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Pedestrian Characteristics in the Holy City of Makkah and Suitability of the Highway Capacity Manual to Evaluate their Facilities

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خصائص حركة المشاة في مدينة مكة المكرمة و مدى ملاءمة دليل سعة الطرق في تقييم مرافقهم

يفد الملايين من المسلمين إلى مكة المكرمة لتأدية شعائر الحج و العمرة. و تسكن نسبة كبيرة منهم في المناطق المحاطة بالطريق الدائري الثاني، حيث يذهبون إلى المسجد الحرام مشياً على الأقدام لأداء الشعائر المختلفة. و خلال العقود الثلاثة الماضية ، تم بناء الكثير من المنشئات العمرانية الضخمة في هذه المناطق، مما أدى إلى ارتفاع كثافتها السكانية إلى درجات عالية. و على النقيض من ذلك ، لم تحدث زيادة في الطاقة الاستيعابية للطرق تواكب الزيادة في حجم الكثافة السكانية، مما أفضى إلى انحدار مستوى الخدمة على هذه الطرق ووصولها لمستويات تدعو للقلق . و تعتبر المحاكاة وسيلة علمية في تجريب العديد من الحلول وتقييمها والتي يتوقع لها أن تساعد في التخفيف من حدة الازدحام الحالية أو المتوقع حدوثها في المستقبل، ومن ثم اختيار الأنجع منها عن طريق استخدام الحاسب الآلي، مما يوفر الكثير من الوقت و المال. و تحتاج برامج المحاكاة إلى معرفة خصائص حركة المشاة. لذلك تقدم هذه الدراسة خصائص المشاة على شارع خالد بن الوليد بمكة المكرمة ، كما تستنبط الدراسة مستوى الخدمة على هذا الطريق من خلال أخذ رأي عينة من المشاة و مقارنته بالمعايير الدولية باستخدام دليل سعة الطرق.

Abstract

Umrah and Hajj attract millions of Muslims from all over the world to visit the Holy City of Makkah Al-Mukarramah in Saudi Arabia. Most of these visitors live in the area enclosed by the second ring road. This area is within a walking distance to the Holy Mosque. Therefore, the visitors walk to the Holy Mosque with no need for a means of transportation. Over the past three decades, a huge number of multi-storey buildings were constructed in this area. Conversely, there was no expansion in the available road capacity. Thus, the density of pedestrians on these roads has risen to alarming levels. Pedestrian simulation models are tools to allow testing and evaluating the performance of present and future strategies to alleviate congestion. These models require prior knowledge concerning pedestrian characteristics. This paper presents pedestrian characteristics in the Holy City of Makkah. Moreover, it qualitatively infers the level of service (LOS) of Khalid Bin Alwaleed Road by interviewing a sample of pedestrians, and compares the inferred LOS with that obtained qualitatively by using the Highway Capacity Manual.

Keywords: Pedestrians, LOS, Hajj, Umrah, Flow, Speed, Density.

INTRODUCTION

The Holy City of Makkah attracts millions of Muslims from all over the world to perform Umrah and Hajj. The vast majority of these visitors live within the areas enclosed by the second ring road. This majority walks through the different streets leading to the holy mosque to perform different rituals.

Over the past three decades, a huge number of multi-storey buildings were constructed in the area enclosed by the second ring road. Thus, the population density in this area has risen dramatically. On the other hand, the available road capacity did not witness any increase to match the increased demand. Consequently, the density of pedestrians on these roads reached alarming levels and degraded their quality of service.

The quality of service of pedestrian facilities are determined by using known standards such as the Highway Capacity Manual (HCM, 2000), which is developed in the industrial nations of the west. The nations that are different than the Eastern and Middle-Eastern societies that accept much closer spacing and a greater degree of personal contact than is normally tolerated by the western societies (Fruin, 1971).

Situational and societal differences were recognized and research was conducted to develop the level of service (LOS) to suit these differences. To adopt with situational differences, a study was performed at three different international airports in Canada to develop a new set of LOS criteria to pedestrian traffic in airport terminal arrival corridors. These corridors represent a suitable situation for its high incidence of platoon formation and the willingness of pedestrians to accept the relatively higher densities of platoon flow because the travel time within the regime is of limited duration. The differences were found to be great enough to warrant the revision of LOS standards for arrival corridors (Davis and Braaksma, 1987). To account for societal differences, a study resulted in a proposal of LOS criteria for planning pedestrian walkway facilities in Bangkok, Thailand. The pedestrian area occupancies determined in the study were lower than those obtained in the United States, but the flow that can be accommodated in each LOS was higher (Tanaboriboon and Guyano, 1989).

In order to develop the LOS criteria for walkways, pedestrian characteristics which are represented by speed, density, and flow need to be examined and analyzed. The analysis includes the establishment of the relationship among the pedestrian characteristics. This process helps in optimizing land use in pedestrian design and result in more efficient and safer designs for the pedestrians. It will also help to develop vigorous models that can be utilized in developing simulation programs to mimic the flow of pedestrians through the existing roads or the roads which are planned to be constructed in the future. These programs help to design roads to operate under certain performance or to analyze the performance of existing roads which is represented by their level of service.

In Singapore, a study was conducted to estimate the characteristics of pedestrians on three different sidewalks along main streets. The pedestrians were manually timed over a measured test length and speeds were then calculated. The major findings of the study included free flow speed, maximum flow rate, and density. Their values were 74 m/min, and 89 ped/m/min, and 4.8 peds/m^2, respectively (Tanaboriboon, et. el., 1986).

Realizing the importance of the walking mode of travel to the individual, the environment, and the community as a whole, a study was conducted in central Riyadh, Saudi Arabia, with the main objective to enrich the understanding related to the walking characteristics. An understanding believed to assist in the optimization of policies concerning urban land use and in the locational distribution of transport-related facilities in rapidly growing urban areas of the developing nations. The major finding of the study was the walking speed of 65 m/min. It should be noted here that thirty seven different nationalities were represented in this study (Koushki, 1988).

This research paper focuses on building pedestrian models that establish the relationship among pedestrian speed, flow, and density. Also, it investigates the perception of a sample of pedestrians by using a questionnaire to know their opinion regarding the quality of service offered by Khalid Bin Alwaleed Road.

PROBLEM DESCRIPTION

Statement of the Problem

Pedestrian characteristics are represented by flow, speed, and density or space. The relationship among these variables has useful information about the pedestrian facilities as well as the pedestrians themselves. It indicates the capacity of walkways, which represents their throughput in terms of the maximum number of pedestrians that can walk through the walkway per unit width in one minute. Moreover, it shows the free flow speed and jam density. This study will shed some light on the values of maximum speed and capacity of the facility under study compared to other pedestrian models sited in the literature. It will also point to the difference in perceived LOS of the facility by subject pedestrians compared to the facility LOS obtained by using the Highway Capacity Manual criteria (HCM, 2000).

Objectives of the Research Study

There are two main objectives for this research paper. The first is to establish the models relating flow, speed, and density for a pedestrian's facility over the evenings of the month of Ramadan before and after the prayers of Isha and Taraweeh (or night prayer. The second objective is to estimate the level of service of the pedestrian facility qualitatively. To accomplish these objectives, the following tasks were undertaken.

- The selection of a representative study site nearby the Holy Mosque;
- The selection of a building that overlooks the study site;
- The development of a questionnaire;
- The estimation of pedestrian flow, speed, density, and space;
- Modeling the relationship among flow, speed, density, and space;
- The estimation of capacity and free flow speed, and;
- The determination of the pedestrian LOS, qualitatively.

Scope of the Research Study

The scope of this research paper is limited to a specified segment on Khaled Bin Al-Waleed Street. Also, the time of the study is limited to selected evenings of the month of Ramadan (before and after the prayers of Isha and Taraweeh).

FIELD STUDY

Selection and Description of the Study Location

The selected site is located about 300 meters from the Holy Mosque in Al-Shubaikah on Khalid Bin Al-Waleed Street. It lies in the west direction of the Holy Mosque. The street is considered as one of the most crowded streets in the central area of the Holy City of Makkah. The strip chosen has a level grade and an appropriate shape that allows easy calculation of the variables under investigation. These variables are characters of pedestrians that are represented by flow, density, and speed. During Ramadan and Hajj, this street is closed to vehicles and opens exclusively to pedestrians. It gets overcrowded around prayer times as prayer queues pass this site. Figure 1 illustrates the location of the site on the city map of Makkah Al-Mukarramah.

Site Preparation for Data Collection

The study area was clearly marked to allow easy acquisition of the pedestrian data. A building that has a clear vantage over the site was chosen and a video camera was mounted over the roof of the building to video-tape the entire period of the data collection. A walky-talky was also attached to the microphone of the camera to record the information that was needed to be recorded and retrieved at certain times. The dimensions of the site are shown in Figure 2.

Selection of Dates and Days for Data Collection

The pedestrian traffic data were collected during the evening hours of the month of Ramadan in which the street experienced variable intensity of pedestrian traffic. The time assigned for collecting the data was from 8:30 pm to 10:30 pm. The dates and days are listed in Table 1.

METHODOLOGY

Modeling of Pedestrian Characteristics

The videotaped pedestrian traffic data is extracted in the Civil Engineering Transportation Laboratory. Two traffic variables are extracted: the first is the flow, which is measured in the number of pedestrians that cross the centreline of the study area per meter per minute; the second is the density, which is measured in the number of pedestrians in the study area per square meter.

To calculate the pedestrian flow and density, four observers are allocated to accomplish this task. The videotapes are viewed on a television screen where a plastic sheet with a grid marked on it is attached to the screen to facilitate accomplishing this assignment. The boundary of the study area is marked by using a marker, and a line is drawn perpendicular to the direction of the pedestrian flow located at the centre of the study area. The length of this line is divided into four equal parts. Each part is assigned to an observer. Each of the four observers is in charge of counting the number of pedestrians that cross his assigned segment of the line per minute when a pedestrian subject is present in the study area. At the end of the minute, the four counts per minute are added and divided by the width of the total line to yield the average flow in ped/m/min.

To compute the pedestrian density, the study area is divided into four parts and each part is assigned to an observer. When a subject pedestrian is present in the study area, the number of pedestrians occupying each segment are counted at three instances of the minute. The three instances represent the beginning, the middle, and the end of the minute. At each of these instances, the tape is paused to allow counting the pedestrians and at the end of each of the three instances. The four counts are added to yield the total number of pedestrians occupying the study area. The three counts for each minute are averaged to yield the minute average count. This count is divided by the study area to yield the average minute density in the number of pedestrians per square meter. This process is performed only at the time a subject pedestrian is present in the study area.

The average pedestrian speed is calculated by using the fundamental equation which describes the traffic stream:

$$q = u\,k \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

q = pedestrian flow in ped/min/m
u = average pedestrian speed in m/min
k = pedestrian density in peds/m^2

Inference of the Perceived Qualitative Level Of Service
To infer the perceived level of service by subject pedestrians using the study area, a questionnaire is developed to accomplish this task in a qualitative manner. It includes eleven questions divided into two parts: the first includes ten questions; the second part includes one question used only for pedestrians walking in a reverse direction or those walking across the flow of traffic. The questions are arranged to target the different LOS in a descending order, i.e. from LOS A to F as described by the HCM. The LOS for each question is determined and the decision in determining the overall LOS is based on averaging all questions and choosing the most probable LOS. The selection of the most probable LOS is illustrated by an example in the following paragraph.

The first question describes the pedestrian ability to walk in a desired path without altering the pedestrian's movement in response to other pedestrians. The answer to the first question describes the intensity of the pedestrians and the interaction among them. This answer is matched with the description of the various levels of services and the most probable level of service is chosen. The second question describes the pedestrian’s ability to choose the normal speed, which is the speed normally walked by the pedestrian. The third question describes the pedestrian’s ability to choose the desired speed at that situation, which might be greater than the pedestrian normal speed. For example, some pedestrians who are late for the prayer on their way to the Holy Mosque need to walk faster to catch the prayer. The fourth question describes the extent of the intensity of pedestrians and checks whether or not it has reached the level where friction and interaction with other pedestrians is reached. The ability to bypass other pedestrians in the direction of pedestrians is considered in the fifth question. The sixth question determines if the pedestrian had to stop due to the stoppages of the flow. The seventh question indicates the need to shuffle to move forward. The presence of reverse movement or crossing movement is explored in the eighth question. The ninth question describes the case related to the ability to avoid conflict with other pedestrians walking in opposite directions. The tenth question examinees the need for a change in speed and position to avoid pedestrians walking in different directions. The last question concerns the level of the difficulty walking across or in reverse direction relative to the flow of traffic.

The different LOS obtained are averaged to obtain the overall LOS. For example, if the levels of service were EBDDBCBCCD, LOS E and C are replaced by their average LOS D. This process continues until the most probable LOS is obtained. In this example, the final result is C. Accordingly, the most probable overall LOS is C. Table 2 includes the questionnaire done in this study.

Determination of the Quantitative Level Of Service

Subject pedestrians are selected and asked to participate in the study. Upon agreement, the subject pedestrian is briefed on the objectives of the study and the questionnaire. The time during which the subject pedestrian is walking in the study area is communicated via a walky talky by the observer and recorded on the videotape. The observer follows the subject pedestrian until the subject exits the study area where the subject is handed the questionnaire to fill. The time at which the subject is present in the study area is used to determine the flow and density from the videotapes. Also, the average pedestrian speed is calculated by dividing flow by density. The HCM is used to determine the LOS for the determined flow, density, and speed. The most probable LOS is determined, using the same procedure of the preceding paragraph. This overall LOS is considered to be the quantitative LOS.

Suitability of HCM to Evaluate Pedestrian Facilities in the Holy City of Makkah

The levels of service obtained qualitatively and quantitatively are assigned numbers from 1 to 6 (A =1, B = 2, C = 3, D = 4, E = 5, F = 6), and the numbers assigned to the overall qualitative and quantitative LOS are plotted against each other. Using Excel, a trendline that is forced to pass through the origin is also plotted on the same figure. The slope of the trendline is used to determine whether the perceived LOS by the subject pedestrians is close to the LOS determined quantitatively by using the HCM or not.

RESULTS AND ANALYSIS

Pedestrian Characteristics

The collected traffic pedestrian data for all days were used to model the flow, speed, density, and space relationships. The speed density relationship was assumed to be linear (Koushki, 1988). This relationship can be represented by the following equation:

$$u = 65.57 - 21.14\ k \qquad (2)$$

where u = walking speed in m/min, and k = density in ped/m^2. Equation 2 is plotted in Figure 3.

Based on the linear relationship between the speed and density, the relationship between flow and density was formulated as follows:

$$q = uk = 65.57\ k - 21.14\ k^2 \qquad (3)$$

where q = pedestrian flow in ped/m/min.

The relationship between flow and Density is illustrated in Figure 4. Similarly, the relationship between flow and speed was formulated and can be represented by the following equation:

$$q = 3.103\ u - 0.0473\ u^2 \qquad (4)$$

Figure 5 shows the relationship between flow and speed. The flow space and speed space relationships are illustrated in Figures 6 and 7, respectively.

The free flow walking speed derived from the second equation was 65.6 m/min. This goes in parallel with a study conducted in Riyadh which found the walking speed to be 65 m/min (Koushki, 1988). Table 3 shows that the pedestrian free flow walking speed is considerably less than that of the United States (Hoel 1968; Fruin ; Navin and Wheeler 1969; and Sleight 1972), England (Older 1964), and Singapore (Tanaboriboon 1989). The maximum flow rate and the jam density derived from Equation 3 were 51 ped/m/min and 3.1 ped/m^2, respectively. These figures are lower than any of the figures cited in the literature as indicated in Table 3. The nature of activity conducted by the pedestrians who took part in this study might have reduced the values of pedestrian characteristics compared to that cited in the literature.

In this study, the pedestrians were freed from the possibility of being penalized if they did not show up at certain times at their destinations, especially on their way back home. Nevertheless, they were in a serene worshipping environment, which might have caused the pedestrians to slow down in their walking speed and enjoy greater space. The night time is another reason for the pedestrians to calm down.

Perceived Qualitative Level Of Service

After the questionnaires were filled by the subject pedestrians, the level of service was determined for each of the questions included in the questionnaires. The eleventh question which determines the level of difficulty for walking across or in reverse directions relative to the flow of traffic was not covered by any of the subject pedestrians. The selection of the most probable LOS was also determined. Table 3 includes the qualitative estimation of LOS for the questionnaires conducted on 24-09-1426 (27-10-2005).

Quantitative Level Of Service

The pedestrian characteristics represented by flow and density from the videotapes during the time the subject pedestrian was crossing the study area was determined. The average pedestrian speed was calculated using Equation 1. Table 5 includes flow, density, and average speed during which the subject pedestrian was present in the study area. The HCM was used to determine the LOS for each of these characteristics. The overall most probable LOS was determined by using the same procedure presented in the previous sub-section. Table 5 includes the quantitative estimation of LOS for the questionnaires conducted on 24-09-1426 (27-10-2005). Two versions of the HCM were used; (HCM, 2000) was used to determine the LOS for flow and density, and the (HCM, 1985) was used to determine the LOS for average pedestrian speed. It should be noted here that the estimated LOS varied for the same time depending on the criterion that was used to determine LOS. The average speed criterion always resulted in the lowest levels for LOS followed by density, then by flow.

Suitability of HCM to Evaluate Pedestrian Facilities in the Holy City of Makkah

The estimated overall LOS obtained qualitatively and quantitatively was used to plot Figure 8. This figure indicates the closeness of the perceived qualitative LOS obtained from the questionnaire, which represents the opinion of subject pedestrians, to the LOS obtained quantitatively by using the HCM. The closeness is indicated by the value of the slope of the trendline that was added to Figure 8 and forced to pass through the origin. The slope of the trendline is 0.91. This means that, if pedestrians from the industrialized countries of the west were present at the site and of the time the stud, their opinion regarding the quality of service of the facility would have been 91% of that of the subject pedestrians.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This paper presents pedestrian characteristics in the Holy City of Makkah and determines the LOS for Khalid Bin Alwaleed Road qualitatively and quantitatively. Subject pedestrians participated in this study to determine the LOS qualitatively. Their participation was represented by walking in a study area and filling a questionnaire that was developed to accomplish this task. The LOS was determined quantitatively by determining the flow, density, and the average speed during the time the subject pedestrian was present at the study site from the videotaped traffic. The qualitative LOS was calibrated against the quantitative LOS to determine the suitability of the HCM to be used in evaluating pedestrian facilities in the City of Makkah.

The free flow walking speed was 65.6 m/min. This goes well with the study conducted in Riyadh, Saudi Arabia which found the walking speed to be 65 m/min. The pedestrian free flow walking speed is considerably less than that of the United States, England, and Singapore.

The maximum flow rate and the jam density were 51 ped/m/min and 3.1 ped/m^2, respectively. These figures are lower than any of the figures cited in the literature. The nature of activity conducted by the pedestrians who took part in this study might have reduced the values of pedestrian characteristics compared to that cited in the literature.
In this study, pedestrians were freed from the possibility of being penalized if they did not show up at certain times at their destinations, especially on their way back home. Nevertheless, they were in a serene worshipping environment, which might have caused them to slow down in their walking speed and enjoy greater space. The night time is another reason for the pedestrians to calm down.

The overall LOS obtained qualitatively and quantitatively was plotted against each other. This plot indicates how far or close is the perceived qualitative LOS obtained by the respondents to the developed questionnaire which represents the opinion of subject pedestrians to the LOS obtained quantitatively by using the HCM. The closeness is indicated by the value of the slope of the trendline that was added to the plot and forced to pass through the origin. The slope of the trendline was 0.91. This means that if pedestrians from the industrialized countries of the west were present at the site and time the study was conducted, their opinion regarding the quality of service of the facility would have been 91% of that of the subject pedestrians.

It should be pointed out here that due to the scarce resources available, the study was limited to one site and few days of data collection. To have reliable results, it is recommended that another study be conducted to cover different sites, times and seasons.

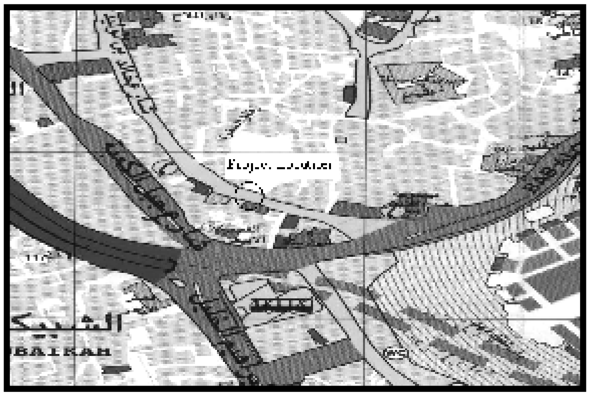

Fig. 1: Location of the site on the city map of Makkah

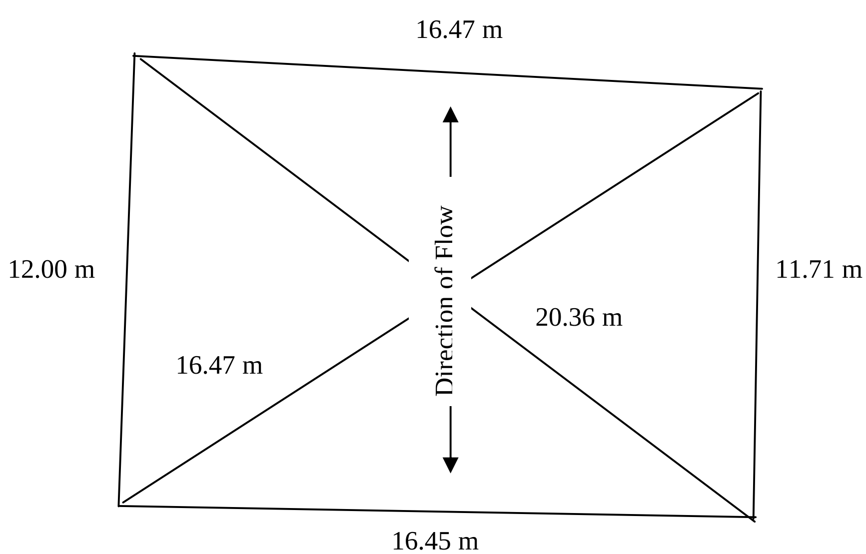

Fig. 2: Schematic diagram of the site of study

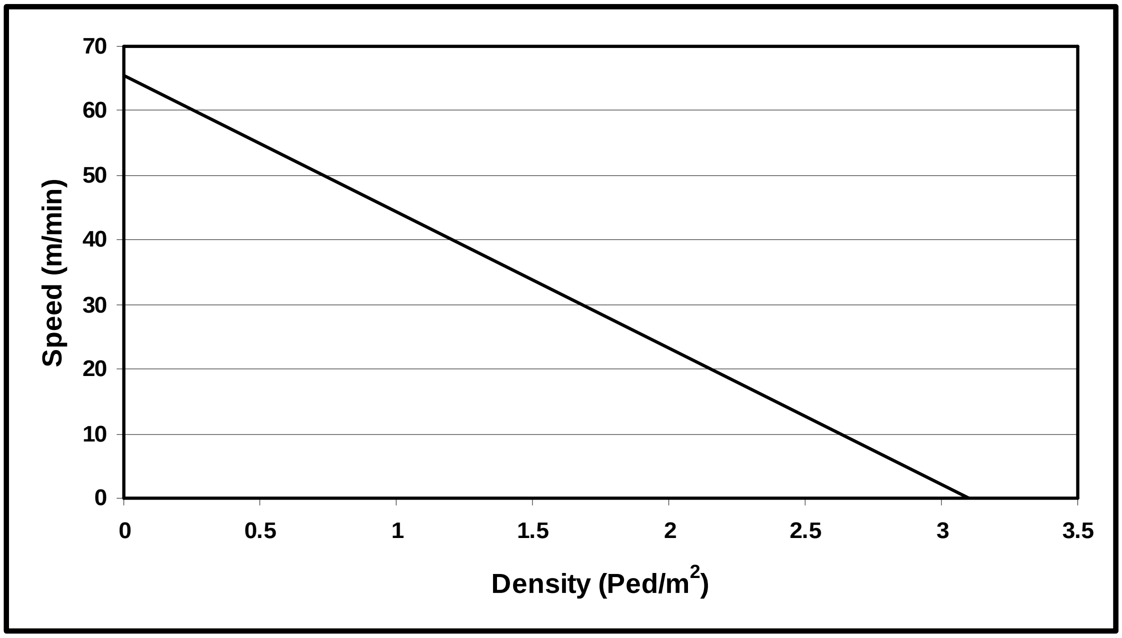

Fig. 3: Speed Density Relationship

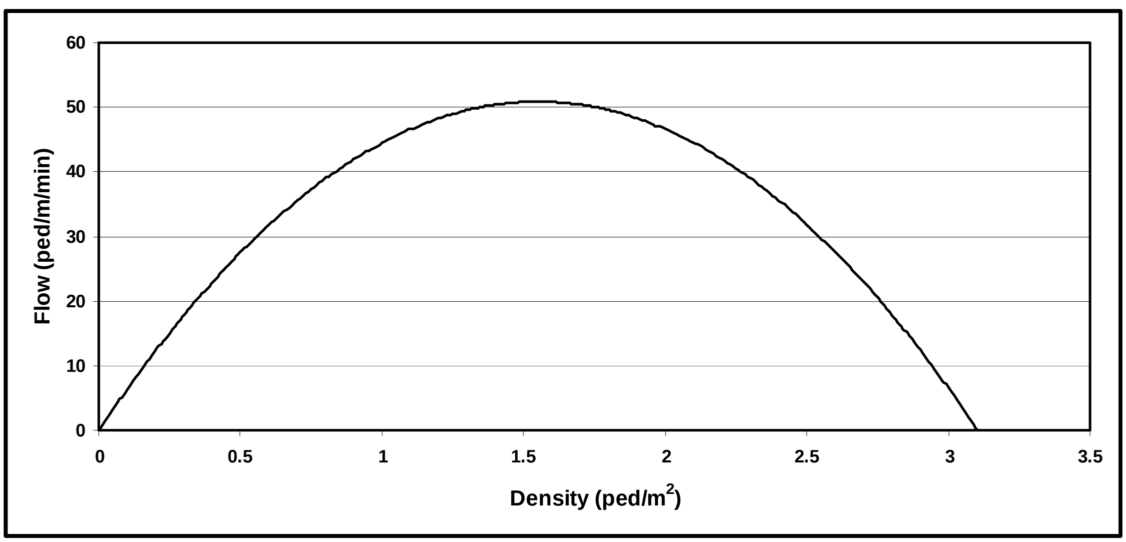

Fig. 4: Flow Density Relationship

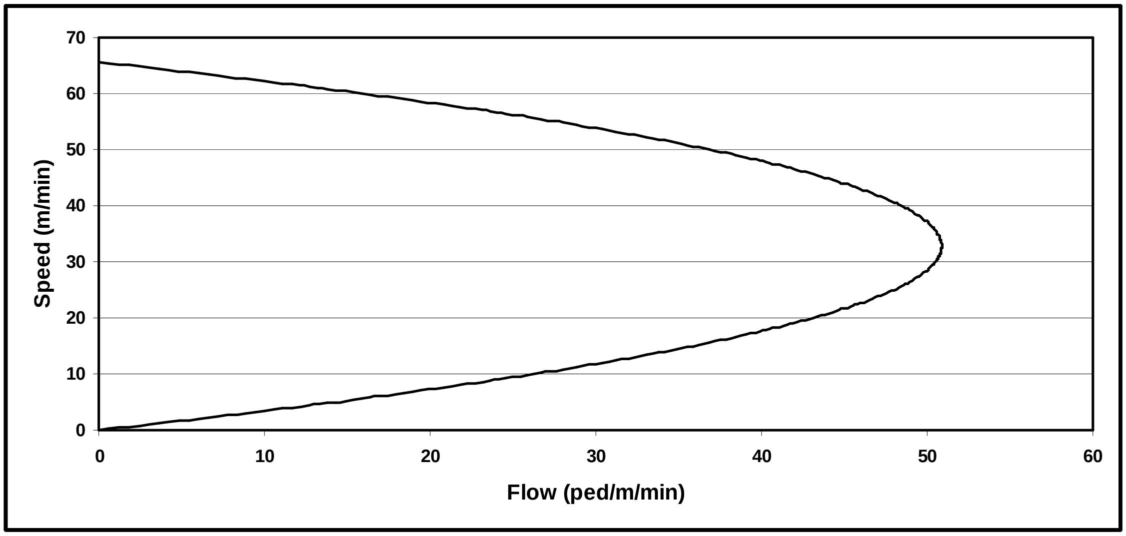

Fig. 5: Flow Speed Relationship

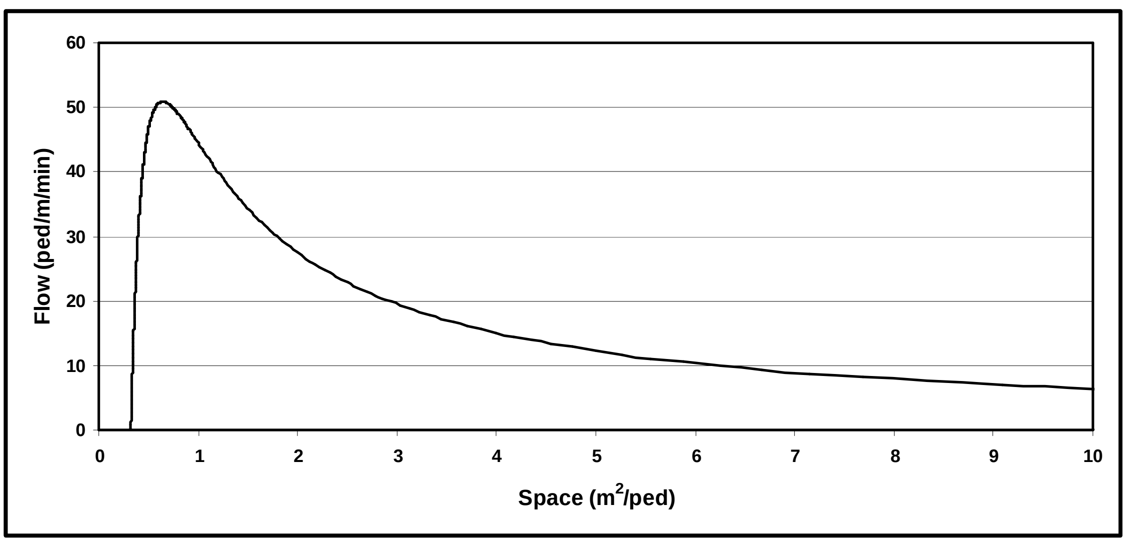

Fig. 6: Flow Space Relationship.

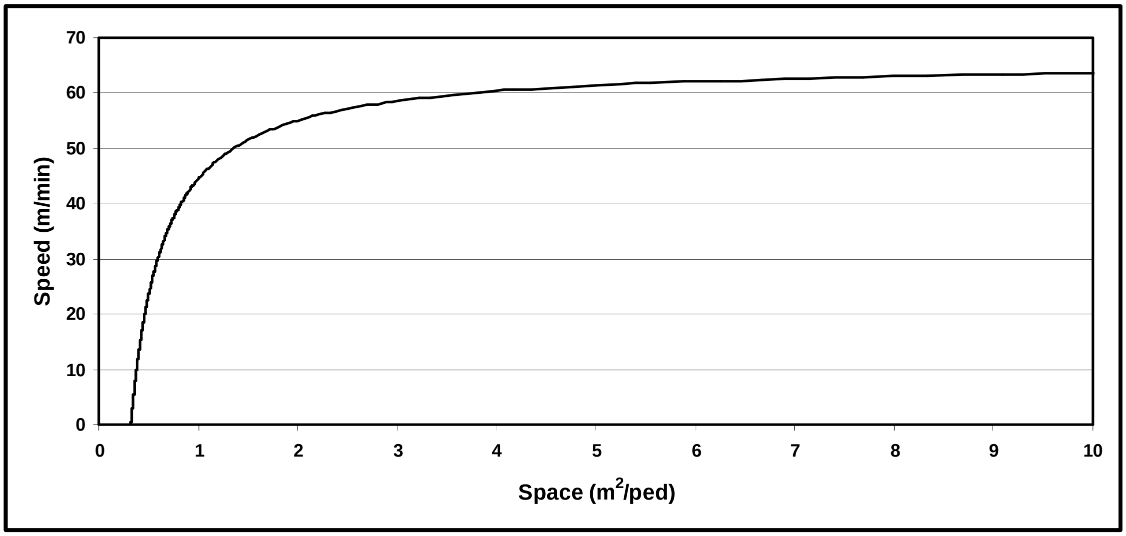

Fig. 7: Speed Space Relationship

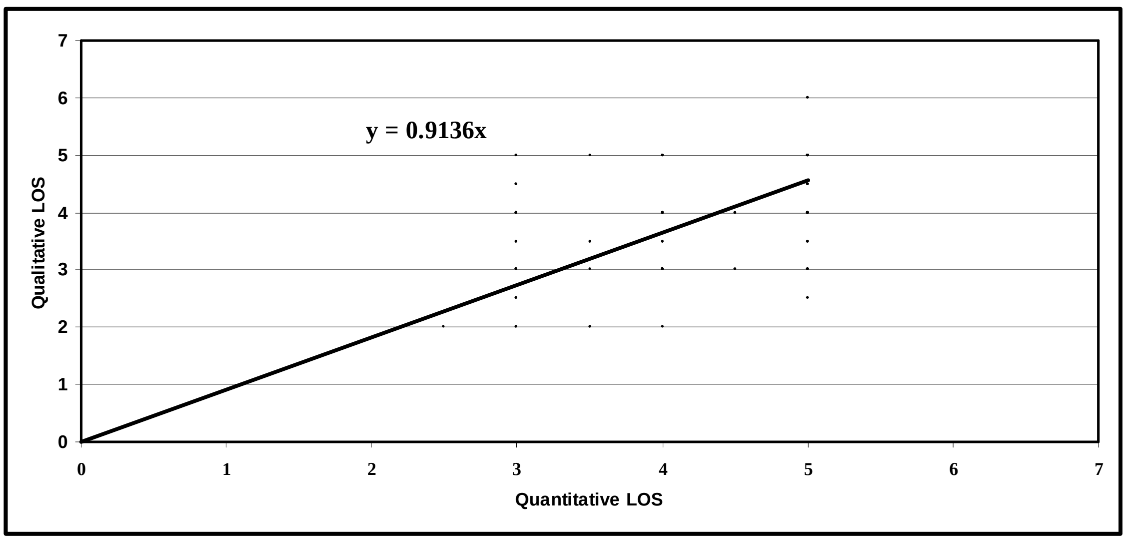

Fig. 8: Relationship Between Qualitative and Quantitative LOS

Table 1: Schedule of data collection.

No	Day	Date
1	Friday	18-9-1426, 21-10-2005
2	Sunday	20-9-1426, 23-10-2005
3	Monday	21-9-1426, 24-10-2005
4	Tuesday	22-9-1426, 25-10-2005
5	Thursday	24-9-1426, 27-10-2005

Table 2: The questionnaire used to determine the Level of Service qualitatively.

Nationality:-			**Age:-**		**Time: __:__:__**	
Level of Education:-					**Sex:-**	M F
1-	Ability to walk in desired path without altering movement in response to other pedestrians					
	a. Not restricted	1	b. Moderately restricted	2	c. Restricted	3
	d. Very restricted	4	e. Severely restricted	5		
2-	Ability to choose desired speed					
	a. Not restricted	1	b. Moderately restricted	2	c. Restricted	3
	d. Very restricted	4	e. Severely restricted	5		
3-	Ability to choose normal speed					
	a. Not restricted	1	b. Moderately restricted	2	c. Restricted	3
	d. Very restricted	4	e. Severely restricted	5		
4-	Presence of reverse direction or crossing movement					
	a. Absent	1	b. Light	2	c. Moderate	3
	d. Considerable	4	e. Severe	5		
5-	Ability to bypass other pedestrians					
	a. Not restricted	1	b. Moderately restricted	2	c. Restricted	3
	d. Very restricted	4	e. Severely restricted	5		
6-	Ability to avoid conflict with other pedestrians					
	a. Not restricted	1	b. Moderately restricted	2	c. Restricted	3
	d. Very restricted	4	e. Severely restricted	5		
7-	Need for change of speed and position					
	a. Never	1	b. Rare	2	c. Occasional	3
	d. Frequent	4	e. Considerable	5	f. Always	6
8-	Friction and interaction with other pedestrians					
	a. Never	1	b. Rare	2	c. Occasional	3
	d. Frequent	4	e. Considerable	5	f. Always	6
9-	Had to stop due to stoppage of flow					
	a. Never	1	b. Rare	2	c. Occasional	3
	d. Frequent	4	e. Considerable	5	f. Always	6
10-	Need for shuffling to move forward					
	a. Never	1	b. Rare	2	c. Occasional	3
	d. Frequent	4	e. Considerable	5	f. Always	6

Nationality:-			**Age:-**		**Time:- : :**	
Level of Education:-					**Sex:-**	M F
1-	Walking across or in reverse relative to other pedestrians was					
	a. Very easy	1	b. Easy	2	c. Slightly easy	3
	d. Difficult	4	e. Extremely difficult	5	f. Impossible	6

Table 3: Comparison of pedestrian characteristics

City and Country	Author	Free Flow Speed (m/min)	Maximum Flow (ped/min/m)	Jam Density (ped/m^2)
United States	Hoel	88	n/a	n/a
United States	Frui	81	81	3.8
United States	Navin and Wheeler	79	64	3.9
United States	Sleight	82	n/a	n/a
London, England	Older	79	78	3.7
Singapore, Singapore	Tanaboriboon, et. al.	74	89	4.8
Riyadh, Saudi Arabia	Koushki	65	n/a	n/a
Makkah, Saudi Arabia	Saif	66	51	3.1

Table 4: Qualitative estimation of level of service for 24-09-1426 (27-10-2005)

Questionnaire Query Number										Most Probable LOS
1	2	3	4	5	6	7	8	9	10	
E	E	D	E	F	E	B	D	E	D	E
E	E	F	D	F	D	D	D	F	C	E
C	B	C	B	E	D	D	F	B	B	C
E	F	E	E	F	B	D	D	B	C	E
E	F	E	E	E	F	E	D	E	D	E
E	B	D	D	B	C	B	C	C	C	C
C	E	D	E	C	D	D	B	E	D	D
C	E	D	E	C	D	D	D	E	F	D
C	D	E	F	D	D	D	D	D	E	D
C	E	E	D	E	E	B	C	E	E	D,E
E	E	B	B	B	E	B	F	B	B	B,C
E	D	D	D	C	E	E	D	D	C	D
E	D	E	F	E	E	D	D	E	D	E
C	B	C	E	B	D	B	D	B	C	C

Table 5: Quantitative estimation of level of service for 24-09-1426 (27-10-2005)

(1) Time (hh:mm)	(2) Flow ped/min/m	(3) LOS Based On Flow	(4) Density ped/m^2	(5) LOS Based on Density	(6) Speed m/min	(7) LOS Based On Speed	(8) Overall Most Probable LOS
20:46	14	A	0.37	C	38.8	F	D
20:52	23	B	0.61	D	36.8	F	D
20:56	33	D	0.78	E	42.4	F	E
21:06	29	C	0.65	D	43.7	F	D
21:10	33	D	0.65	D	50.9	E	D
21:13	30	C	0.56	D	52.7	E	D
21:18	27	C	0.48	D	56.7	E	D
21:24	18	B	0.32	C	56.9	E	C
21:29	20	B	0.33	C	60.0	E	C
21:35	46	D	0.72	E	64.1	E	E
21:59	27	C	0.84	E	32.7	F	E
22:04	30	C	0.83	E	36.5	F	E
22:16	32	C	0.94	E	34.0	F	E
22:20	44	D	0.70	D	63.7	E	D

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