PROPOSED LEVEL OF SERVICE STANDARDS FOR WALKWAYS IN METRO MANILA

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ABSTRACT

This research presents an evaluation of pedestrian facilities according to the behavioral characteristics of pedestrians in the central business district and their preference toward the factors that affect their choice of a pedestrian facility. The study also proposes level of service standards for walkways in the central business district. This integrates space requirement and several qualitative factors gleaned from the pedestrians' preference and behavior. Three kinds of surveys were included in the study to achieve the objectives, namely: pedestrian behavior questionnaire survey which provides information on the pedestrian behavior particularly the factors necessary for choice of route and elements that describe the evaluation of the facilities, the preferences of facilities survey which shows the pedestrians' preference of the factors which describe the facility they want to use and the photographic technique survey which gives the relationship of speed, flow and density of pedestrians. Six level of service (LOS) design standards for walkways in Metro Manila are proposed. The proposed service levels are based on the integration of the ranking of qualitative factors of pedestrian facilities done, average flow as well as area module or space allocation for a Filipino pedestrian. A guide was also presented in table form to be able to know the minimum requirements of street furniture or subfactors in a walkway design. LOS A or B is the recommended design guide for a better and cohesive environment for pedestrians and to be able to promote walking as an alternative transport mode inside the CBD.

1. INTRODUCTION

The planning and design techniques developed for pedestrian facilities are closely associated with traffic engineering principles and often have no relation to the actual pedestrian movement patterns. The knowledge of pedestrian needs is useful in refining the design of pedestrian facilities and their appropriate layouts especially in the Central Business Districts (CBD). This study on pedestrian behavior is believed to be the first endeavor to be done in Metro Manila and its facilities. The findings of this study will be very useful for planners and designers of pedestrian facilities for the improvement of the existing condition, and an economical and safe design in the future. The objective of this research is to the evaluation of the existing condition of pedestrian structures and is also aimed to examine the characteristics of pedestrians and service requirements of pedestrian facilities in Metro Manila. Level of service standards for walkways in Metro Manila are the output of this study.

2. DATA COLLECTION

The study was conducted in Makati, Metro Manila, one of the CBD's in Metro Manila. Three kinds of transportation survey techniques were used in this study namely: photographic technique survey, pedestrian behavior questionnaire survey and pedestrian preference of facility survey.

2.1 Photographic Technique Survey

A video camera was set up in five sidewalk locations and three crosswalk locations for the photographic technique survey (See Figure 1). The survey measured the walking speeds, flow and density of the pedestrians in the walkways. A four hour time period was utilized to take the peak and off-peak periods, specifically from 7:00 - 9:00 and 14:00 - 16:00 hours.

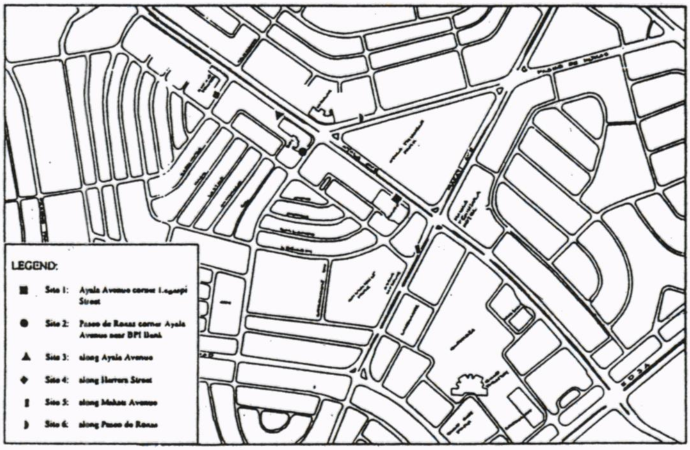

Figure 1 Sidewalk locations inside the study area

2.2 Pedestrian Behavior Questionnaire Survey

Pedestrian behavior questionnaires were distributed inside office buildings and the interviews were also conducted outside. A total of 561 questionnaires was collected in the survey. The questionnaire was divided into five parts namely: trip makers' characteristics, trip information, evaluation of walking characteristics, evaluation of route choice and evaluation of pedestrian facilities. Questions on the trip maker's characteristics were about the respondents' socio-economic characteristics, while the trip information included the respondents' trip characteristics. The evaluation of walking characteristics items consisted of walking time of respondents, walking distance from origin to their destination and the maximum distance that the respondent can walk. It also included a map in which the respondent has drawn his chosen route from his origin to the specified destination points. The evaluation of route choice section contained a choice set of factors that the respondent thought affected his route choice decision. The walking time and walking distance of the respondent in using the route were also asked. The last segment in the questionnaire is the evaluation of pedestrian facilities, a fivepoint scale was used to determine the satisfaction of the respondents with the facilities according to the specified criteria. Respondents were also asked to rate, according to their level of importance, the six factors which describe the pedestrian facility. The binary logit model was used to develop a route choice model. The utility function was estimated by using the logistic regression analysis in the statistical packages, SPSS and SST. The explanatory variables were developed from the questionnaire and alternative routes were generated using minimum distance path. This was done by selecting the routes which has a minimum distance from the respondent's origin to his destination.

2.3 Pedestrian Preference Facility Survey

A five-minute video presentation of the study area showing the six factors that describe the pedestrian facility was viewed by the respondents. After the presentation, the respondents were asked to answer the questionnaire provided. The factors are safety, convenience, comfortability, continuity, system coherence and level of congestion. If a factor was not clear to the respondents, the video was again shown. The questionnaire simply consists of paired comparisons of the factors which describe the pedestrian facility. Its purpose was to know the respondents preferred factors. The survey was conducted in a classroom where the video facilities are available and a total of 124 questionnaires was collected in this survey. The Analytic Hierarchy Process (AHP) developed by Thomas Saaty was used to analyze the results of the questionnaire. The consistency ratio, C.R. is an index to know the consistency in the judgment of a respondent. The consistency ratio can have an acceptable value of less than or equal to 10% for the judgments to be consistent, however, two consistency ratios were utilized to be able to show if there is much difference in the preferences of an individual, another reason is that if a consistency ratio of 10% is used, only a small percentage of response can be selected.

2.4 Level of Service Design Standards

The breakpoints of the proposed level of service standards were taken from the speed-density-flow models generated from the photographic technique survey. The capacity or maximum volume was calculated from the density flow model and the volume capacity (v/c) ratio was computed. The diagrams for flow - speed - area module were also plotted.

3. PEDESTRIAN BEHAVIOR

Results highlight the behavior and attitude of Filipino pedestrians especially pertaining to the route they have chosen and trips they have made. Walking as a transport mode and the walking patterns of Filipinos were closely analyzed. Filipinos generally make four kinds of trips in going to the Central Business District namely: work trip, shopping trip, business trip and recreational trip as shown in Table 1.

The main purpose for Filipino pedestrians in going to the Central Business District is work which comprises almost half of the total trips. Moreover, shopping is the secondary purpose with a 17 percent share. Business trips are mainly composed of visitors to the banks or to other offices and job hunters.

Table 1. Trip purposes of respondents.

Trip Purpose	Percentage
Employment	53.8
Business	15.6
Shopping	17.4
Recreation	13.2

The predominant mode used by the respondents in going to the CBD is the bus (48.7 %) while the second one is the widely popular jeepney (28.3 %) and the third one is the car with only 10.5 % share. Figure 2 shows the modal percentage of the respondents. "Others"mode is composed of vans or pickups that are a sort of paratransit that comes from their origin to Makati.

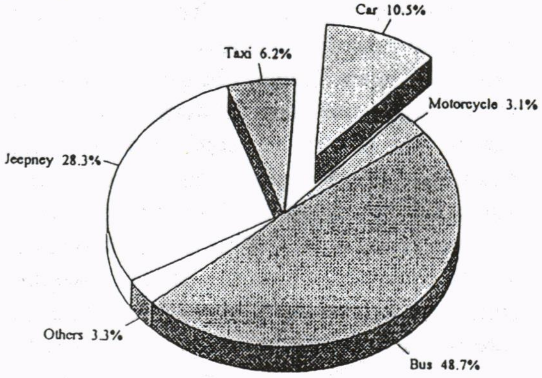

Figure 2 Modal percentage of respondents

Walking distances are essential in determining the location of pedestrian facilities and other infrastructure to best suit the pedestrian's needs. Table 2 shows the average walking distance by purpose and income.

Table 2 Average Walking Distance by Purpose and Income

Purpose	Average Walking Distance (m)
Work	251.56
Business	184.72
Shopping	193.11
Recreation	211.61
Income	
< 9,999	214.14
10,000 - 19,999	234.97
20,000 - 29,999	114.50
30,000 - 39,999	207.50
40,000 - 49,999	111.72
50,000 - 59,999	190.30
> 60,000	50.00

The work trips in the area have a longer walking distance because bus stops and other terminal facilities are located far from people's offices. Recreation trips are longer than shopping trips by as much as 9% because window shopping was considered a recreation by the respondents. People do not walk long if their trip purpose is for business because these trips are normally short and not routinary. Moreover, people tend to use their own vehicle when doing business in the CBD. People with high income usually walk less than people with low incomes as shown in the table above. The respondents with incomes greater than 60,000 only walk an average of 50 meters. People with salaries ranging from 9,000 - 19,000 walk on the average of at least 200 meters. Based on the respondents answers, the mean walking distance of Filipinos was found to be 215 meters while the maximum distance that they can travel on foot was calculated to be 376 meters.

Currently, a crosswalk interval in Makati ranges from 150-620 meters depending on the kind of street. Along the busiest street in the CBD, Ayala Avenue and Makati Avenue, the crosswalk intervals are from 390 meters to 620 meters. This situation leads to jaywalking because there are no midblock crosswalks available. From the walking distance results, the average distance that a Filipino will tread is about 200 - 350 meters therefore pedestrian facilities in the CBD such as bus stops or crosswalk intervals should not be more than 300 meters apart.

3.1 Evaluation of the Facilities by the Pedestrians

The available pedestrian facilities in Makati were sidewalks, zebra crossings and crosswalks with pedestrian signals. The adequacy and the degree of satisfaction of the pedestrians regarding the facilities were evaluated. Table 3 shows the ranking of factors for each pedestrian facility.

A composite index was done to be able to evaluate the importance of factors for each pedestrian facility. The indices were calculated based on the weights given on the scale. One (1) was given a negative two (-2) weight, three (3) was assigned a zero (0) weight while five (5) was given a positive two (+2) weight. The weights were then multiplied to the corresponding frequencies. The sum of the product was divided by the total frequency. Ranks of the qualities were then based on the calculated index, meaning the higher the index the higher the rank. It can be shown that the pedestrians were satisfied with the presence of the trees/shrubs along the walking area. Respondents consider less important the presence of vendors along the sidewalks since they gave it the last ranking. Space was also given much importance for it got a number two rank while the physical condition of a pedestrian facility was not an important factor for the respondents when considering sidewalks. Moreover, the respondents showed disinterest for the presence of street furnitures when evaluating the sidewalk. For the zebra crossing, on the other hand, the respondents were satisfied with the space of the cross walk while they found the interval of the crossings unsatisfactory. This is due to the fact that there are only a few midblock crossings in the area and the distance between intersections is around 350-620 meters. It is also notable to know that the respondents were satisfied with the availability of signalized pedestrian crossing but the interval of these signals were quite unsatisfactory. This is also related to the maximum walking distance that a Filipino wants to tread. The computed indices for all types of pedestrian facilities are greater than zero which shows that the general assessment of the condition of facilities in Makati is satisfactory.

Table 3 Ranking of factors for each pedestrian facility

QUALITIES	VALUES					INDICES	RANK
	1	2	3	4	5		
SIDEWALKS							
A. SPACE	42	35	83	152	212	0.8855	2
B. CONDITION	32	56	98	147	177	0.7000	4
C. PRESENCE OF VENDORS	58	82	74	99	164	0.4298	5
D. PRESENCE OF STREET FURNITURE	32	46	61	121	199	0.8606	3
E. PRESENCE OF TREES/SHRUBS	19	36	67	118	230	1.0362	1
ZEBRA CROSSING							
A. CONDITION	33	66	94	147	176	0.6473	4
B. SAFETY WHEN CROSSING	37	56	102	120	186	0.6846	2
C. SPACE	27	55	103	138	180	0.7177	1
D. LENGTH	23	55	127	114	175	0.6700	3
E. INTERVAL OF CROSSINGS	37	64	106	130	154	0.5560	5
CROSSING WITH PEDESTRIAN SIGNAL							
A. TIMING	79	59	110	133	131	0.3867	2
B. INTERVAL	67	63	116	133	116	0.3475	3
C. AVAILABILITY	50	52	114	125	136	0.5094	1
PEDESTRIAN OVERPASS							
A. HEIGHT OF STEPS	42	49	108	106	129	0.5161	1
B. HEIGHT OF STAIRS	40	50	100	98	124	0.5000	2
C. INCLINATION OF STAIRS	34	48	117	84	117	0.4700	3
D. AVAILABILITY OF ROOF	51	70	96	63	120	0.2800	6
E. PRESENCE OF VENDORS	85	71	82	60	100	0.0829	7
F. SPACE	36	52	92	94	111	0.4571	4
G. CONDITION	34	55	91	102	103	0.4260	5

Note: 1: Not Important
5: Very Important

The state of the pedestrian facilities in Metro Manila is much better than in Bangkok, in which the overall assessment was poor (Hokao, et. al. (1994)). These qualities for each pedestrian facility are very important to be able to consider them when designing new or improving existing facilities.

3.2 ROUTE CHOICE EVALUATION

A qualitative appraisal and a quantitative analysis was done to evaluate the choice of route of the pedestrian. Qualitative analysis is the evaluation of the route choice factors according to the pedestrian's attitude. The second one is the estimation of explanatory variables which depend on real data but based on the respondents' drawn route. The respondents were asked to rank the important factors among ten choice factors to find out the significant reasons for their route choice. The ten factors presented to the respondents are described below:

a) Habit - this factor is attributed to the regular use of the particular route;

b) Only available route - this factor is associated to the availability of choice of routes from an origin to a destination;

c) Quickest route - this is related to the shortest distance and shortest time to travel the route;

d) Least crossings - this pertains to the number of crossings used by the respondent in reaching his/her destination;

e) Least crowded - this factor is related to the density or the number of people in the walking area;

f) Attractions - this factor is associated to the presence of shops and restaurants along the walking area;

g) Weather protection - it is attributed to the protection of the pedestrian from the sun or the rain;

h) Environment - this is associated with the presence of trees and air and noise quality along the walking area;

i) Security - this factor is attributed to the safety of the walking area which includes presence of railings and/or guards in the area;

j) Paratransit - this factor pertains to the availability of a paratransit mode along the walking area;

Table 4 shows the ranking of the factors concerning the respondent's choice of route. The table below shows the mean rank of the variables according to the Kendall coefficient of concordance.

Table 4 Ranking of factors pertaining to route choice evaluation.

Factor	Mean Rank	Rank
1. Habit	3.79	2
2. Only Available Route	5.48	4
3. Quickest Route	2.06	1
4. Least crossings	5.51	5
5. Least crowded	5.33	3
6. Attractions	6.95	9
7. Weather Protection	5.96	6
8. Environment	5.98	7
9. Security	6.40	8
10. Paratransit	8.90	10

The quickest route was the number one factor affecting the respondents' route choice. Quickest here means shortest distance at the least possible time. The secondary factor was habit with a mean rank of 3.79. Respondents liked a least crowded route so it was the third highest factor garnering a mean rank of 5.33. Attractions or presence of shops along the way was not very important as it garnered a ninth rank among the factors. Weather protection and the environment did not have much difference in the mean ranking which just shows the preference of the Filipinos to an environment-friendly atmosphere. The factors are interrelated with each other because it has a 95% significance. The quantitative analysis of the route choice was based on the respondents' drawn route from his origin to his destination. The destinations were two shopping centers and one park. Out of the 561 questionnaires collected, 295 samples were used to get a relationship between the route choice and explanatory variables. Explanatory variables were conceptualized based on the factors which resulted from the qualitative analyses. Quickest route was divided into two categories mainly distance and walking time, least crowded, on the other hand, was interpreted to be the pedestrian volume in the area. Moreover, weather protection and environment were combined to come up with air quality as a factor, air quality can be translated in terms of the traffic volume along the walking area. Air quality is reduced as the number of vehicles increases. Security was incorporated in the safety of the walking area. Width of the walking area as a qualitative factor was included in the level of congestion (LOC). The six (6) important factors to describe the pedestrian facility were also included. Therefore, sixteen (16) variables were developed. After several trials, the model below yielded the best results with a satisfactory ρ^2 value. Table 5 shows the model with the parameters and the corresponding statistics.

Table 5 Model parameters with the basic statistics

VARIABLE	PARAMETER	STD ERROR	WALD STATISTIC	SIG	T - STATISTIC
TW (Walking Time), minutes	-0.21781	0.0430	25.6621	.0000	-5.0625
MINSW (Sidewalk Width), m	0.87691	0.00308	17.8048	.0000	+4.9159
PV (Pedestrian Volume),ped/m/min	-0.1516	0.20708	24.2098	.0000	-4.2347
CONT (Continuity)	4.05204	0.73457	30.4620	.0000	+5.5161
CONSTANT	0.14430	0.78214	0.0392	.8430	0.18450
PERCENT CORRECT OVERALL : 79.32% Route Chosen: 86.75% Alternative: 69.77%		ρ^2: 0.21 Likelihood Ratio: 81.036			

Note: SIG : Significance

Out of the sixteen variables used in the model, only four have an effect on the route choice. The variables which affect route choice are: total walking time (TW), pedestrian volume (PV), continuity index (CONT) and sidewalk width (MINSW). It can be seen that total walking time has a negative effect on the choice of route, meaning that a shorter time is preferred for the route choice than a longer walking time. Walking time has more weight in terms of the preference to walk than actual distance. It is can therefore be said that quickest route from the qualitative factors means shortest time. Minimum sidewalk width has an effect on route choice than the average. The wider the sidewalk width the more the preferred the route is. The choice of route is also affected by the lone qualitative factor which is continuity. The definition of continuity here is the flow of pedestrians or the avoidance of conflict while walking. Another variable, pedestrian volume has a negative effect on the choice of route. It means that the more people on the route, the probability that the route will not be chosen is high. The logit model formulated suggests that in the choice of route, density and flow characteristics of pedestrians are very important. The planning of routes in the CBD should consider this fact. It means that routes from a facility such as bus stop or parking lot to shopping centers or business establishments or even offices should have adequate sidewalk widths, less dense sidewalks, low pedestrian volume and a short walking time.

3.3 ANALYSIS OF THE RESULTS OF THE PREFERENCE SURVEY

Analytical Hierarchy Process (AHP) is a general theory of measurement used to derive ratio scales from discrete and continuous paired comparisons (SAATY, 1987). It is a type of model which decides the relative importance of a set of activities to reach a certain goal. It involves qualitative as well as quantitative judgment to make a decision. The analysis starts with the structuring of criteria to create a heirarchy, then preferential weights of each criteria are obtained from the respondents' filled questionnaires. Consistency ratios are calculated based on the normalized weights. The weights for the sub-factor of each criterion are also aggregated to be able to come up with its own normalized weights. In the analysis, four levels were used in the hierarchy: the first level is the decision that is to evaluate the level of service standards for each type of pedestrian facility. The second level is the type of pedestrian facility. The third stage, on the other hand, is the criteria or the factors which describe the level of service for each facility. The last level is the sub-criteria that characterize each criterion. The criteria are compared with each other to be able to get the preferred factor for a facility. The sub-criteria, on the other hand, are also weighed together to come up with the desired description for a criterion. The hierarchy shows a system of stratified levels, each consisting of elements or factors. Figure 3 shows the flowchart for this analysis.

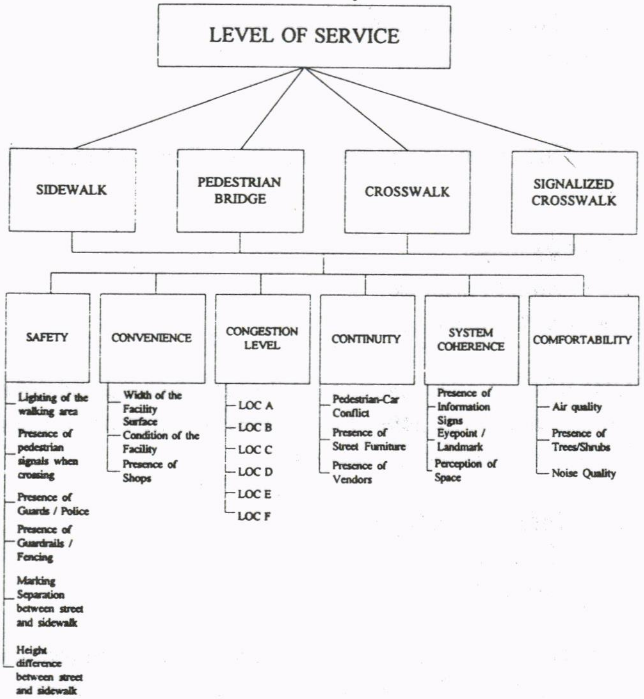

Figure 3 Hierarchy of the AHP Analysis

Four kinds of pedestrian facility were used in the structure. These are the sidewalk, pedestrian bridge, crosswalk and signalized crosswalk. Nevertheless, comparison was made based on the preferred factors of the user of the facility. The six factors and the description of the sub-factors are as follows:

(1) SAFETY. This factor is defined to be the security of the walking area. The sub-factors for this criterion are:

a) Presence of Guardrails and Fencing;
b) Lighting in the Walking Area;
c) Presence of Security Guards or Police;
d) Availability of Pedestrian Signals when crossing;
e) Height difference between street and sidewalk. This is difference in level between the road and sidewalk;
f) Marking separation between street and sidewalk;

(2) CONVENIENCE. This factor pertains to the attractiveness of the walking area. The sub-criteria are :

a) Presence of shops;
b) Surface condition of the facility;
c) Width of the facility;

(3) COMFORTABILITY. This includes the environmental and climactic condition in the walking area. The sub-factors which describe this criteria are:

a) Presence of Trees/shrubs along the walking area;
b) Air quality;
c) Noise quality;

(4) CONTINUITY. This relates to the walking flow of the pedestrian. The sub-criteria for this factor are:

a) Presence of Vendors;
b) Presence of Street Furniture;
c) Pedestrian-Car Conflict;

(5) SYSTEM COHERENCE. This pertains to the architectural and cohesive design of the facility to the buildings and it also relates to the clear orientation of the user of the facility within the area. The sub-criteria for this factor are:

a) Presence of Information Signs;
b) Perception of Space;
c) Eyepoint or Landmark;

(6) LEVEL OF CONGESTION. This factor describes the space requirement and level of service standard of the facility. The sub-factors are related to the 6 levels-of-service by the FRUIN (1971):

(a) LOC A. The pedestrian can freely select their own walking speed and to bypass slower moving pedestrians and to avoid crossing conflicts with others;

(b) LOC B. The space available is sufficient for the pedestrian to select a normal walking speed and to bypass other pedestrians. Only minor conflicts occur;

(c) LOC C. The freedom to select individual walking speed and to bypass other pedestrians is restricted;

(d) LOC D. The majority of the pedestrians would have their normal walking speeds restricted and reduced, due to difficulties in bypassing slower-moving pedestrians and avoiding conflicts;

(e) LOC E. Virtually all pedestrians need to adjust their normal walking pattern and their normal walking speeds restricted;

(f) LOC F. All pedestrian walking speeds are extremely restricted, and forward progress can only be made by shuffling;

Table 6 shows the comparison of consistency ratios considering the pedestrian's preference of the facility.

Table 6 Comparison of AHP Consistency Ratios considering the criteria for each type of facility

FACTOR	RELATIVE WEIGHTS (CR ≤10%)	RANK	RELATIVE WEIGHTS (CR ≤25%)	RANK
SIDEWALK				
1. SAFETY	0.3606	1	0.3900	1
2. CONVENIENCE	0.1112	5	0.1255	4
3. COMFORTABILITY	0.1321	4	0.1412	2
4. CONTINUITY	0.1327	3	0.1098	5
5. SYSTEM COHERENCE	0.0965	6	0.1031	6
6. LEVEL OF CONGESTION	0.1668	2	0.1305	3
PEDESTRIAN BRIDGE				
1. SAFETY	0.3193	1	0.3508	1
2. CONVENIENCE	0.1271	5	0.1327	4
3. COMFORTABILITY	0.1435	3	0.1389	3
4. CONTINUITY	0.1294	4	0.1295	5
5. SYSTEM COHERENCE	0.1037	6	0.1015	6
6. LEVEL OF CONGESTION	0.1771	2	0.1475	2
CROSSWALK				
1. SAFETY	0.3426	1	0.3911	1
2. CONVENIENCE	0.1111	6	0.1220	3
3. COMFORTABILITY	0.1363	3	0.1190	5
4. CONTINUITY	0.1316	4	0.1214	4
5. SYSTEM COHERENCE	0.1180	5	0.1072	6
6. LEVEL OF CONGESTION	0.1604	2	0.1393	2
CROSSWALK WITH PEDESTRIAN SIGNAL				
1. SAFETY	0.3663	1	0.3778	1
2. CONVENIENCE	0.1177	5	0.1236	3
3. COMFORTABILITY	0.1287	3	0.1213	5
4. CONTINUITY	0.1209	4	0.1230	4
5. SYSTEM COHERENCE	0.1155	6	0.1111	6
6. LEVEL OF CONGESTION	0.1509	2	0.1431	2

The table shows that for every facility the number one factor preferred by pedestrians is safety.

It is interesting to note that for the different consistency ratios, there is no variation on the number one factor but the disparity is seen in the succeeding ranks. It is also notable to see that Filipino pedestrians don't care much about the architectural and cohesive design of the pedestrian facilities with the buildings because system coherence was given the lowest ranking for both consistency ratios and for almost all the types of pedestrian facility. The second factor preferred is density consideration because level of congestion got the second place on all types of pedestrian facility. From the comparison of the four types of facilities, it can be seen that the factors can be structured into four parts.

The structure is very similar for both consistency ratios and is as follow: one is safety, second is level of congestion, third are the three C's (comfortability, convenience and continuity) and the last is system coherence. It is interesting to note that Filipinos want or desire a safe and secure walking area and a larger walking space. After the fulfilment of these requirements, the 3 C's follows next together with the architectural design.

The criteria developed for the level of service were too abstract for the respondents if there were no descriptions or explanations which characterize each one. The subfactors or sub-criteria in the hierarchy were the illustrations of the criteria. Table 7 shows the ranking of priorities of the subfactor.

Table 7 Priority Ranking of the subfactors

RANK	SUBFACTORS	Weights
1	Presence of Information Signs	0.0754
2	Width of the Facility	0.0719
3	Lighting in the Walking Area	0.0662
4	Air Quality	0.0621
5	Presence of Guards	0.0593
6	Surface Condition of the Facility	0.0576
7	Pedestrian-Car Conflict	0.0563
8	Presence of Trees/shrubs	0.0513
9	Presence of Street Furniture	0.0510
10	Availability of Pedestrian Signal	0.0429
11	Presence of Guardrails / Fencing	0.0400
12	Eyepoint / Landmark	0.0334
13	Presence of Vendors	0.0327
14	Marking separation between street and sidewalk	0.0319
15	Height Difference between Street and Sidewalk	0.0279
16	Noise Quality	0.0263
17	Perception of Space	0.0237
18	Presence of Shops	0.0235

All the weights of the subfactors were compared with each other and ranked. Weights were normalized to be able to compare the subfactors with each other. The higher the relative weight the higher the priority. The top five subfactors which should be given priority in the design of the sidewalk are presence of information signs, width of the facility, lighting in the walking area, air quality and presence of guards, respectively. Weights of each rank just differ by a two to four percent margin, it means that level of priority cannot be so clearly defined and the decision whether to install or improve these subfactors depend on the decision maker.

3.4 SPEED STUDIES

From the two previous sections, level of congestion was an important factor to consider. This section quantifies this factor in terms of speed, flow and density studies. The mean walking speed of Filipino pedestrians is 70.65 m/min. This value is based on the average speed at six sites. The pedestrian mean speed in the Philippines is considerably less than that of the United States or Britain. It is, however, similar to its Asian counterparts, although slightly lower. In comparison with its middle eastern counterparts, Filipinos walk slightly faster than them. Several factors maybe attributed to the relatively low walking speed in the Philippines. First, the daily temperature in the Philippines makes the people walk slow and they wouldn't be in a hurry as compared with that of the Western countries. Second, the proliferation of paratransit modes which can stop anywhere may affect the speed of Filipinos as compared to its other Asian counterparts like Singapore. Third, the walking distance in the Philippines is very low compared with other cities, thus it can be said that Filipinos do not really prefer to walk. Table 8 shows the mean walking speeds in different countries.

Table 8 Mean Walking Speeds in Different Countries

COUNTRY	AUTHOR	MEAN SPEED (m/min)
New York, USA	Fruin	81
Pittsburgh, USA	Hoel	88
Columbia, USA	Navin and Wheeler	79
London, England	Older	79
Israel	Polus, et al.	79
Riyadh, Saudi Arabia	Koushki	65
Kuwait	Koushki	71
Singapore	Tanaboriboon, et al.	74
Thailand	Tanaboriboon & Guyano	73
China	Yu	72
Metro Manila, Philippines		70.65

3.4.1 Pedestrian Flow Characteristics

A linear model was found to have the best fit among the four models it was compared with. The bases for the choice are the r^2 value which represents the linearity of the data and the asymptotic confidence interval. From the aggregation of the results, it was found out that the speed-density relationship is assumed to be linear. The relationship is as follows:

$$\mathbf{u = 83.23 - 23.11k} \quad (1)$$

where u = speed in meter/min
k = density in ped/sq.m.

The r^2 value for the above equation is 0.85 while the confidence interval is 86.32. The theoretical speed attained under free flow conditions is 83.23 m/min. With this speed, it means that there is an unlimited amount of space per pedestrian. Moreover, the jam density is equal to 3.60 ped/m^2. This occurs when all pedestrian movement stops and where speed is also zero. Figure 4 shows graphical relationship of speed and density. The figure also shows the goodness of fit of the model to the data.

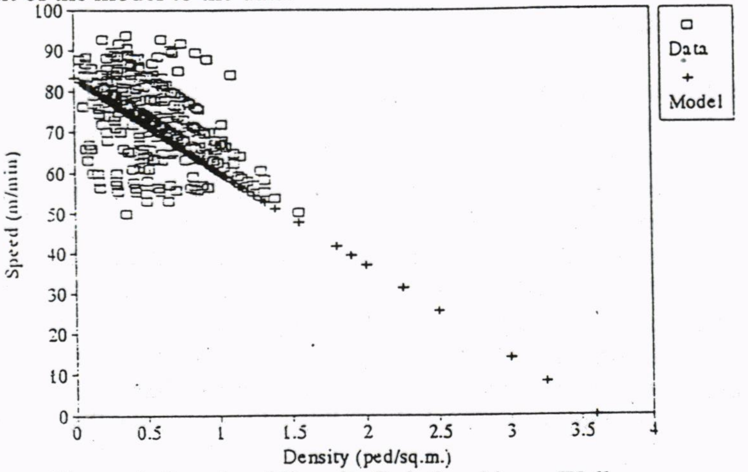

Figure 4 Speed and Density Relationship on Walkways

From the linear relationship of the speed and density, the density- flow and speed-flow equations are formulated as follow:

$$q = 83.23k - 23.11k^2 \tag{2}$$

and

$$q = u\,(83.23 - u)/\,23.11 \tag{3}$$

where q = flow in ped/m/min;
u = speed in m/min;
k = density in ped/m^2.

It is easier to explain and visualize the space requirement of a pedestrian in terms of area module. Thus, the equation below shows the relationship between the area module and flow.

$$q = 83.23 / M - 23.11 / M^2 \tag{4}$$

where q = flow in ped/m/min;
M = area module in m^2/ped.

Figure 5 shows the relationship between density and flow. This curve was derived from equation 2. The capacity can reach a maximum of around 75 ped/m/min with a density of 1.80 ped/m^2. Figure 6 depicts the speed and flow relationship. Similarly, this figure is also a parabolic curve. At maximum flow, the average walking speed is 41.62 m/min. Pedestrians resort to a shuffling gait at this condition. The space allocation per pedestrian at maximum flow is approximately equal to 0.56 m^2/ped. As space is reduced to less than 0.56 m^2/ped, the flow rate declines abruptly. All movement comes to a standstill at a space allocation of around 0.28 m^2/ped. The design of a walkway at an allocation of 0.56 m^2/ped will lead to a crush of pedestrians and it will be poorly designed.

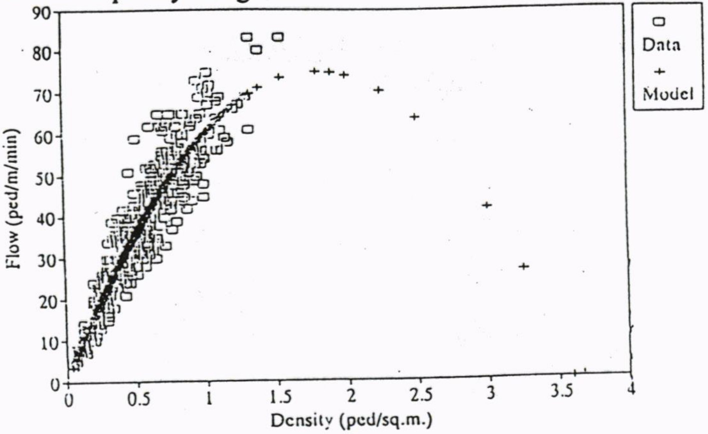

Figure 5 Flow and Density Relationship on Walkways

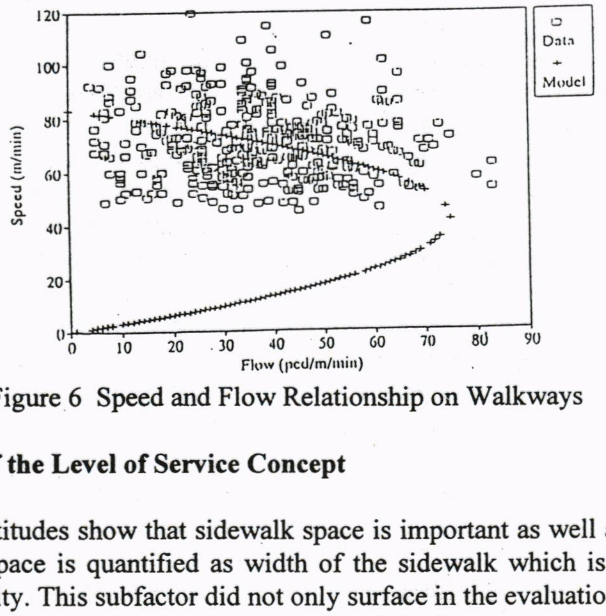

Figure 6 Speed and Flow Relationship on Walkways

3.5 Explanation of the Level of Service Concept

The respondents' attitudes show that sidewalk space is important as well as environmental factors. Sidewalk space is quantified as width of the sidewalk which is related to space requirement or density. This subfactor did not only surface in the evaluation of the sidewalk but also from the logit model developed. Sidewalk width was an important variable for the choice of route as represented in the minimum sidewalk width variable. This space requirement can be generalized to connote level of congestion (LOC). Level of congestion is not only space, but, also density of pedestrians in the walking area as reflected in the variable called pedestrian volume. Inclusion of the factors in the level of service standard is not enough to evaluate a facility or design a facility. It is also necessary to describe each factor. The sub-criteria of the factors were ranked to see which among these sub-criteria have a priority over each other. Level of congestion was the important factor, next to safety, for the behavior as well as the preference of the individual. Thus, the standards are based on these criteria. Level of congestion is the qualitative meaning of space requirement. Filipino pedestrians prefer more space and less density, in terms of people and street furniture, based on the ranking of factors. All the qualitative factors are based on LOC. The overall results of the factors were calculated based on composite indexing. From the composite indexing done, the percentages of each factor was then taken based on level of congestion. Table 9 shows the percentages of each factor in terms of the level of congestion.

Table 9 Priority of Ranking in terms of Level of Congestion

FACTORS	% above LOC
	10%
SAFETY	2
CONVENIENCE	0.6667
COMFORTABILITY	0.7920
CONTINUITY	0.7956
SYSTEM COHERENCE	0.5785
LEVEL OF CONGESTION	1

Based on the percentage above, safety is twice more important therefore safety should be the priority factor in the level of service design standard. "Continuity" and "comfortability" almost have the same weights which mean that these factors have almost the same priority. These factors when incorporated in the LOS would have the same effect if one of the factors were not included. "Convenience" is also included in the design standards but it only has a two-thirds weight and system coherence has taken the last priority. The results from the table shows that in the level of service design standards, these factors should be included since their effect with respect to level of congestion are high. Composite indices of the level of congestion according to the subfactors were also calculated to be able to determine which subfactor is significant for a particular level. This means that the weights of the subfactors were multiplied to the results of table 9 to be able to get indices in table 10. The results are shown in Table 10. Column two in the table show the relative weights in terms of the level of congestion and the succeeding columns represent the normalized weights of each subfactor. The composite indices in the last row of the table show that the priority of introducing or establishing the subfactors are in level A while level F has the last priority. It means that level F is the worst case while level A is the best level for establishing a design standard. Interestingly, the weights for each subfactor at level B and C are very close to each other with only around four to five percent difference. Values of subfactors at levels D, E and F are similar as well, it means that the degrees of importance of placing these subfactors in the walking area for the aforementioned levels are similar. Levels A to F are the names of the proposed levels of service. This is based on the qualitative description of the level of congestion. It was clearly seen that the levels were prioritized according to the preference of the pedestrians and level A was the first priority and level F the last. The weights of the subfactors did not differ much in some levels therefore, installation or design of the walkway at those levels should be at the discretion of the decision maker. The table above represents the types of subfactor necessary for each design level, a minimum value of 0.009 is the recommended standard breakpoint because of the 10% inconsistency. All values above 0.009 in each level are the minimum proposed qualities in a walkway at the particular design level. Evidently, information signs, sidewalk width, lighting and good air quality are the minimum requirements in a walkway. The proposed levels of service standards are enumerated below with some suggestions as to which subfactor are important. Evidently, level A or B is the best design standard for a sidewalk.

Table 10 Composite Index of the Level of Congestion in terms of Subfactors

	Weights	A	B	C	D	E	F
Presence of Information Signs	0.0754	0.0173	0.0127	0.0121	0.0113	0.0110	0.0110
Width of the Facility	0.0719	0.0165	0.0121	0.0116	0.0108	0.0105	0.0105
Lighting in the Walking Area	0.0662	0.0152	0.0111	0.0107	0.0099	0.0097	0.0096
Air Quality	0.0621	0.0142	0.0104	0.0100	0.0093	0.0091	0.0090
Presence of Guards	0.0593	0.0136	0.0100	0.0096	0.0089	0.0087	0.0086
Surface Condition of the Facility	0.0576	0.0132	0.0097	0.0095	0.0091	0.0084	0.0084
Pedestrian-Car Conflict	0.0563	0.0129	0.0095	0.0091	0.0084	0.0082	0.0082
Presence of Trees/shrubs	0.0513	0.0118	0.0086	0.0083	0.0077	0.0075	0.0075
Presence of Street Furniture	0.0510	0.0117	0.0086	0.0082	0.0076	0.0075	0.0074
Availability of Pedestrian Signal	0.0429	0.0098	0.0072	0.0069	0.0064	0.0063	0.0063
Presence of Guardrails / Fencing	0.0400	0.0092	0.0067	0.0064	0.0060	0.0059	0.0058
Eyepoint / Landmark	0.0334	0.0077	0.0056	0.0054	0.0050	0.0049	0.0049
Presence of Vendors	0.0327	0.0075	0.0055	0.0053	0.0049	0.0048	0.0048
Marking separation between street and sidewalk	0.0319	0.0073	0.0053	0.0051	0.0048	0.0047	0.0046
Height Difference between Street and Sidewalk	0.0279	0.0064	0.0047	0.0045	0.0042	0.0041	0.0041
Noise Quality	0.0263	0.0060	0.0044	0.0042	0.0039	0.0038	0.0038
Perception of Space	0.0237	0.0054	0.0040	0.0038	0.0036	0.0035	0.0035
Presence of Shops	0.0235	0.0054	0.0039	0.0038	0.0035	0.0034	0.0034
COMPOSITE INDEX		**0.1911**	**0.1399**	**0.1342**	**0.1247**	**0.1219**	**0.1214**

3.6 Proposed Level of Service Design Standards

The proposed level of service standards are summarized in the table below:

Table 11 Proposed Level of Service Standards

DESCRIPTIONS	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
Average Flow (ped/m/min)	23	23-34	34-42	42-51	51-76	76 or variable
Average pedestrian Area Occupancy (m^2/ped)	3.25 or greater	2.05 - 3.25	1.65 - 2.05	1.25 - 1.65	0.56 - 1.25	0.56 or lesser
Presence of Information Signs	✔	✔	✔	✔	✔	✔
Width of the Facility	✔	✔	✔	✔	✔	✔
Lighting in the Walking Area	✔	✔	✔	✔	✔	✔
Air Quality	✔	✔	✔	✔	✔	✔
Presence of Guards	✔	✔	✔			
Surface Condition of the Facility	✔	✔	✔			
Pedestrian-Car Conflict	✔	✔	✔			
Presence of Trees/Shrubs	✔					
Presence of Street Furniture	✔					
Availability of Pedestrian Signal	✔					
Presence of Guardrails/Fencing	✔					

The minimum requirements for a particular level of service are ticked, in addition, the average flow and area occupancy are also indicated in the table. Figure 7 illustrates the service levels as represented in the flow and area module diagram. The values for average flow and area occupancy are needed for calculation of sidewalk width. A better design is expected with the utilization of the proposed level of service standards for Metro Manila.

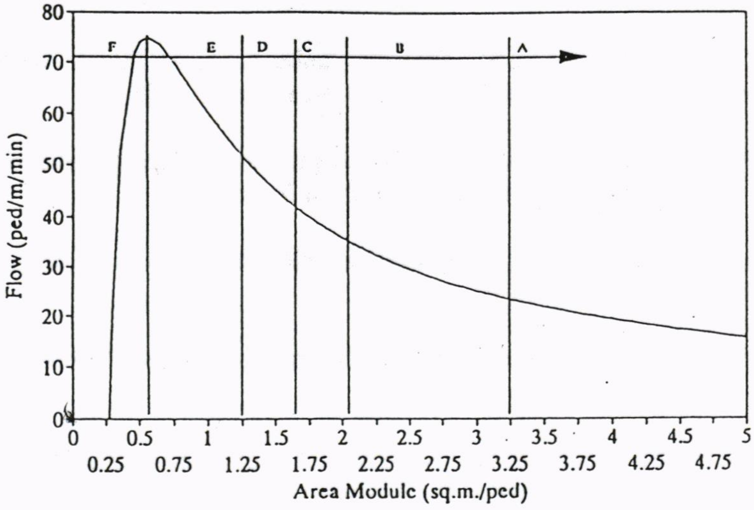

Figure 7 Representation of the six levels of service on the flow and area module diagram of walkways

4.0 CONCLUSION

Walking is very important in the core of the city. People should therefore be encouraged to walk within the CBD. The behavior of a pedestrian is very important in the design of a facility especially a walkway. The results show that Filipinos do not prefer to walk , as an incentive for them, improvement of facilities especially sidewalks are necessary. Consideration of the average walking distance of a Filipino should also be done to improve accessibility of bus stops to places of work or recreation. Overall assessment of the present condition of the pedestrian facilities in Makati was satisfactory but improvements can be added to better satisfy the user. Safety and level of congestion were the two qualitative factors preferred by pedestrians in a design of a facility. It is therefore important to consider these factors. Filipinos also prefer comfortability and continuity so these factors should also be looked into. A number of subfactors were suggested in the study wherein the pedestrians themselves have chosen therefore it can be used as a guide for planners. The proposed level of service standards which incorporated the preference of the pedestrian is very significant in the design of walkways. Level of service A or B is the recommended design for the walkway.

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