PERCEPTION BASED PEDESTRIAN LEVEL OF SERVICE

By

Soumitra Jena

Roll no.-212CE3432

Under guidance of

Dr. P.K. Bhuyan

DEPARMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

NATIONAL INSTITUTE OFTECHNOLOGY
ROURKELA – 769008

CERTIFICATE

This is to certify that project entitled "**Perception based Pedestrian Level of Service** " submitted by ***Soumitra Jena*** in partial fulfillment of the requirements for the award of **MASTER IN TECHNOLOGY** Degree in **Civil Engineering** at National Institute of Technology, Rourkela is an authentic work carried out by him under my personal supervision and guidance. To the best of my knowledge the matter embodied in this project review report has not been submitted in any college/institute for awarding degree or diploma.

Prof. P.K Bhuyan
Department of civil engineering
National Institute of Technology
Rourkela -769008

ACKNOWLEDGEMENT

I would like to thank NIT Rourkela for giving me the opportunity to use their resources and work in such a challenging environment.

First and foremost I take this opportunity to express my deepest sense of gratitude to the guide PROF.PRASANTA KUMAR BHUYAN for his able guidance during the project work.

This project would not have been possible without his help and the valuable time that he has given amidst his busy schedule.

I would also like to extend my gratitude to PROF. NAGENDRA ROY, Head, Department of Civil Engineering, who has always encouraged and supported in doing my work.

Last but not the least I would like to thank all the staff members of Department of Civil Engineering who have been very cooperative with me.

SOUMITRA JENA

212CE3432

DEPARTMENT OF CIVIL ENGINEERING

NIT ROURKELA

CONTENTS

LISTS OF FIGURES AND TABLES

ABSTRACT

In urban India version of transportation, the traffic planners mostly give stress on motorized mode of movement .All kinds of steps are taken for development of roads in terms of safety, speed or time interval at intersections in case of motorized vehicle. But in present traffic condition, the non-motorized mode of traffic is also increasing. The pedestrians and bicyclists are occupying the track of motorized vehicle as no separate grades are provided for them. It leads to traffic congestion as well as the safety factor of pedestrian is at stake. According to HCM 2010, for this heterogeneous traffic, we can't just increase the level of service by developing the quality of roads for vehicles

Steps have been taken to reclaim pavement for pedestrians by removing the encroachment on footpath. A study was carried out on Bhubaneswar market complex at Unit -2 where about 260 meters of footpath surrounding it and separated from road by divider along road side. The users were asked to answer the questions the quality of service provided by the system in terms of questionnaire formed .The format of questionnaire was based on the factors that user perceive.

From the ratings, an analysis was carried out to find the level of service based on perception of the interviewers .The analysis consisted of five factors as safety, Comfort level vendors encroachment ,accessibility and side walk performance, climate condition. The analysis was done on SPSS and the area was categorized to a specific level of service out of 6 degrees of level of service (LOS).

It is difficult to have LOS value for an area based on perception as it varies from person to person. So the trail is made to its best possible value of LOS depending on majority of the majority of user's perception.

Key words-Reliability test, kmo (kieser–Meyer olkin's) test, consistency limit, chronbach's alpha test

CHAPTER-1

1.1 General

Due to rapid urbanization in India, the traffic volume is increasing on the roads. The motor vehicle industry is demanding with an annual production rate of 5 million vehicles. This leads to clumsiness on roads giving an unsuitable condition for movement. For some time, transportation engineers and planners have focused on the development vehicular transportation system. Even today, the motorized transportation system receives an overwhelming priority over systems that serve the needs of non-motorized users such as pedestrians and bicyclists. However, in recent years, emphasis has been shifted towards multimodal approaches for improvement in pedestrian facilities and operations in order to counteract the challenges of congestion, air quality, improving safety and quality of life. The researchers are promoted to step forward in improvements of traffic behavior in all aspects. There has been progress in measuring quality-of-life of pedestrian facilities and in walkability. For example Saelens et al.(2003) mentioned this from the way of users' walking decision and neighboring environmental conditions such as population density, connectivity to different transitions ,land use pattern are also the factor of influence.

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 the street quality.

As stated by Litman (2007) an improved pedestrian safety and a safer walkable environment will help the community in achieving the following:

- For non- drivers the accessibility would improve.
- Cost of transportation will sharply reduce.
- The parking efficiency in the area would be greatly enhanced.
- There would be improvement in aesthetics.
- Reduction in land needed for road construction.
- Reduction in the level of pollution and it acts as a support for transit.

1.2 Statement of the problem

Rapid urbanization has taken its toll on pedestrian safety levels, often the traffic engineers in order to provide better transportation facilities either fail to provide pedestrian facilities on the roadside or compromise the safety of pedestrians. So the need of the hour is to provide a safe environment for pedestrians without any conflicts with other modes of transportation. 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 vendor's presence in correlation with sidewalk performance.

1.3. Objective and scopes

The objective of this study is to develop an instrument for determining factors affecting sidewalk performance based on pedestrian perception. A questionnaire with different items is developed to measure pedestrian perception in five different areas: (a) safety, (b) comfort/convenience, (c) vendors presence, (d) movement easiness and accessibility, (e) environmental condition. It is believed that each item could potentially impact on sidewalk performance. The main objectives are: To provide higher safety to pedestrians without obstructing/hampering the inflow and outflow of traffic.

- To devise a yardstick for calming the traffic and to design the streets in such a way that it improves the pedestrian walking environment.
- Very little study has been carried out to perk up the pedestrian walking environment and the factors which define it.

CHAPTER-2

C0NCEPT OF LEVEL OF SERVICE

2.1 General

Level of service is defined as measurement of satisfaction level traffic system is providing to user in terms of density, speed, congestion etc. The 2010 HCM incorporates tools for multimodal analysis of urban streets to encourage users to consider the needs of all travelers. Stand-alone chapters for the bicycle, pedestrian, and transit have been eliminated, and methods applicable to them have been incorporated into the analyses of the various roadway facilities.

The primary basis for the new multimodal procedures is NCHRP Report 616: Multimodal Level of Service Analysis for Urban Streets. This research developed and calibrated a method for evaluating the multimodal LOS (MMLOS) provided by different urban street designs and operations. This method is designed for evaluating "complete streets," context-sensitive design alternatives, and smart growth from the perspective of all users of the street. It is used to evaluate the tradeoffs of various street designs in terms of their effects on the perception of auto drivers, transit passengers, bicyclists, and pedestrians of the quality of service provided by the street

The Highway Capacity Manual has defined levels of service (LOS) as "qualitative measures that characterize operational conditions within a traffic stream and their perception by motorists and passengers." LOS (designated as A through F, with LOS F being the least desirable) includes speed, travel time, freedom to maneuver, interruptions in traffic, comfort and convenience. The LOS concept was introduced to qualify the characteristics associated with various levels of vehicles and people passing a given point during specified time periods. Hence, LOS has been a qualifier of conditions relating to vehicle or person throughout rather than a qualifier of conditions relating to individual comfort level. According to HCM-2010, level of service can be classified into 6 categories LOS-A to LOS-F.

2.2 Factors affecting Pedestrian Level of Service

Traffic volume: We would observe that as the traffic volume increases the PLOS consequently tends to decrease. One can easily observe that during heavy traffic the pedestrians are more apprehensive of their safety than other time.

On street parking: this factor has a positive influence on LOS as it acts as a buffer in between the traffic and the pedestrian thus providing a sense of security. As the people perceive they are safe, hence it results in higher LOS.

Sidewalk width: greater the width of sidewalk greater is the level of safety being perceived by pedestrians as they feel more comfortable which results in a higher LOS.

Roadway width: with increase in width of road the pedestrian feels it more difficult to cross the road from one end to another thereby decreasing the LOS. Normally now a days in order to accommodate the traffic we find carriage ways of large widths resulting in a lower LOS.

Speed limits: The speed limit for the road surveyed was 40 km/hr. with increase in speed there is a drastic decrease in the pedestrian level of service. It is due to the fact that at higher speeds the pedestrians perceive higher threat levels to their life hence resulting in a decrease in LOS.

Number of lanes: With increase in number of lanes there's a increase in the total width of the road hence there is greater probability of pedestrian-vehicle interaction which leads to lower safety levels and hence it leads to lower LOS score.

Encroachment by vendors: Footpath in India is mostly occupied by vendors resulting in traffic congestion.so the user has to occupy the road for movement which leads to risk exposure. It reduces LOS.

Pavement condition: Good pavement condition leads to comfortable movement which increases Los.

Several other factors such as lighting, marking (crosswalk), presence of buffer (trees,manholes), accessibility to transit areas, driveway, space between road and footpath speed of vehicle on road also affect pedestrian Los.

CHAPTER-3

LITERATURE REVIEW

Pedestrian Planning & Design - John Fruin: "Service standards for user depends on the freedom to select the free speed of locomotion, bypass slow-moving pedestrians and the relative ease of cross and cross-reverse flow to various density of traffic avoiding physical accident. The average dimension of a fully clothed is 13 inches body depth and shoulder width 23 inches. The plan view of the average human male body occupies an area of approximately 1.5 m2. ". User requires a lateral space of 28 to 30 inches and longitudinal spacing for walking 8 to 10 feet. This results in a minimum personal area of 20 to 30 ft2/person for group movement.

Pushkarev and Zupan: found that "speed deviates according to flow rate i.e. person per space. If the flow rate is 60 persons per hour, or one person passing a point every minute, and the people are walking at a speed of 260 ft per minute, then the average distance between them is 260 ft. Multiplying that by the width of the path will give us the space allocation per person at that flow rate and that speed."

Pedestrian Time-Space Concept: A New Approach to the Planning and Design of Pedestrian Facilities - Gregory Benz: In the time-space approach of Benz methodology pedestrian activities generate time-space needs. The areas where these activities take place are time-space zones. Mathematically, the time-space concept can be described as:

$$T\text{-}Sreq. = \Sigma\ PiMiTi$$

Where, T-Sreq. = time-space required

Pi = number of people involved in activity i

Mi = space required per person for activity i

Ti = time required for activity i

T-Sreq is then compared with the time-space available. The time-space available (T-Savail.) is simply the product of the area available (Aavail.) and the time it is available (Tavail.).

Multi-Modal Levels of Service (Abridged) - David Mozer: The work area width volume(WWV) is determined using an equation which includes measures of peak hour pedestrian volumes, mode split that is not pedestrian (wheelchairs, bicyclists, skaters, runners, etc.), usable width of the walk area, and a "travel pattern factor" representing the one way or bi-directional nature of the facility's pedestrian traffic.

Quality of Service for Uninterrupted Pedestrian Facilities in the 2000 Highway Capacity Manual - Joseph S. Milazzo et al: For platooning movement, the major flow does not undergo a significant change up to a pedestrian density of about 0.8 to 1.0 peds/ m2. The minor flow begins to change when densities approach 0.7 to 0.8 peds/m2.

Field Studies of Pedestrian Walking Speed and Start-Up Time - Richard L. Knoblauch, Martin T. Pietrucha, and Marsha Nitzburg: The mean speed for pedestrians 65 years old and younger was 4.95ft/sec. The mean speed for pedestrians older than 65 was 4.11 ft/sec. Meanwhile, females 65 years old and under walked 0.32 ft/sec slower than males, while 65 and above females walk 0.4ft/sec slower than males.

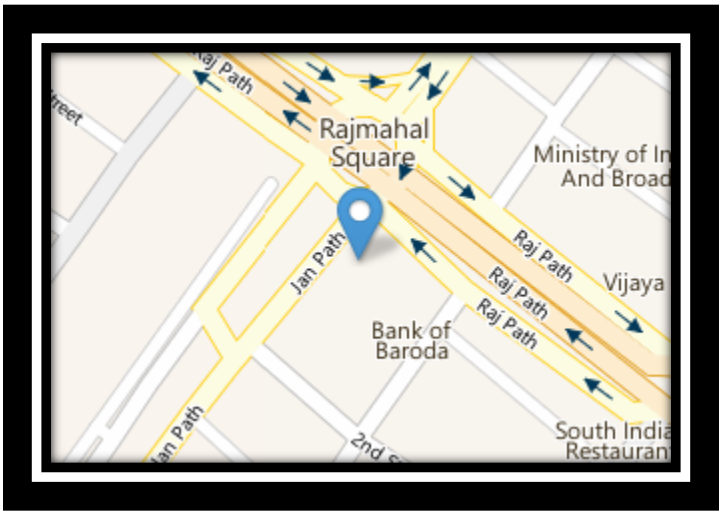
Obstacles in Pedestrian Simulations - Pascal Stucki, Christian Gloor and Kai Nagel: A person requires a 0.3m lateral spacing on each side and extra longitudinal space for speed deviation. On this basis the measured distance to obstacles are 0.45m for wall, 0.35m for fence and roadway, 0.3m for poles.

Walking Behavior in Bottlenecks and its Implications for Capacity - Serge P. Hoogendoorn: For bottleneck condition**,** due to lack in speed of movement the pedestrians make layer like trails.one layer is formed inside neck and one outside. The space between the two layers is 45 cm which is less than effective width of single pedestrian (55 cm).This is called "zipper" effect.

CHAPTER-4

METHODOLOGY AND STUDY AREA

4.1 General: site map(Unit-2 market complex area)



The key step by step procedures for applying methodology for determining performance measures and level of service for the study area are

- Selecting a tool for analysis.
- Facility segmentation.
- Gathering qualitative data by questionnaire
- To measure or forecast performance of pedestrians.
- Calculating pedestrian LOS

4.2FACTORIAL ANALYSIS

It involves four steps

- Computation of correlation matrix for all variables

- Determining the numbers of factors necessary to represent the data and the method of calculating them(extraction of factors)
- Transformation of factors for interpretation(rotation)
- Computing scores for each factor

KAISER-MEYER-OLKIN TEST

Measure of sampling adequacy is used to in comparing magnitudes of the observed correlation coefficients in relation to the magnitude of partial correlation coefficients. For a KMO value less than 0.5 the factor analysis fails.

KMO value= (sum of observed correlation coefficients)+(sum of partial correlation coefficients between all pairs of variables)

If the sum of partial correlation coefficients between all pairs of variables is less than sum of observed correlation coefficients the KMO measure will be closer to one.

RELIABILITY TEST (CHRONBACH'S ALPHA)

Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. A "high" value of alpha is often used (along with substantive arguments and possibly other statistical measures) as evidence that the items measure an underlying (or latent) construct. 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).

Cronbach's alpha can be written as a function of the number of test items and the average inter-correlation among the items. Below, for conceptual purposes, we show the formula for the standardized Cronbach's alpha:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

Here N is equal to the number of items,

c-bar is the average inter-item covariance among the items and

v-bar equals the average variance.

One can see from this formula that if you increase the number of items, you increase Cronbach's alpha. Additionally, if the average inter-item correlation is low, alpha will be low. As the average inter-item correlation increases, Cronbach's alpha increases as well (holding the number of items constant).

A linear relationship was framed in between the PLOS and the data obtained from the questionnaire. The relationship was formulated as follows

$$y = aX_1 + bX_2 + cX_3 + dX_4 + eX_5$$

Here in the linear relationship the coefficients were determined by **inverse variance** method. The coefficient **(a)** stood for safety,**(b)** represented comfort,**(c)** represented vendors' obstruction, **(d)** considered accessibility,**(e)** represented environmental condition.

The value of X_1, X_2 ,X_3 ,X_4 ,X_5 was determined by averaging the whole rating obtained for the respective cluster.

In order to determine the limits of PLOS the best and worst conditions were chosen and the respective y_{max} & y_{min} was obtained. From this the difference between the y_{max} & y_{min} was determined and they were divided by the number of intervals to be obtained.

Next starting from minimum by consecutively adding the interval we obtain the boundary limits of the respective LOS. By comparing the value found i.e. y, we can estimate the PLOS of the road.

The questionnaire used to obtain the data was shown below.

1. QUESTIONNAIRE FORMATION:

A questionnaire with a total of 21 variables is developed to measure pedestrian perception in five different areas: (a) safety, (b) comfort (c) vendors obstruction (d) movement easiness and accessibility (e) environmental condition. It is believed that each variable could potentially impact on sidewalk performance. However, it is unsure which items would contribute the greatest impact and to what degree. 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, onsite interviews were conducted in the study location. Some interviewers stopped the pedestrians and asked them for possibility to interview. The yes/no type questions were answered as 1(yes)/0(no).

QUESTIONNAIRE FORMAT:

NAME-

AGE -

SEX-

1. **COMFORT**

   - I have space to avoid the obstruction without decelerating my pace.
   - I can move freely from without any physical obstruction.

- I feel comfortable walking through the sidewalk
- I can move freely without obstruction from vendors
- I think that the sidewalk is clean
- I can move freely without obstruction

2. VENDOR'S ATTRACTION

- I am interest in goods sold by vendors
- I enjoy walking in this sidewalk, to window shopping and it is not just walking
- I intend to buy something in street vendors
- Based on my perception, the sidewalk is good in serving pedestrian flow
- I think that there are a large number of pedestrians causing sidewalk crowded

3. SAFETY

- I feel safe from trips, slips and falls. Does the road have any provision for zebra crossing? (yes/no)
- I feel safe from vehicle traffic danger
- I feel safe from intimidation or physical (Rate it 1-5)
- I think that the remain sidewalk width can accommodate pedestrian flow

NAME	AGE	SEX	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
L.D. DAS	45	M	2	3	3	1	1	1	2	4	2	1	1	1	1	1	1	2	3	3	3	1	1
B.K. MISHRA	53	M	1	2	3	2	2	3	3	2	2	2	1	1	2	2	2	3	3	3	4	1	0

4. MOVEMENT EASINESS AND ACCESSIBILITY

- I can choose my walking speed freely
- I think that the total width of sidewalk is wide enough
- I can overtake other pedestrians easily
- I can view the bus stop clearly
- The sight distance to bus stop is adequate

5. ENVIRONMENTAL CONDITION

- I don’t like go walking on sunny day
- I only go in the morning
- I only go in the evening for marketing

Chapter 5

Data collection

DEEPAN	28	M	2	2	2	3	1	2	1	1	1	1	1	1	3	2	3	2	2	3	3	1	1
SHEETAL AGARWAL	21	F	1	2	3	3	2	2	2	1	1	2	3	3	3	1	2	2	3	2	2	1	1
MEENAKHI	14	F	1	2	3	4	3	1	2	3	2	3	4	4	4	4	2	2	2	3	2	2	0
S.PARIJA	33	M	1	2	3	4	3	1	2	3	2	3	3	3	3	4	2	1	3	2	2	2	1
T.BEURA	35	M	2	2	3	4	3	1	2	2	2	2	4	3	3	4	2	1	3	2	2	2	1
S.PADHI	25	M	1	2	3	4	3	1	2	2	2	3	4	4	4	4	2	2	2	3	2	2	1
BABU	25	M	1	3	3	4	3	1	2	2	3	3	3	2	2	4	2	2	3	2	2	2	1
D.MOHARANA	32	M	2	2	3	4	3	3	2	1	3	3	3	4	2	4	3	2	3	3	2	2	1
VICKY	22	M	2	2	3	4	3	1	2	3	3	3	2	2	4	4	1	2	3	3	3	2	1
S.SETHI	56	M	1	2	3	4	3	3	2	2	1	3	4	4	4	4	3	2	3	2	2	2	1
SUCHITRA SAHU	35	F	1	2	3	4	3	1	2	4	2	2	4	4	4	4	2	2	3	3	2	2	1
DIBKAR DAS	44	M	1	2	3	2	3	2	2	1	2	2	2	4	4	4	2	2	3	3	3	2	1
AJIT SEN	36	M	1	2	3	4	3	1	2	2	1	3	4	4	2	4	2	2	4	3	3	2	1
RAMBABU	30	M	1	2	3	2	3	2	2	3	3	2	4	2	2	4	2	1	3	3	1	2	1
SUBHASHREE ROUT	20	F	1	2	3	4	3	1	2	4	3	3	2	4	4	4	3	1	3	2	2	1	1
D.MAJHI	22	M	1	2	3	4	3	1	2	1	3	2	4	4	4	4	3	2	3	3	2	1	1
MADHU YADAV	19	F	1	2	3	2	3	2	2	1	2	3	4	2	2	4	2	2	3	4	2	1	1
PINTU	22	M	1	2	3	4	3	1	2	1	2	3	4	4	2	4	3	2	4	3	2	1	1
RAKESH KUMAR	25	M	1	2	3	2	3	3	2	2	1	4	2	2	4	4	1	1	3	2	2	3	1
S.SAMAL	26	F	1	2	3	4	3	1	2	1	1	3	2	4	4	4	2	2	3	3	2	2	0
BISNUPRIYA SAHOO	12	F	1	2	3	2	3	3	2	2	4	2	4	4	4	4	1	2	3	3	2	3	1
S.BAGH	15	M	1	2	3	3	3	3	2	1	2	3	3	4	4	4	2	1	3	2	2	3	0
P.NAYAK	22	M	1	2	3	4	3	1	2	3	4	4	3	4	2	4	2	2	4	3	2	2	0
L MOHANTY	54	M	1	2	3	3	3	3	2	3	4	4	4	3	2	4	2	2	3	2	1	2	0

Chapter 6

Results and Analysis

6.1 Introduction

After analyzing by using inverse variance method the results were obtained. From the data the PLOS of the road was determined by suitably determining the range of each LOS. The result obtained can be utilized by a traffic engineer to improve upon the present roads and a better walkable environment can be provided to the pedestrians in future by adopting suitable design methods for the road.

6.2 Respondent's Characteristic

The majority of the subjects were male (60%). Respondents grouped in age in under 18 years (32%), from 18 to 30 years (61%), and 31 to 56 years (7%). 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. Most of the users were using carriage way(40%) rather than footpath due to the preoccupation by vendors.

Pedestrian counting (morning)

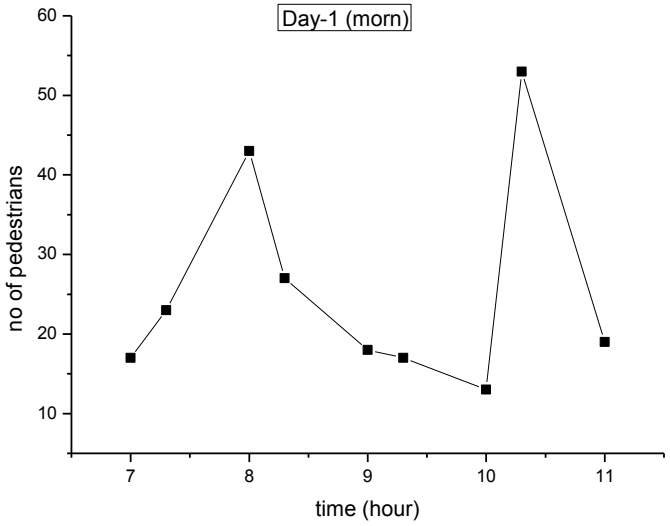

Day-1 (morn)
no of pedestrians
time (hour)
60
50
40
30
20
10
7
8
9
10
11

FIG-1

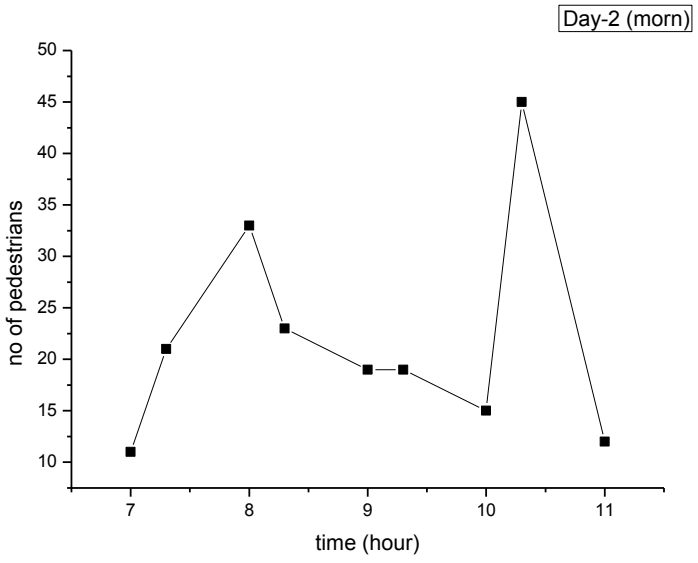

Day-2 (morn)
no of pedestrians
time (hour)
50
45
40
35
30
25
20
15
10
7
8
9
10
11

FIG-2

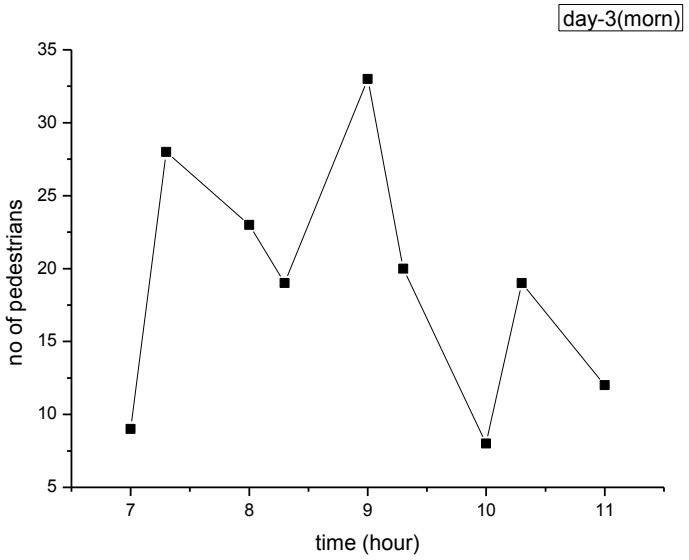

day-3(morn)
no of pedestrians
time (hour)
35
30
25
20
15
10
5
7
8
9
10
11

FIG-3

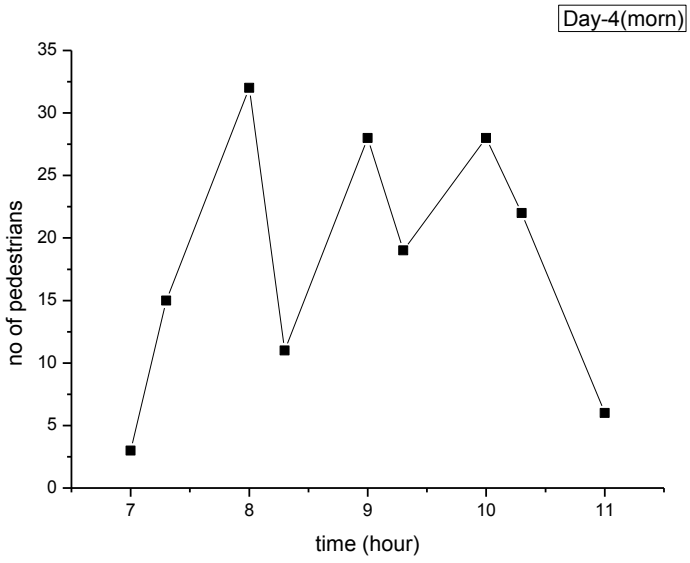

Day-4(morn)
no of pedestrians
time (hour)
35
30
25
20
15
10
5
0
7
8
9
10
11

FIG-4

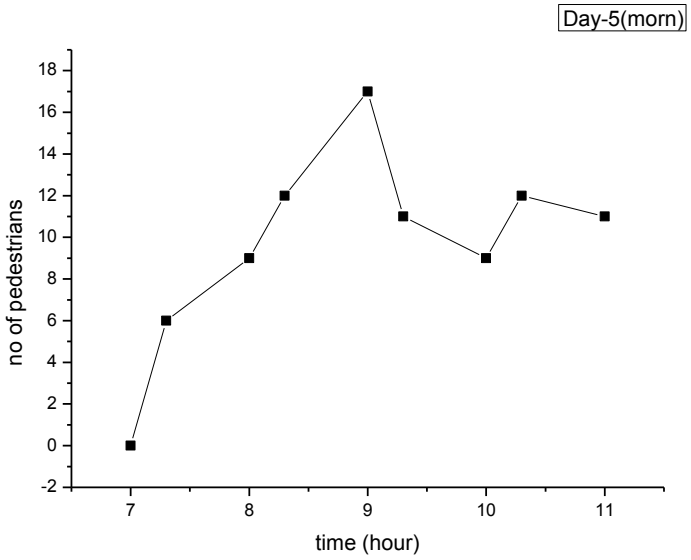


FIG-5

Pedestrian counting (afternoon)

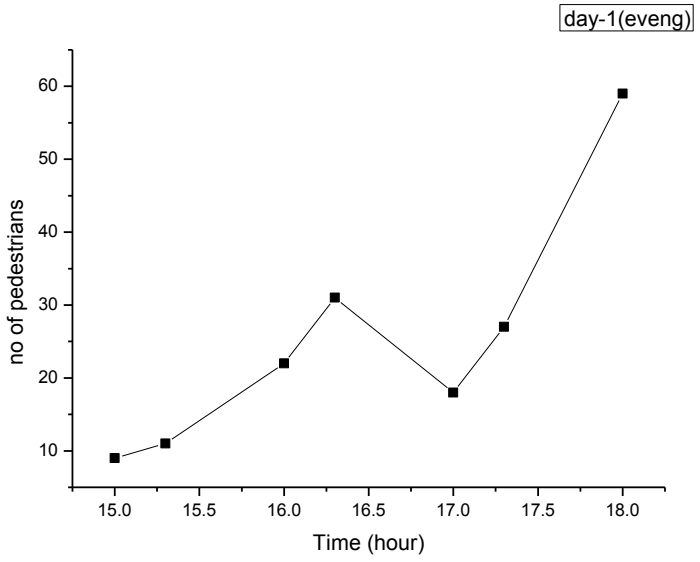

day-1(eveng)
no of pedestrians
60
50
40
30
20
10
15.0
15.5
16.0
16.5
17.0
17.5
18.0
Time (hour)

FIG-6

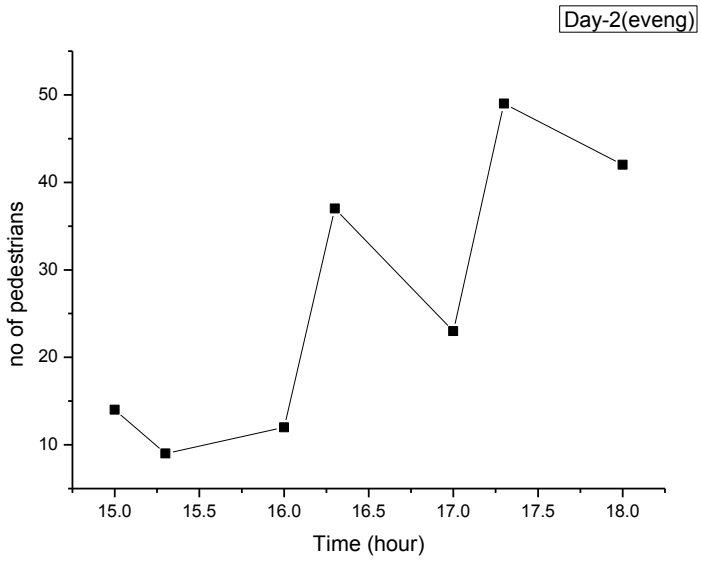

Day-2(eveng)
no of pedestrians
50
40
30
20
10
15.0
15.5
16.0
16.5
17.0
17.5
18.0
Time (hour)

FIG-7

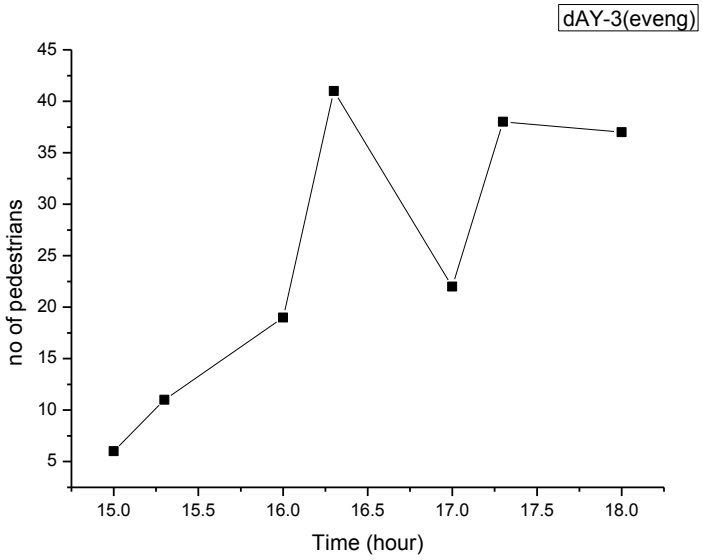

dAY-3(eveng)
no of pedestrians
Time (hour)
45
40
35
30
25
20
15
10
5
15.0
15.5
16.0
16.5
17.0
17.5
18.0

FIG-8

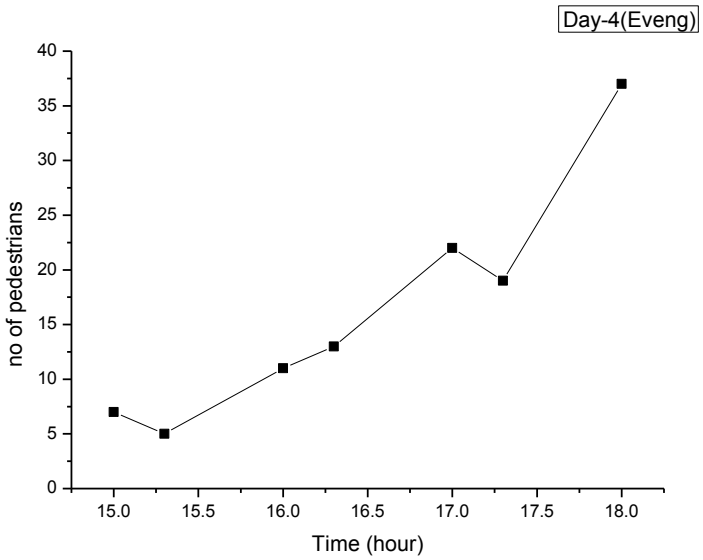

Day-4(Eveng)
no of pedestrians
Time (hour)
40
35
30
25
20
15
10
5
0
15.0
15.5
16.0
16.5
17.0
17.5
18.0

FIG-9

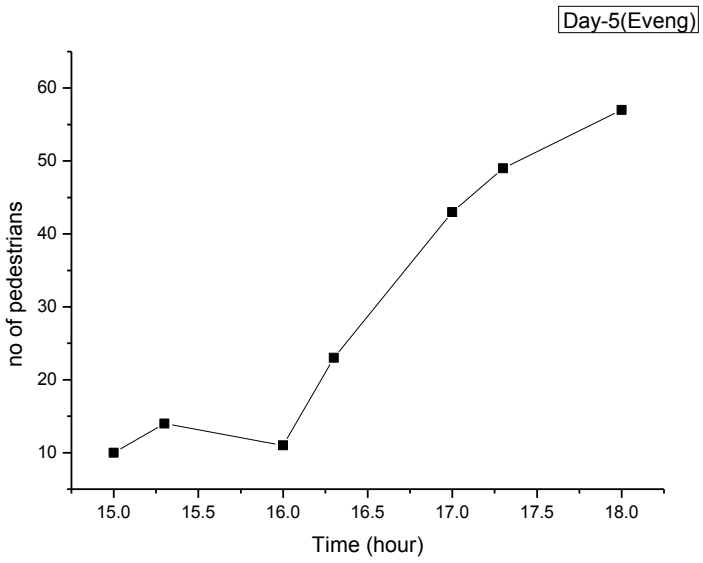


FIG-10

6.3 Factor Determination

Principal component factor analysis with a varimax rotation was conducted on the 21 items. The result of the KMO for all of the 21 variables was shown in Table-1. The KMO test resulted in a value of 0.63, which was greater than 0.5, so the factor analysis was ok. Inspection of the scree plots and the eigenvalues initially suggested a five-factor solution. Items that have communalities below 0.50 were not included.

Table 1

Kaiser-Meyer-Olkin's measure of sampling adequacy	0.63

The proposed solution has five factors, and is accounted for 71% 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 = 31.054%), 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 = 17.533%), 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 = 8.67%), 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 and accessibility (4 items, variance = 9.525%), refers to pedestrian freely to choose their speed, and space availability for their movement. Factor 5, environmental condition (2 items, 4.17%)

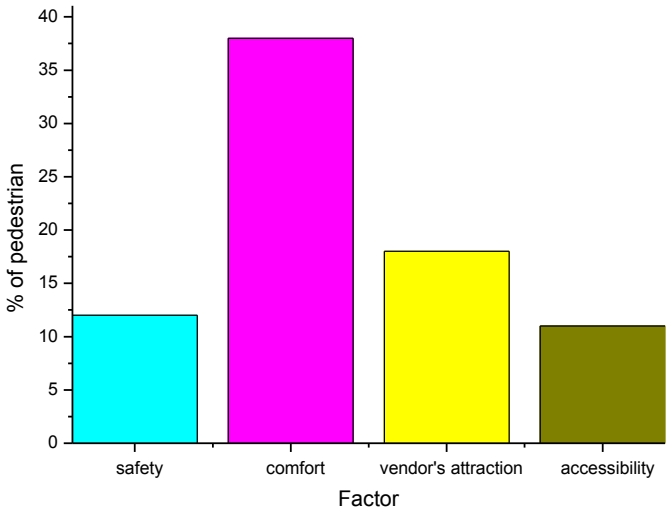

40
35
30
25
20
15
10
5
0
% of pedestrian
safety
comfort
vendor's attraction
accessibility
Factor

FIG-11

Table-2

variables	Factors comfort	vendors ‘obstruction	safety	accessibility	Environmental condition
I have space to avoid the obstruction without decelerating my pace	.674	-			
I can move freely without obstruction from physically features	.658				
I feel comfortable walking through the sidewalk	.541				
I can move freely without obstruction from vendors	.533				
I think that the sidewalk is clean	.480				
I am interest in goods sold by vendors	.511				
I enjoy walking in this sidewalk, to window shopping and it is not just walking		.688			
I intend to buy something in street vendors		.675			
Based on my perception, the sidewalk is good in serving pedestrian flow		.541			
I think that there are a large number of		.512			

pedestrians causing sidewalk crowded					
I feel safe from trips, slips and falls		.413			
I feel safe from vehicle traffic danger			.712		
I feel safe from intimidation or physical attack			.701		
I think that the remain sidewalk width can accommodate pedestrian flow			.663		
I feel safe from trips, slips and falls. Does the road have any provision for zebra crossing? (yes/no)			.583		
I can choose my walking speed freely				.679	
I think that the total width of sidewalk is wide enough				.705	
I can overtake other pedestrians easily				.583	
The sight distance to bus stop is adequate				.574	
I don't like walking on a sunny day					.65
I like walking in evening for marketing					.71
Total variance due to factors (%)	31.054	17.533	8.67	9.525	4.17

(3) Reliability

Table-3(chronbach's alpha)

	comfort	Vendors 'obstruction	safety	accessibility	environment	Total
Mean	2.091	3.188	3.052	2.12	1.89	2.4682
Standard deviation	0.178	0.169	0.183	0.051	0.198	.198
minima	2.003	3.05	2.887	1.998	1.765	2.538
maxima	2.187	3.257	3.189	2.202	1.985	3.416
Chronbach's Alpha	.867	.744	.705	.583	.781	.895

CALCULATION OF PEDESTRIAN LEVEL OF SERVICE

TABLE-4

CONSTANTS	PARAMETERS	PRODUCTIVITY FACTOR	VARIENCE	INVERSE VARIENCE
a	safety	.12	3.397	0.294
b	comfort	.38	2.829	.353
c	Vendors ‘obstruction	.18	2.659	.376
d	accessibility	.11	2.541	.393
e	Environmental condition	.08	1.36	.735

TABLE-5

X	MEAN
X1	2.019
X2	3.188
X3	3.052
X4	2.12
X5	1.89

The level of service value of the system=5.081

RANGES OF LEVEL OF SERVICE

TABLE-6

LOS	RANGE
A	2.157-3.134
B	3.134-3.91
C	3.91-4.435
D	4.435-5.293
E	5.293-6.171
F	6.171-7.935

CHAPTER-7

SUMMARY AND CONCLUSION

SUMMARY

This study was carried out the find the LOS qualitatively. The qualitative method is a better method to determine LOS as it inputs the real time response of people thus providing an option of achieving a better and more accurate result. the data was analyzed by using inverse variance method and the LOS score table was obtained by determining the ranges for each level of service which helped in the estimation of the PLOS of the study area.

CONCLUSION

After analyzing the data we arrive at following conclusions:

The LOS score obtained by inverse variance analysis was found out to be5.08whichwas within the range of LOS D i.e. in between 4.435-5.293.This signified that PLOS of the road segments in the study area are providing not good quality of service to the pedestrians in the prevailing geometry and surrounding environmental characteristics.

REFERENCES

1.Burde, A.: A Study on Road Users' Overall Perceptions of Highway Maintenance Service Quality and the Variables that Define the Highway Maintenance Service Quality Domain, Dissertation, Virginia Polytechnic Institute, Blacksburg, Virginia, 2008.

2) Field, A. : Discovering Statistics Using SPSS, Second Edition, SAGE Publications Ltd., London, 2005.

3) Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C.: Multivariate Data Analysis, 6th Edition, Prentice Hall, New Jersey, 2006.

4) HuangT. H., Chen-Jr C.: Modeling Level of Service on Pedestrian Environment, Journal of the Eastern Asia Society for Transportation Studies, Vol. 7, 2007.

5) Landis, Bruce, et al.: Modeling the Roadside Walking Environment: A Pedestrian Level of Service, Transportation Research Board 1773, Washington DC, 2001.

6) Parasuraman, A., Zeithaml, V.A., Berry, L.L.: SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality, Journal of Retailing, Volume 64, Number 1, 1988.

7) Tan D, Wang W, Lu J, Bian Y.: Research on Methods of Assessing Pedestrian Level of Service for Sidewalk, Journal of Transportation Systems Engineering and Information Technology, Volume 7, 2007.

8) TRB: Highway Capacity Manual, Transportation Research Board, National Research Council, Washington, 2000.

9) Zhang, X.: Factor Analysis of Public Clients' Best-Value Objective in Public–Privately Partnered Infrastructure Projects, Journal Of Construction Engineering And Management ASCE, pp, 956-965, September 2006.

10)