalk performance model. Total effect is sum of indirect and direct effect that represents importance of each latent variable on sidewalk performance. Table 6.2 indicates that the most important determinant (the largest total effect) for sidewalk performance in male group is pedestrian perception of interaction, whereas the most important determinant for sidewalk performance in female group is perception of sidewalk condition. These findings agree with previous finding that factor of “vendor attraction” is considered important in male group. Negative impact of interaction on male groups indicates that this variable important but the male group is not satisfy with the interaction activities along the sidewalks, they think that vendor activities are an obstruction for walking. Agree with studied by Bernhoft and Carstensen (2008), that stated male often select the fastest and directly route when walking, otherwise female group take more appreciate on sidewalk facilities such as availability of lighting, crossing bridge and other support facilities on comfort and safety.

Table 6.2 Estimates of Direct and Indirect Effect on Sidewalk Performance Based on Gender

Causal Paths	Effects	Male	Female
Interaction → sidewalk performance	Indirect effect	-0.331	0.161
	Direct effect	-1.480	-0.530
	Total effect	***-1.811***	**-0.369**
Sidewalk condition → sidewalk performance	Indirect effect	-1.295	-0.219
	Direct effect	1.911	0.589
	Total effect	**0.616**	***0.370***
Traffic → sidewalk performance	Direct effect	**0.161**	**0.294**

It can be seen in Table 6.3 that the most important determinant for sidewalk performance for young group is perception of traffic and movement, whereas the most important determinant for sidewalk performance for old group is perception of sidewalk condition. This statement conform to a study conducted by Bernhoft and Carstensen (2008), that revealed younger group of pedestrian generally found it is important to move fast and directly in traffic, since they tend to be in a hurry. Providing even surface of sidewalk is important based on older pedestrian group perception, because uneven surface can be the cause of some safety problems such as falling, tripping, or slipping. The older pedestrian tents to be careful and gives more concern on their safety than younger group. Therefore, they give more attention on pedestrian facilities such as lighting and crossing bridge to increase their feeling of safety and comfort.

Table 6.3 Estimates of Direct and Indirect Effect on Sidewalk Performance Based on Age

Causal Paths	Effects	Young	Old
Interaction → sidewalk performance	Indirect effect	0.536	0.083
	Direct effect	-0.468	-0.215
	Total effect	**0.068**	**-0.132**
Sidewalk condition → sidewalk performance	Indirect effect	0.186	0.024
	Direct effect	0.157	0.495
	Total effect	**0.343**	***0.519***
Traffic → sidewalk performance	Direct effect	***0.701***	**0.219**

Table 6.4 and Table 6.5 show the most important determinant for sidewalk performance for daily walking frequency and go to/from work/school group are perception of interaction, whereas the most important determinant for sidewalk performance for rarely and recreational group are perception of traffic. For daily walkers and go to/from work/school groups, the most important variable is interaction activities that found to have negative influence on sidewalk performance. As commuters, they feel that vendor activities on the sidewalk in an obstruction because generally they want to save the time and tend to walk in a hurry. For rarely walkers and recreational groups, they think interaction activities is not a problem, rather than negative impact, it is found that interaction activities have positive effect for rarely walkers group, and even found to have negative impact for recreational group, the effect is quite small. People that rarely walking in those locations and recreational

purpose group tent to be satisfied with their trip. The most important variable for rarely walker and recreational group are traffic condition that found to have the biggest total effect value, as can be seen in Table 6.4 and Table 6.5. They concern on traffic condition, when face crowded condition or found many delays, they cannot enjoy walking as recreational activities.

Table 6.4 Estimates of Direct and Indirect Effect on Sidewalk Performance Based on Walking Experience

Causal Paths	Effects	Daily	Rarely
Interaction → sidewalk performance	Indirect effect	-0.362	0.357
	Direct effect	-0.488	-0.278
	Total effect	***-0.850***	**0.079**
Sidewalk condition → sidewalk performance	Indirect effect	0.041	0.175
	Direct effect	0.356	0.179
	Total effect	**0.397**	**0.354**
Traffic → sidewalk performance	Direct effect	**0.575**	***0.531***

Table 6.5 Estimates of Direct and Indirect Effect on Sidewalk Performance Based on Trip Purposes

Causal Paths	Effects	Work/School	Recreational
Interaction → sidewalk performance	Indirect effect	-0.116	0.274
	Direct effect	-0.665	-0.372
	Total effect	***-0.781***	**-0.098**
Sidewalk condition → sidewalk performance	Indirect effect	-0.566	-0.020
	Direct effect	0.839	0.382
	Total effect	**0.273**	**0.362**
Traffic → sidewalk performance	Direct effect	**0.144**	***0.380***

6.4 Level of Service Model

To establish level of service model, this study develops a model use multiple regression analysis. Confirm to the objectives of study that independent variables are incorporation of qualitative and quantitative variables, this study finds the variables in the best model are: comfort (pedestrian feeling of comfort), vendor's attraction (pedestrian perception on intention to interact with vendor), and pedestrian volume. Even R square value is low (R^2 = 0.603), the proposed model tries to focus on establishing pedestrian level of service for sidewalk segment in the commercial area with street vendor activities by considering pedestrian perceptions as the independent variable, in addition to pedestrian volume.

By including pedestrian perception on sidewalk condition, the proposed model provides different point of view in assessing sidewalk performance. Most of previous models take into account traditional variables traffic, geometry, and road physical characteristics (Huang and Chiun, 2007; Landis et al., 2001; TRB, 2000) and road environment (Jaskiewicz, 2000; Sarkar, 2003). Also, by considering of street vendor activities variables, this model agree with study by Byrd and Sisiopiku (2006) and Jaskiewicz (2000) that recommended a combined model must be developed to incorporate the main quantitative and qualitative variables, and specific urban characteristics. The model is useful for evaluation of the sidewalk in the commercial districts in developing cities. Street vendor activity is one of the unique sidewalk characteristic that is found mostly in the developing cities only. Their obstructions in walking movement are not taken into account in the previous pedestrian LOS model that came from developed countries.

Chapter VII

Conclusion and Recommendation

7.1 Conclusions

Sidewalk performance can be assessed by many ways, such as based on pedestrian/vehicle traffic, physical geometry, environment, and user perceptions. Most of previous sidewalk performance studies were performed using quantitative variables such as pedestrian space, pedestrian and/or vehicle traffic, and sidewalk width (Huang and Chiun, 2007; Landis et al., 2001; TRB, 2000). Pedestrian opinions can be used for determining adequate levels of service from the road user's perspective. Some previous studies considered qualitative variables to determine level of service. For instance, Tan et al. (2007) collected pedestrian perceptions about their feelings of safety and comfort, although the pedestrian level of service model was proposed based on quantitative variables, including bicycle traffic, pedestrian traffic, vehicle traffic, driveway access quantity, and distance between sidewalk and vehicle lane. Sarkar (2003) introduced some theoretical guidelines for qualitative evaluation of the levels of comfort offered along walkways in major activity centers (urban areas). Observations from urban design, environmental psychology, landscape architecture and urban planning were utilized in the study. The method is expected to offer a useful framework to assess comfort requirements in order to efficiently provide pedestrian circulation system in major activity centers. In a similar vein, Jaskiewicz (2000) proposed a method for evaluating pedestrian LOS based on trip quality. Nine specific items were measured for evaluating pedestrian systems in terms of pleasantness, safety and functionality. The research revealed that pedestrian level of service needs more than volumes and capacities. To make walking a more attractive mode of transportation, it was essential to pay more attention to pedestrian comfort and safety in addition to volume and capacity factors. Rahaman et al. (2005) tried to explore the qualitative level of comfort of pedestrians in Dhaka City by offering six broad categories of roadside walking environment in terms of safety, security, convenience and comfort, continuity of the walkway, system coherence and attractiveness of some specific facilities. Similarly, Kim et al. (2008) studied the impact of street furniture on pedestrian level of service in Waikiki, Hawai. The impact of fourteen different furniture was observed and results revealed that the larger the dimension of the street furniture, the greater the impact on pedestrian level of service.

Generally, studies described above take into account pedestrian opinions regarding sidewalk performance; however, such opinions were not included as one of the variables in the level of service model (Jaskiewicz, 2000; Rahaman et al., 2005; Tan et al., 2007). In some studies, only safety and comfort of pedestrian are considered as important aspects (Rahaman et al., 2005; Sarkar, 2003; Tan et al., 2007). Considering these findings, it can be said that pedestrian opinions about behavior, traffic, and sidewalk performance as qualitative variables are important for inclusion in the sidewalk performance measurement.

Therefore, this study attempts to examine potential relationships among those variables and sidewalk performance. In this study, field observations are performed in the sidewalk where street vendors exist along the sidewalk. Therefore, pedestrian opinions would incorporate street vendor activities in correlation with sidewalk level of service. Street vendors are considered important factors in the present study because it is a unique characteristic in the sidewalk particularly in some developing countries.

Hence, considering the needs of the overall sidewalk performance assessment, this study is conducted to measure the sidewalk performance by investigating the relationships among four latent variables (constructs), namely, “interaction perception”, “sidewalk condition perception”, “traffic perception”, and “sidewalk performance perception”. All the latent variables have their observed variables with a total number of 46 variables.

In order to collect information about those mentioned four latent variables and their measured 46 variables, questionnaire survey are undertaken to 1381 and 523 respondents in Bangkok and Jakarta, respectively. A set of questionnaire is established and asked (in a 1-7 Likert-scale) from the respondents who walk in the selected sidewalk.

This study investigates a structural equation model among pedestrian perceptions of interaction between pedestrians and street vendors, traffic and movements, and sidewalk condition as determinants for perception of sidewalk performance in commercial districts with street vendor activities. Four latent variables establish a model in order to understand their role in sidewalk performance measurement. Validity of the constructs and their constituent variables are verified with content and construct validity tests. The model which has a potential to be used in assessing of sidewalk performance is close to the needs and the requirement of the developing countries sidewalk characteristics since street vendor activities and pedestrian perceptions are added as measures and indicators. A statistical technique called Structural Equation Modeling (SEM) was used to analyze the data collected from the respondents in order to investigate the validity of the measures and to construct valid interrelationships among the measures and the indicators of the model. Finally, a performance measurement model is specified displaying the interrelationships and their path coefficients among the predetermined measures of performance. Hypotheses which are established at the beginning of the study are therefore confirmed. The major findings of the study are in line with the aforementioned hypotheses. It verifies that qualitative variables have relatively significant relationships and play an important role in assessing sidewalk performance. Therefore, traditional quantitative performance measures are reduced and the qualitative measures of the sidewalk performance are presented.

"Interaction perception" construct of the model has a direct effect on "traffic perception" and "sidewalk performance perception". These findings reveal that, interaction activities among pedestrians and vendors or other pedestrians have significant influence in the sidewalk situation. Considering the factor loadings of the constructs, interactions relating to shopping activities ("Sidewalk interaction" (FA-6) for Bangkok, and "I enjoy vendor activities in this sidewalk" (Q1-14) for Jakarta) are found to be more prominent than the other variables which justified the fact that shopping is interested activities along the sidewalks since vendors are available.

To cope with this fact, it is essential to accommodate the activities on the sidewalk in an economically, socially, and environmentally acceptable manner by increasing sidewalk capacity of the sidewalk in Bangkok and Jakarta, as represented the highest factor loading of the construct of “traffic perception”. In this regards, shopping activities arrangement play a key role to increase sidewalk performance in urban commercial areas.

The analyses of this current study indicate the considerable impact of “traffic perception” on “sidewalk performance perception”. Strength of the relationships was discussed and confirmed also in the literature (Huang and Chiun, 2007; Landis et al., 2001; TRB, 2000). Pedestrian traffic arrangement is considered important to increase sidewalk performance. When the supporting infrastructures are considered insufficient, as can be met in most sidewalks in Jakarta, increasing of overall sidewalk environment is the most essential action to increase sidewalk performance.

Relating to the most Southeast Asian developing countries culture, street function is not only for distribution or movement, but also accommodate people activities in related with economic and social purposes. Therefore, the sidewalks not only accommodate pedestrians with walking activities, but also serve some other activities such as informal street economy (street vendors) and other street users. Informal economy agglomerations are generally found near activity generators such as commercial areas, in front of shops and stores, shopping malls, at intersections, and access toward train stations. Even street vendors are often considered as obstruction to walking flow, their presence should be accommodated. Therefore, establishing policies and management to accommodate the vendors are required in order to accept high performance of the sidewalk service and to support the city’s economy.

7.2 Recommendations and Policy Implications

The findings of this study encourage the importance of combining the qualitative and quantitative variables with regard to sidewalk performance assessment. Sidewalk performance assessment taking into account of pedestrian perceptions, while incorporating with traffic variables (volume and capacities) can be investigated to propose a better model.

Walking activities become one of the popular and common transportation modes. Many big cities in the Southeast Asian countries are facing socioeconomic and transportation problems, such as increasing private vehicle ownership and lack of roadway infrastructure. Development of public transport facilities like mass rapid transit, sky train, bus rapid transit in Bangkok or bus-way in Jakarta can also encourage walking activities. As a result, policy makers and urban planners should pay more attention in developing such a pedestrian infrastructure as well. The findings of this study are expected to help traffic engineers and planners understand pedestrian perceptions toward sidewalk performance and the environment nearby especially in dense commercial areas, because the results of this study indicate relationships among some qualitative variables that are considered important for determining sidewalk performance based on pedestrian opinions. In this concern, contribution of pedestrian as one of the part in urban transport must be accommodated by the policy makers and transport planners to provide better sidewalk design.

The study findings contribute empirically evidence by using SEM to analyze relationships among sidewalk assessment components. Based on SEM analyzing, it can be concluded that sidewalk condition is the most important in assessing sidewalk performance in both Bangkok and Jakarta. Whereas based on pedestrian characteristics, it can be found that each group of pedestrian has difference perception on importance of variables. Young group of pedestrian is found to consider walking traffic as the most important variables, whereas the older group gives more appreciation on sidewalk condition. Male group judges that interaction variable is the most important, but female group gives more attention on sidewalk condition variable. Daily walkers and pedestrians who walk to/from work/school consider interaction activities is the most important, whereas pedestrian with rarely walking experience and recreational purposes think that traffic condition is the most important variable in assessing sidewalk performance. Thus, by these findings, transport planners and decision makers should to handle service standard to meet pedestrian's expectation, which would raise the level of pedestrian satisfaction. For example, design of sidewalks for commuters in public transport transfer location must pay more attention on space availability and avoiding interaction with vendors, whereas sidewalks located in tourism and shopping area need more opportunity to interact with vendor.

Findings of investigating structural relationships reveal that sidewalk performance for Bangkok and Jakarta cities is strongly influenced by condition of sidewalk. It is clear that policy maker and transport planner must pay attention to improve sidewalk condition in order to increase satisfaction level for users, especially for female and elderly groups.

By considering effect of interaction perception and concerning socio-culture in some developing Asian countries, establishing policies and management to accommodate and control street vendors and other socio-economics activities on the sidewalk are required in order to encourage walking activities. The development regulation to accommodate socio-economics activities on the sidewalk is one of the solutions since it is accepted by minimizing negative impact of street vendors. More advantages can be accepted with the planning of integration of these activities, so the sidewalk can attract more economic and profitable activities without neglecting the walking activities.

7.3 Future Research

R square value of the proposed regression model is low, but the focus of this study is to investigate of incorporating qualitative and quantitative variables into one model. For future research, other variables that were not surveyed in this research should be tested in order to improve the model predictive power. A larger sample size might be needed.

Questionnaire survey was deployed to respondents established in Bangkok and Jakarta therefore perceptions of only both cities are acquired. The conclusions of the study may be tested in different developing cities and a more global view of the performance requirements of sidewalk in practice may be determined. Adoption of a global mode may be lack of local requirements specific to each country, nevertheless a globally homogenized and mobile model may be designed responding to the requirements of different countries' environment.

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APPENDIX

APPENDIX A. Interview sheet

PEDESTRIAN INTERVIEW SHEET

Day/Date: ……….…………………………… Sheet Number: ……………………..

Location : ……………..…………………… Interviewer: …………………………..

Time : ……………...………………………

Part 1. Based on your experience on this sidewalk, check your opinion

No.	Statement	Strongly Disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree
1	I feel safe from vehicle traffic danger (S)	1	2	3	4	5	6	7
2	I feel safe from trips, slips and falls (S)	1	2	3	4	5	6	7
3	I feel safe from intimidation or physical attack (S)	1	2	3	4	5	6	7
4	I think that the available sidewalk width can accommodate pedestrian flow (S)	1	2	3	4	5	6	7
5	I think that the sidewalk is flat enough to accommodate wheelchair users (S)	1	2	3	4	5	6	7
6	I think that the street vendors keep the sidewalk clean (C)	1	2	3	4	5	6	7
7	I can move freely without obstruction from physically features (phone boxes, column, bench, etc) (C)	1	2	3	4	5	6	7
8	I am not impeded by other pedestrians (C)	1	2	3	4	5	6	7
9	I can move freely without obstruction from vendors (C)	1	2	3	4	5	6	7
10	I have enough space to avoid the vendor's obstruction without decelerating my pace (C)	1	2	3	4	5	6	7
11	I feel comfortable walking through this sidewalk with the presence of on street vendors (C)	1	2	3	4	5	6	7
12	I am interested in goods sold by vendors along this sidewalk (VA)	1	2	3	4	5	6	7
13	I intend to buy something from street vendors (VA)	1	2	3	4	5	6	7
14	I enjoy vendor activities in this sidewalk (VA)	1	2	3	4	5	6	7
15	I think that too many street vendors occupy this sidewalk (VA)	1	2	3	4	5	6	7
16	I think that too many buyers cause this sidewalk crowded (VA)	1	2	3	4	5	6	7
17	I think that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded (VA)	1	2	3	4	5	6	7
18	I think that vendor's displays do not obstruct pedestrian movements (ME)	1	2	3	4	5	6	7
19	I think that the total width of sidewalk is wide enough (ME)	1	2	3	4	5	6	7
20	I can choose my walking speed freely (ME)	1	2	3	4	5	6	7
21	I can overtake other pedestrians easily (ME)	1	2	3	4	5	6	7
22	At the crosswalk, sidewalks are at the same grade level as streets, so I can move easily for crossing roadway (ME)	1	2	3	4	5	6	7
23	I think that I can enter/exit to/from this sidewalk easily (SP)	1	2	3	4	5	6	7
24	I can not walk side by side with my friend because the sidewalk width is too narrow (SP)	1	2	3	4	5	6	7
25	If I want to access public transport, it is easy to find bus stop/BTS Station in this sidewalk (SP)	1	2	3	4	5	6	7
26	I don't mind delays as long as I am comfortable (SP)	1	2	3	4	5	6	7
27	From my opinion, this sidewalk is bad for pedestrians (SP)	1	2	3	4	5	6	7

28 In overall, I would give _______ points for the performance of this sidewalk. (1 - 10 score where 1 for the lowest and 10 for the highest)

S= Safety/Security; C= Comfort; VA=Vendors Attraction; ME=Movement Easiness; SP=Sidewalk Performance

Part 2. Please indicate your agreement with the next set of statements

No.	Statement	Strongly Disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree
1	I think this sidewalk is crowded because of a large amount of pedestrians, not the presence of vendors (T)	1	2	3	4	5	6	7
2	I think if the vendors is prohibited, the volume of pedestrians will be higher (T)	1	2	3	4	5	6	7
3	I found delay when I walk along this sidewalk (T)	1	2	3	4	5	6	7
4	The street vendors occupy too many spaces in this sidewalk (G)	1	2	3	4	5	6	7
5	I think pedestrians with visual impairment can walk this sidewalk easily (G)	1	2	3	4	5	6	7

(Continued)

		Strongly Disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree
6	This sidewalk is too narrow to accommodate the vendors and pedestrians (G)	①	②	③	④	⑤	⑥	⑦
7	It is easy to interact with the vendors (B)	①	②	③	④	⑤	⑥	⑦
8	I want to look around commodities sold by vendors (B)	①	②	③	④	⑤	⑥	⑦
9	Walking slowly to enjoy goods from street vendors is inconvenient for other pedestrians (B)	①	②	③	④	⑤	⑥	⑦
10	I should walk in the sidewalk although the sidewalk is crowded by vendors (B)	①	②	③	④	⑤	⑥	⑦
11	I will still walk on the roadway (pavement) even when the sidewalk is very crowded (B)	①	②	③	④	⑤	⑥	⑦
12	In this sidewalk segment, walking on the roadway is more convenient than walking in the sidewalk (B)	①	②	③	④	⑤	⑥	⑦
13	I will walk along this sidewalk only for shopping (B)	①	②	③	④	⑤	⑥	⑦
14	On street vendors make me easy to buy something (A)	①	②	③	④	⑤	⑥	⑦
15	I love shopping along sidewalk (A)	①	②	③	④	⑤	⑥	⑦
16	My friends or my relatives like to walk along this sidewalk (A)	①	②	③	④	⑤	⑥	⑦
17	I feel that the government should ban the vendors along the sidewalk (A)	①	②	③	④	⑤	⑥	⑦
18	I think the regulation of vendors along the sidewalk is not that strict (A)	①	②	③	④	⑤	⑥	⑦

T = Traffic; G = Geometric; B = Behavior; A = Attitude

Part 3. Pedestrian characteristics		
1. What is your gender?	◯ Male	◯ Female
2. Age : …………………		
3. What is your current occupational status?	◯ Student	◯ Retired
	◯ Administrative/office business	◯ Unemployed
	◯ Factory employee	◯ Self employee (specify) ………………….
	◯ Government employee	◯ Others ………………………..
	◯ Housewife	
4. What is the highest level of education that you have completed?		
	◯ primary school	◯ undergraduate university
	◯ secondary school	◯ postgraduate university
	◯ high school	
5. Are you walking in a group?	◯ Yes	◯ No
If Yes, how many people in your group?	◯ 2 people	◯ > 3 people
	◯ 3 people	
6. Is the walking your main trip mode?	◯ Yes	◯ No
7. How often do you normally walk in this sidewalk?		
	◯ Daily	◯ Rarely
	◯ ………times per week	
8. What is your trip purpose?	◯ go to/from work	◯ recreational
	◯ go to/from school	◯ visiting friends/family
	◯ shopping	◯ others
9. Please select your monthly income		
	◯ 0 - 5,000 Baht	◯ > 20,000 - 30,000 Baht
	◯ > 5,000 - 10,000 Baht	◯ > 30,000 - 40,000 Baht
	◯ > 10,000 - 20,000 Baht	◯ > 40,000 Baht

- Thank You for Your Participation -

APPENDIX B

Table 1. Pedestrian Survey of Bangkok

time interval	BANG RAK						SILOM					
	ped. count		ped. walk outside sidewalk		Ped. contact vendor		ped. count		ped. walk outside sidewalk		Ped. contact vendor	
	3/11/2010	4/11/2010	3/11/2010	4/11/2010	3/11/2010	4/11/2010	15/6/2010	16/6/2010	15/6/2010	16/6/2010	15/6/2010	16/6/2010
10:00 - 10:15	-	-	-	-	-	-	-	83	-	7	-	4
10:15 - 10:30	-	-	-	-	-	-	75	76	17	14	1	0
10:30 - 10:45	184	228	3	4	15	20	66	81	13	8	11	17
10:45 - 11:00	215	241	1	7	4	5	72	79	10	5	5	13
11:00 - 11:15	225	232	2	4	24	6	58	74	5	9	7	14
11:15 - 11:30	234	213	1	2	18	20	76	84	5	1	17	9
11:30 - 11:45	213	259	6	2	12	21	127	174	9	11	12	26
11:45 - 12:00	223	260	0	4	13	7	221	239	14	12	27	60
12:00 - 12:15	247	326	0	14	13	13	257	285	14	32	59	142
12:15 - 12:30	305	287	5	10	27	10	233	196	37	30	110	126
12:30 - 12:45	338	340	3	1	24	13	297	208	23	24	91	89
12:45 - 13:00	331	315	2	6	11	17	201	181	10	28	78	60
13:00 - 13:15	239	319	1	6	7	23	104	167	6	25	61	37
13:15 - 13:30	201	283	4	2	10	10	145	136	5	6	32	19
13:30 - 13:45	187	276	4	0	3	7	118	79	6	3	14	13
13:45 - 14:00	-	-	-	-	-	-	-	-	-	-	6	-
14:00 - 14:15	-	-	-	-	-	-	-	-	-	-	-	-
14:15 - 14:30	174	270	0	1	0	8	-	-	-	-	-	-
14:30 - 14:45	243	259	4	9	9	9	-	64	-	9	-	11
14:45 - 15:00	210	262	0	0	8	11	74	74	15	9	15	18
15:00 - 15:15	254	278	4	9	11	1	99	94	8	26	17	14
15:15 - 15:30	211	327	3	13	3	7	63	88	10	7	26	14
15:30 - 15:45	344	364	8	3	3	12	136	151	18	9	26	5
15:45 - 16:00	602	614	27	30	8	11	177	127	9	8	24	6
16:00 - 16:15	778	750	56	48	13	6	274	289	8	20	1	5
16:15 - 16:30	587	588	28	42	12	5	398	364	39	44	6	13
16:30 - 16:45	426	440	7	15	9	8	162	212	9	26	13	0
16:45 - 17:00	483	544	9	15	6	7	236	185	11	9	20	1
17:00 - 17:15	445	543	11	6	11	9	462	371	31	24	20	20
17:15 - 17:30	321	465	4	5	1	9	370	376	53	57	17	16
17:30 - 17:45	301	-	3	-	3	-	169	197	25	23	18	21
17:45 - 18:00	238	-	2	-	5	-	177	182	9	15	5	17

Table 1. Pedestrian Survey of Bangkok (continued)

time interval	ON NUT						PRATU NAM					
	ped. count		ped. walk outside		Ped. contact vendor		ped. count		ped. walk outside		Ped. contact vendor	
	17/6/2010	18/6/2010	17/6/2010	18/6/2010	17/6/2010	18/6/2010	25/6/2010	2/7/2010	25/6/2010	2/7/2010	25/6/2010	2/7/2010
10:00 - 10:15	311	-	4	-	11		173	-	1	-	0	-
10:15 - 10:30	327	311	4	3	4	5	187	-	6	-	8	-
10:30 - 10:45	340	309	2	6	8	13	171	-	8	-	21	-
10:45 - 11:00	327	327	1	0	7	8	174	157	14	18	22	17
11:00 - 11:15	343	299	6	1	14	12	207	197	9	10	24	7
11:15 - 11:30	345	372	2	1	11	4	205	169	16	4	31	16
11:30 - 11:45	359	342	3	2	11	11	198	219	11	7	22	18
11:45 - 12:00	322	311	3	1	33	15	191	178	23	1	6	30
12:00 - 12:15	406	387	1	3	35	10	262	242	25	6	21	35
12:15 - 12:30	388	336	1	0	14	9	244	279	8	17	4	21
12:30 - 12:45	311	379	3	1	9	11	291	259	8	9	26	30
12:45 - 13:00	326	358	1	3	16	8	218	266	9	13	15	47
13:00 - 13:15	325	322	2	1	11	9	237	303	3	19	15	14
13:15 - 13:30	310	277	1	0	23	5	264	281	6	2	33	21
13:30 - 13:45	306	312	2	4	18	13	242	292	5	10	22	47
13:45 - 14:00	-	-	-	-	-	-	-	-	-	-	-	-
14:00 - 14:15	-	-	-	-	-	-	-	-	-	-	-	-
14:15 - 14:30	-	-	-	-	-	-	-	-	-	-	-	-
14:30 - 14:45	248	247	0	3	13	8	235	189	0	3	11	37
14:45 - 15:00	272	316	1	0	9	9	305	310	7	15	57	38
15:00 - 15:15	282	316	8	2	10	11	299	358	21	19	61	15
15:15 - 15:30	272	295	0	0	18	15	266	300	19	27	33	24
15:30 - 15:45	329	266	1	0	9	15	281	351	29	21	32	49
15:45 - 16:00	297	316	1	0	25	16	252	312	16	15	6	45
16:00 - 16:15	334	342	0	0	30	33	293	321	2	0	44	36
16:15 - 16:30	324	342	7	3	33	24	244	319	7	12	25	26
16:30 - 16:45	333	313	2	2	25	26	344	344	11	5	9	14
16:45 - 17:00	382	352	0	1	35	29	322	370	68	8	15	35
17:00 - 17:15	370	436	0	0	21	31	354	304	40	11	16	7
17:15 - 17:30	405	380	4	2	35	24	317	418	3	8	12	50
17:30 - 17:45	440	473	2	3	51	38	325	375	9	14	22	42
17:45 - 18:00	451	443	4	3	27	38	312	308	13	10	15	9

Table 2. Pedestrian Survey of Jakarta

time interval	MAMPANG (9/6/2010)			SABANG (9/6/2010)		
	ped. count	ped. walk outside sidewalk	Ped. contact vendor	ped. count	ped. walk outside sidewalk	Ped. contact vendor
10:00 - 10:15	32	4	3	36	9	13
10:15 - 10:30	38	0	4	34	11	10
10:30 - 10:45	36	7	5	44	17	9
10:45 - 11:00	38	5	2	42	6	11
11:00 - 11:15	56	8	10	40	7	11
11:15 - 11:30	45	6	4	61	9	13
11:30 - 11:45	32	2	10	84	15	26
11:45 - 12:00	48	2	9	100	9	27
12:00 - 12:15	22	0	20	204	31	52
12:15 - 12:30	41	2	7	142	12	37
12:30 - 12:45	-	-	-	-	-	-
12:45 - 13:00	-	-	-	-	-	-
13:00 - 13:15	41	1	6	126	39	30
13:15 - 13:30	42	2	3	117	14	15
13:30 - 13:45	34	1	4	84	14	8
13:45 - 14:00	62	3	6	82	9	8
14:00 - 14:15	42	4	3	63	11	11
14:15 - 14:30	32	4	2	54	11	12
14:30 - 14:45	25	5	2	60	16	19
14:45 - 15:00	42	4	4	27	34	9
15:00 - 15:15	32	8	0	50	14	25
15:15 - 15:30	28	3	0	33	10	17
15:30 - 15:45	32	8	0	34	9	8
15:45 - 16:00	20	7	0	51	19	12
16:00 - 16:15	29	7	3	33	14	6
16:15 - 16:30	33	16	6	27	13	8
16:30 - 16:45	37	11	3	35	14	13
16:45 - 17:00	16	20	1	41	21	8
17:00 - 17:15	37	24	5	40	17	4
17:15 - 17:30	40	31	14	44	8	2
17:30 - 17:45	32	31	14	48	30	5
17:45 - 18:00	55	50	24	47	18	3

Table 2. Pedestrian Survey of Jakarta (continued)

time interval	JATINEGARA PONDOK KOPI (15/6/2010)			JATINEGARA STASIUN (15/6/2010)		
	ped. count	ped. walk outside sidewalk	Ped. contact vendor	ped. count	ped. walk outside sidewalk	Ped. contact vendor
10:00 - 10:15	-	-	-	-	-	-
10:15 - 10:30	-	-	-	189	53	30
10:30 - 10:45	159	0	17	167	88	36
10:45 - 11:00	158	0	14	188	68	34
11:00 - 11:15	135	1	19	209	90	33
11:15 - 11:30	126	3	20	214	64	33
11:30 - 11:45	156	1	23	178	103	31
11:45 - 12:00	141	2	21	190	102	22
12:00 - 12:15	145	3	27	206	118	33
12:15 - 12:30	166	5	37	201	119	39
12:30 - 12:45	129	5	26	127	65	43
12:45 - 13:00	130	2	21	130	25	48
13:00 - 13:15	-	-	-	-	-	-
13:15 - 13:30	-	-	-	-	-	-
13:30 - 13:45	132	2	21	-	-	-
13:45 - 14:00	127	0	12	-	-	-
14:00 - 14:15	143	1	15	155	23	15
14:15 - 14:30	136	0	19	110	24	32
14:30 - 14:45	127	3	15	140	31	33
14:45 - 15:00	121	0	22	113	52	38
15:00 - 15:15	158	2	10	127	66	21
15:15 - 15:30	88	0	16	199	68	26
15:30 - 15:45	112	2	14	127	43	32
15:45 - 16:00	109	2	16	176	56	36
16:00 - 16:15	100	3	10	186	108	29
16:15 - 16:30	87	0	15	120	188	16
16:30 - 16:45	71	0	12	98	111	22
16:45 - 17:00	83	0	5	92	62	14
17:00 - 17:15	79	0	9	62	0	9
17:15 - 17:30	58	0	8	74	0	10
17:30 - 17:45	70	0	7	70	0	10
17:45 - 18:00	27	0	1	59	0	7

BIOGRAPHY

Nursyamsu HIDAYAT

I was born in Sleman, Yogyakarta Special Region Province, Indonesia on December 28^{th}, 1973. I completed elementary to senior high school in Yogyakarta. In 1998, I finished my bachelor degree of civil engineering in Gadjah Mada University (UGM) Yogyakarta. After graduated, I joined to the Faculty of Engineering UGM as a lecturer in Civil Engineering Diploma Program. In 2004, I continued my master study in civil engineering in Bandung Institute of Technology (ITB), and finished in 2006. By the end of 2007, I got scholarship from AUN/SEED-Net JICA to pursue doctoral program in Chulalongkorn University, Bangkok, Thailand.