DETERMINATION OF FACTORS RELATED TO SIDEWALK PERFORMANCE BASED ON PEDESTRIAN PERCEPTION*

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1. Introduction

Sidewalk performance can be assessed by many ways. Pedestrian input can be used for determining adequate levels of service from the road user's perspective. In past studies, Parasuraman et al. (1988) studied the scale for measuring service quality in the private service sector and developed an instrument (called SERVQUAL) for assessing customer perceptions of service quality in service and retailing organizations. The original SERVQUAL scale included five factors i.e. (1) Tangible: physical facilities, equipment, and appearance of personnel, (2) Responsiveness: willingness to help customers and provide prompt service, (3) Reliability: ability to perform the promised service dependably and accurately, (4) Assurance: knowledge and courtesy of employees and their ability to inspire trust and confidence, and (5) Empathy: caring, individualized attention the firm provides its customers. These five factors are considered generic service quality factors and applicable to any type of service. In highway applications, Burde (2008) evaluated road users' overall perceptions of highway maintenance service quality. Referring to SERVQUAL factors, two factors were proposed, namely, safety and reliability. The safety factor is a combination of two service dimensions: assurance and tangible.

Most of previous sidewalk performance studies were performed with quantitative variables such as pedestrian space, pedestrian and/or vehicle traffic, and sidewalk width (e.g. TRB, 2000., Landis et al. 2001., Huang et al. 2007). Tan et al. (2007) collected pedestrian perception about their feeling of safety and comfort. The pedestrian level of service model has been proposed based on quantitative variables: bicycle traffic, pedestrian traffic, vehicle traffic, driveway access quantity, and distance between sidewalk and vehicle lane.

This paper attempts to determine factors affecting sidewalk's performance based on pedestrians' perception. Information collected from pedestrians is used to predict a set of qualitative variables to determine the extent to which sidewalk's current level of service meet pedestrian's expectation. In addition, improvements that can be achieved based on pedestrian's perception of the condition of the sidewalk were discussed. In this study, field observation is performed in the sidewalk where street vendors exist along the sidewalk. Therefore, the pedestrian opinions can incorporate street vendors presence in correlation with sidewalk performance.

2. Objective and Methodology

The objective of this study is to develop an instrument for determining factors affecting sidewalk performance based on pedestrian perception. A questionnaire with a total of 27 items is developed to measure pedestrian perception in five different areas: (a) safety, (b) comfort/convenience, (c) vendors presence, (d) accessibility, and (e) sidewalk performance. It is believed that each item could potentially impact on sidewalk performance. However, it is unsure which items would contribute the greatest impact and to what degree. In some service quality studies, a nine-point scale was adopted for measuring service quality, but the scale may be considered too large (Burde, 2008). Therefore, in the present study all items are scored on a five-point Likert-type scale with "one" representing strongly disagree, and "five" representing strongly agree. To collect the data, on-site interviews were conducted in the study location. Some interviewers stopped the pedestrians and asked them for possibility to interview.

Based on data availability, principal component factor analysis is used for analyzing the pedestrian's responses. This method can identify representative variables from original larger set of variables. A small number of factors that adequately represent the original set of variables can be defined.

Data collection is performed in Pratunam area, one of the commercial areas in downtown Bangkok, Thailand. Street vendors exist side by side along the sidewalks at Pratunam area. The sidewalk condition in Pratunam area can be seen in Figure 1. Such a sidewalk condition can be found to be different from other western and developed countries, and only few studies have investigated the presence of street vendors along the sidewalk. The subjects of this study are 119 pedestrians who walked through a sidewalk segment in the study location on April 7th, 2009.

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Figure 1. Sidewalk at Pratunam Area, Bangkok

3. Analytical Tool

Factor analysis is a statistical approach that can be used to verify the conceptualization of a hypothesis by analyzing interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions by condensing the information contained in a number of original variables into a smaller set of dimensions with a minimum loss of information (Hair et al., 2006). Factor analysis can also be used to determine the relative importance amongst these dimensions.

Factor analysis involves a two-step process. Firstly, the elements are resolved into their principal components using principal components analysis. Determining the principal components requires transforming the data into orthogonal variables using the eigenvectors of the matrices of the original variables. Each principal component is a linear transformation of the original variables. Because the principal components are orthogonal, no interdependence or multicollinearity exists in the transformed data.

Once the principal components are determined, a factor rotation is performed. Factor rotation involves rotating the principal component about the axes of the original variables. The factor rotation preserves the orthogonality of the principal components, but a new transformation matrix is formed with each rotation.

The Kaiser–Meyer–Olkin (KMO) test and/or the Barlett's test of sphericity can be undertaken for examining the interview data to see whether it is appropriate to use factor analysis. These two tests refer the strength of the relationship among variables and provide a minimum standard that should be passed before a factor analysis is performed. The KMO measure of sampling adequacy is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients. Its value should be greater than 0.5 for a satisfactory factor analysis to proceed (Zhang, 2006).

4. Results

(1) Respondent's Characteristic

The interview was conducted for 5 hours from 1.00 to 6.00 p.m. on Tuesday, April 7th, 2009. The majority of the subjects were female (60%). Respondents grouped in age in under 18 years (32%), from 18 to 30 years (61%), and 31 to 56 years (5%). Walking behavior included 2 persons (45%), walking alone (29%), walking in group with 3 persons (12%), and walking in group with more than 3 persons (10%). About 67 % of respondents stated that walking was their main mode during the survey.

(2) Factor Determination

Principal component factor analysis with a varimax rotation is conducted on the 27 items. Table 1 presents the results of the KMO and Bartlett's tests for all of the 27 variables. The KMO test resulted in a value of 0.848, which is greater than 0.5, so the factor analysis is justified. Inspection of the scree plots and the eigenvalues initially suggested a four-factor solution. Items that have communalities below 0.50 or do not have loadings factor of at least 0.40 on any scale are dropped individually from the data set, until a final solution is achieved.

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.848
Bartlett's Test of Sphericity	Approx. Chi-Square	868.273
	df	171
	Sig.	.000

The proposed solution has four factors, and is accounted for 59% of the total variance. Inspection of the output confirms that the four-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 2. We arbitrarily name these four factors as comfort, vendor's attraction, safety, and movement easiness. Factor 1, Comfort (6 items, variance = 36.054%), refers to minimize obstructions at the sidewalk, such as physical features, vendors and other pedestrians obstructions. Also, sidewalks cleanness increases comfortable feelings. Factor 2, Vendor's Attractions (5 items, variance = 9.533%), refers to street vendors existence in the sidewalks, intention to look around and buy something on street vendor's commodities. Factor 3, Safety (4 items, variance = 6.97%), includes items that assess pedestrian perceptions regarding vehicle traffic danger, sidewalk surface conditions, and crime attacking. This factor refers to effective sidewalk width as well. Factor 4, Movement Easiness (4 items, variance = 6.265%), refers to pedestrian freely to choose their speed, and space availability for their movement.

Table 2: Factor Structure

Variables	Factors			
	1	2	3	4
X6: I can move freely without obstruction from other pedestrians	.774	-	-	-
X8: I have space to avoid the obstruction without decelerating my pace	.733	-	-	-
X5: I can move freely without obstruction from physically features	.703	-	-	-
X9: I feel comfortable walking through the sidewalk	.665	-	-	-
X7: I can move freely without obstruction from vendors	.646	-	-	-
X4: I think that the sidewalk is clean	.598	-	-	-
X14: I am interest in goods sold by vendors	-	.789	-	-
X26: I enjoy walking in this sidewalk, to window shopping and it is not just walking	-	.767	-	-
X15: I intend to buy something in street vendors	-	.731	-	-
X27: Based on my perception, the sidewalk is good in serving pedestrian flow	-	.562	-	-
X19: I think that there are a large number of pedestrians causing sidewalk crowded	-	.514	-	-
X2: I feel safe from trips, slips and falls	-	-	.727	-
X1: I feel safe from vehicle traffic danger	-	-	.709	-
X3: I feel safe from intimidation or physical attack	-	-	.670	-
X21: I think that the remain sidewalk width can accommodate pedestrian flow	-	-	.445	-
X23: I can choose my walking speed freely	-	-	-	.795
X20: I think that the total width of sidewalk is wide enough	-	-	-	.720
X24: I can overtake other pedestrians easily	-	-	-	.619
X12: I think that vendor's displays do not lead to obstruction to pedestrian movements	-	-	-	.432
Total variance explained by factor	36.054	9.533	6.970	6.265

(3) Reliability

Reliability test can be used to measure the consistency of a questionnaire. The internal consistency is examined to ensure at a certain level that the scale (1–5) for measuring the relative significance of the questionnaire the same result over time. Cronbach's Alpha test is performed to test the internal consistency reliability of the scale and value greater than 0.7 indicates an acceptable value (Field, 2005). Table 3 represents descriptive statistics and the result of Cronbach's Alpha test. It can be observed that all values are all greater than 0.7, indicating acceptable and good internal consistency reliability of questionnaire.

Table 3: Descriptive statistics and Cronbach's Alpha

	Comfort	Vendor's Attraction	Safety	Movement easiness	Total
$\bar{x}$	2.678	3.205	3.004	2.881	2.917
SD	0.155	0.122	0.148	0.063	0.249
Min	2.466	3.060	2.853	2.793	2.426
Max	2.879	3.385	3.207	2.940	3.389
Cronbach's α	0.842	0.768	0.724	0.746	0.899

5. Discussion and Conclusion

Based on the SERVQUAL concept originally proposed by Parasuraman (1988), four factors are found in this study that can be categorized into three factors of service, namely, tangible, reliability, and assurance. It is assumed that sidewalk users are able to perceive sidewalk service quality factors representing by variables of each dimension. Pedestrians evaluate the service tangibles, reliability, and assurance while walking through the sidewalks. Two remaining factors, responsiveness and empathy, can not be applied in measuring sidewalk level of service. The responsiveness factor measures quality of service by the willingness to help costumers and provide prompt service. The empathy measures the perceived quality of attention given by the organization to its customers. To evaluate both of these items, pedestrian and government must be contacted directly.

The four factors found in this study (comfort, vendor's attraction, safety, and movement easiness) can be used as qualitative variables in evaluating sidewalk performance. An alternative qualitative model can be developed besides previous quantitative methods. Tan et al. (2007) collected pedestrian perception about comfort and safety factors, but did not include these qualitative variables in their level of service model.

Many street vendors can be commonly found in the sidewalks in South East Asian countries. They exist side by side with shop stores along the sidewalks, and pedestrians get direct impact from the presence of street vendors, such as reduction of sidewalk width, reduction in walking speed, obstruction in movement, and so on. The result of this study includes a factor regarding the presence of street vendors at sidewalks as one of the factors affecting the sidewalk performance. The finding could be a unique variable for sidewalk performance evaluation compared with previous methods that are mostly studied in developed countries (e.g. TRB, 2000, Landis et al. 2001, Huang et al. 2007).

For further research, the pedestrian level of service model including some qualitative variables based on pedestrian perceptions can be investigated. Street vendor impact can be considered as the specific characteristic in the model that can be applied for cases in South East Asian countries.

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