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Use of Multinomial Logit Model in Evaluation of Service Levels of Pedestrian Facilities

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Abstract
Main aim of this study is to provide service measures for walking facilities such as sidewalk, signalized intersection and un-signalized intersection using pedestrian perception data sets. Based on factors which are mainly affecting the pedestrianôs satisfaction level like traffic, safety, comfort, maintenance and aesthetics proper questionnaire has been prepared for these three facilities. Multinomial logit modeling concept has been applied to estimate probability and category of satisfaction levels of different facilities. Analysis shows that 38.4% of total pedestrians were having problems while walking due to illegal on-street parking and vending encroachment as they covers maximum space of the sidewalks.

Keywords: Pedestrian Perception, Walking Facilities, Service levels

1. Introduction

In a developing country like India walking is an important way of mobility with a high percentage of mode share. However transportation planners and designers are getting more and more inclined towards motorized mode, which leads to discourage people to walk. Undoubtedly, in sustainable transportation system walking is an indispensable mode but unfortunately not enough attention is paid in development of safe and supportive infrastructure for pedestrian facilities. To improve an environment as pedestrian friendly i.e. comfortable and safe the primary job is to assess the satisfaction levels of that facility; which can be directly evaluated from the perception of the road users as it is a qualitative aspect. In this paper an attempt has been made to provide a service measure for walking facilities such as sidewalk, signalized intersection and un-signalized intersection, which will help the road planners, designers and field engineers to assess the quality of the facility for the improvement.

Pedestrian Level of Service (PLOS) is a complex term which represents the operating condition of pedestrian facilities and level of comfort pedestrian experience in using these facilities as Level of Service (LOS) indirectly represents the actual feeling of the people. Although the concept of LOS is meant to reflect road user perception but most of the researchers focused on operational characteristics and road geometric parameters to measure service parameters of facilities meant for pedestrians. The information of which factor affecting the PLOS and to what extent will be known from pedestrians based on their daily experiences about any pedestrian facility. So, it is important to measure the qualitative service level rather focusing only on quantitative way of measurement.

Many researchers have done experiments in order to assess service levels of pedestrian facilities. Although LOS concept was introduced in Highway Capacity Manual (HCM) (1965), after several versions of publications, the version of HCM (2010) improvised the definition as LOS is a quantitative satisfaction of performance measure which represents the quality of service. Recent approach on pedestrian service model developed by Gallin (2001) has not considered the pedestrian perception and in Trafitech model developed by Jensen (2007) has not addressed issues on perception biasness of pedestrians. Muraleetharan et al. (2005) have developed a method for the determination of PLOS at intersections using a stepwise multi-variable regression analysis. This study concludes

that óturning vehiclesô have more influence on PLOS than other factors and the safety of pedestrians decreases with increase in turning vehicles. Lee et al. (2005) presented a new set of LOS standards for pedestriansô crosswalks at signalized intersections, where authors experimented that pedestrian LOS is negatively influenced by bi-directional pedestrian flow. Dandan et al. (2007) model did not consider the parameters of actual dimensions and quantity such as width of the facility. Araujo and Braga (2008) have proposed a different methodology for the evaluation of PLOS of crossing pedestrians at signalized intersections by application of qualitative variables. For assessing the perceptions of the subjects based on Paired Comparison and Constant Sum, psychometric methods were used by the authors.

Rahaman et al. (2012) have developed a model using the Analytical Hierarchy Process (AHP) in the order to prioritize pedestrians walking environment through shopkeeperôs expectations measures. Kang et al. (2013) proposed a model for the assessment of sidewalk level of service in the presence of bicyclists employing a statistical analysis technique such as Ordered Probit method. It was concluded that pedestrian perceptions on LOS are strongly influenced by the pedestrian flow rate. Archana and Reshma (2013) have developed a pedestrian LOS model for signalized intersections using a stepwise regression analysis. Authors concluded that pedestrian flow rate, crossing time and surface condition of the crosswalk influences PLOS more than any other parameters and suggested that with reduction in crossing time of pedestrians, cross pedestrian flow rate increases and average pedestrian delay decreases by which high levels of service can be attained. Bian et al. (2013) have developed a PLOS model for un-signalized intersections based on user perception and field quantitative parameters with the help of step-wise regression analysis. In this study authors have shown that PLOS is highly influenced by conflicting motorized and non-motorized vehicular traffic. Left, right and through bicycles movement from side streets, presence of median, right and left turning bicycles from the street parallel to crosswalk, through bicycles approaches from opposite direction of the crosswalk were also observed to influence PLOS. Ling et al. (2014) have proposed a modified method of pedestrian video simulation (PCVS) used to estimate the pedestrian level of service and found that increase in delay, turning traffic, and mixed two-wheeler volume have negative impact on LOS but pedestrian volume and refuge island presence and two-step crossing improves LOS. Kong and Yang (2010) investigated the association between the impact speed and risk of pedestrian casualties in passenger vehicle collisions with the application of multinomial logistic regression based on real-world accident cases in China. Guo et al. (2014) examined the preferences for pedestrians of crossing locations and the influencing factors in choosing a street to cross. Authors concluded that diversion distance is the most influencing factor in decision making and pedestrians prefers under or over pass for safety purpose.

Although many researchers have considered several factors contributing quantitative estimation of LOS, but userôs perception in defining PLOS has not been given due considerations particularly in a developing country like India. The main objective of this study is to develop a set of models for pedestrian facilities (sidewalk, signalized interception, un-signalized intersection) offering a hierarchy of service levels (A-F). The focus of this study is as follows: i) to identify factors affecting pedestrian service levels, ii) to design an innovative questionnaire for each facility in order to estimate PLOS, iii) to develop PLOS models of three pedestrian facilities by using multinomial Logit analysis over a set of perception data collected from nine mid-sized cities.

2. Methodology

In order to asses quality of service of walking facilities such as sidewalk, signalized intersection, un-signalized intersection, analysis has been carries out by taking the on-site perception of pedestrians. Questionnaires used for perception data collection have been prepared by considering some primary variables. The collected perception data are then investigated to get service levels of pedestrian facilities by developing probability PLOS models of each facility.

2.1 Variable Selection and Questionnaire development

For perception survey questionnaires includes five primary variables with some common socio-demographic variables. These demographic variables are asked to the participants of each facilities to observe the pedestrian characteristics such as age, gender, education, occupation, purpose of trips, house hold size, number of vehicles owned per house hold, platoon size, main mode of travel etc. Other than these questions five primary variables such as traffic, safety, comfort and convenience, road maintenance and aesthetics effects on pedestrian movement are taken into consideration to estimate service levels of the facilities. For the three facilities considered in this study these five variables contain several attributes (questions) under each. The final form of questionnaires has been decided after a thorough pilot survey. Pedestrians are asked to rate each attributes in a five rating scale with respect to their satisfaction level perceived while using the facility.

To assess the service quality under ótrafficô variable for sidewalk facilities, pedestrians were asked about whether they faced problems due to illegal turns of vehicles, high speed of traffic, vehicles swing towards pedestrians, illegal parking or presence of heavy vehicles and non-motorized vehicles. In case of intersection, participants were asked to rate their satisfaction level upon the effect of multiple factors such as traffic speed, waiting time, crossing time, red phase timing in a cycle, left turning and right turning vehicles and problem due to continuous flow of traffic etc. In order to assess effect of ósafetyô variable on the overall perceived satisfaction following questions were included: discomfort caused due to aggressive driving on the main carriageway, undesirable movement intrusion of cars on sidewalk and positive effect of barriers between sidewalk and main carriageway if provided. Under the primary variable óintersectionsô, attributes like apparent danger anticipated during crossing, casual approach in attaining a mobile call while crossing, readiness of drivers to give space for pedestrian crossing, dishonor the traffic rule by vehicular movement even in red phase etc. are asked. óComfortô variable contains attributes like comfort provided by sidewalk, pleasure felling during walking, step out of the way to avoid other pedestrian, heavy crowd and development of streetscapes. To assess comfort at intersections pedestrians are asked concerning street light facility during night, adequacy of space and time to cross, availability of zebra crossing and need of grade separated crossing etc. Under ómaintenanceô pedestrians are asked about signage and signage of roadside features, operational quality, maintenance quality, visual cluster of lights and pavement markings of the road. Whereas under the variable óaestheticsô questions were asked about presence of median, designated roadside vending zone, effect of adverse weather, and need of any improvement in near future. This study converted the perceived scores of each variable from discrete to continuous in a normalized 10 point scale as continuous data work much better in model fitting. In the questionnaires, one question was set aside to ask about óoverall satisfactionô in a 6 point rating scale. Different notions used are: 1, 2, 3, 4, 5 and 6 for extremely satisfied, very satisfied, somewhat satisfied, somewhat dissatisfied, very dissatisfied and extremely dissatisfied. This óoverall satisfactionô rating has been used as the dependent variable and five variable scores such as traffic score (T), safety score (S), comfort score (C), maintenance score (M) and aesthetic score (A) are used as independent variables for the model development.

2.2 Model development for pedestrian service levels

In order to determine the probability categories of PLOS (A-F) statistical approach is employed. Here multinomial logit regression analysis has been used as this technique is most useful for understanding the effect of several independent variables on a single dependent variable. Here the dependent variable óyô having *k* outcomes as 1, 2, 3, 4, 5 and 6 then,

$$\ln\left(\frac{p(y=1)}{p(y=6)}\right)=\beta_1 x_i \Rightarrow p(y=1)=p(y=6)\exp(\beta_1 x_i)$$
$$\ln\left(\frac{p(y=2)}{p(y=6)}\right)=\beta_2 x_i \Rightarrow p(y=2)=p(y=6)\exp(\beta_2 x_i)$$
$$\vdots \qquad\qquad \vdots$$
$$\ln\left(\frac{p(y=5)}{p(y=6)}\right)=\beta_5 x_i \Rightarrow p(y=5)=p(y=6)\exp(\beta_5 x_i) \qquad (1)$$

Where *x* is a vector of variable such as traffic score, safety score etc. which are used for determining perceived satisfaction levels and ß is estimable coefficient. As it is known that sum of probabilities of all the outcomes should be equal to one then,

P(Y=1) +P(Y=2) +é é é é .P(Y=k-1) +P(Y=k) = 1,
and by adding all the left and right hand side terms of equation (1)

$$p(y=1)+p(y=2)+.....+p(y=5)=p(y=6)[\exp(\beta_1 x_i)+\exp(\beta_2 x_i)+....+\exp(\beta_5 x_i)]$$
$$1-p(y=6)=p(y=6)\left[\sum_{k=1}^{5}\exp(\beta_6 x_i)\right]$$

$$1 = p(y=6)\left[\sum_{k=1}^{5}\exp(\beta_6 x_i)\right] + p(y=6)$$

$$1 = p(y=6)\left[1+\sum_{k=1}^{5}\exp(\beta_6 x_i)\right]$$

$$p(y=6) = \frac{1}{\left[1+\sum_{k=6}^{5}\exp(\beta_6 x_i)\right]}$$

Substitute P(y=6) in equation (1)

$$p(y=1) = \frac{\exp(\beta_1 x_i)}{\left[1+\sum_{k=1}^{5}\exp(\beta_6 x_i)\right]}$$

$$p(y=2) = \frac{\exp(\beta_2 x_i)}{\left[1+\sum_{k=1}^{5}\exp(\beta_6 x_i)\right]}$$

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$$p(y=5) = \frac{\exp(\beta_5 x_i)}{\left[1+\sum_{k=1}^{5}\exp(\beta_6 x_i)\right]} \quad (2)$$

Except the reference category, remaining all the categories values are taken as average, so that there will be only single value for each score for a category. Likewise, for the other categories averages are calculated and summations are found out for the logit values of all categories. For each response, the probability of satisfaction level is calculated for all categories. The maximum probability value among all categories is the predicted probability of satisfaction level for that respondent and the corresponding category are taken as the predicted category. The basic multinomial logit model used in this study is be represented as:

$$\log it(p) = \alpha_i + \beta_i X_i \quad (3)$$

Where Ǔ is the intercept parameter of the response level of satisfaction, ɓ$_i$ is the coefficient of parameter and X_i is the parameter score.

3. Study Are and Data Collection

In this research, perception data collection scheme was implemented in order to measure the typical service factors of pedestrian facilities. Responses of pedestrians have been collected from nine mid-sized cities of India, i.e. Bhubaneswar, Cuttack, Ranchi, Raipur, Jamshedpur, Vijayawada, Visakhapatnam, Vizianagaram and Tirupati having population in the range of 0.3-1.2 millions. These nine cities from where data sets were collected are shown in Fig.1. These cities are favorably selected as diverse activities have been observed from residential, commercial, official, educational, recreational areas etc. to get data sets from varied class and community. Data has been collected from three important pedestrian facilities such as sidewalk, crosswalk at signalized and un-signalized intersections having diverse approach road characteristics operating under the influence of heterogeneous traffic flow. Roadways are characterized by having access facilities, on-street parking provisions, nearby vending zones along 2 to 4 lane roads with grade separated footpaths in some cases. Intersections are connected with 3-5 approach legs, which are either major roads, secondary arterial roads or minor roads. Some intersections are well marked with zebra crossings and provided with advanced traffic signals and some are with very poor condition of signals and markings. Data have been collected in five phases between July-December of 2015 during 9-11 AM in the morning and 4-6 PM in the afternoon from different cities.

Three different (for 3 pedestrian facilities) convenient and proper questionnaires have been prepared and conformed through pilot survey using which participants satisfaction levels are collected in terms of ranking. At first participants are convinced about the purpose of data collection and then are asked to fill the questionnaires to assess their real time experience after using the facilities. Around 1425, 630 and 675 effective pedestrianôs perception were collected at all sidewalks, un-signalized and signalized intersections respectively. As view on a single item changes from person to person, perception data had been collected from different gender, age group and platoon size. For 2730 pedestrians responded at all the 3 facilities demographic values of the collected data are shown in the Table 1. From the total data sets 56.2% are male participants, 38% are of young age and 65.8% of pedestrian walk single during data collection.

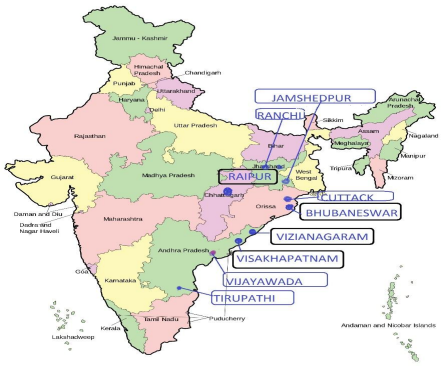
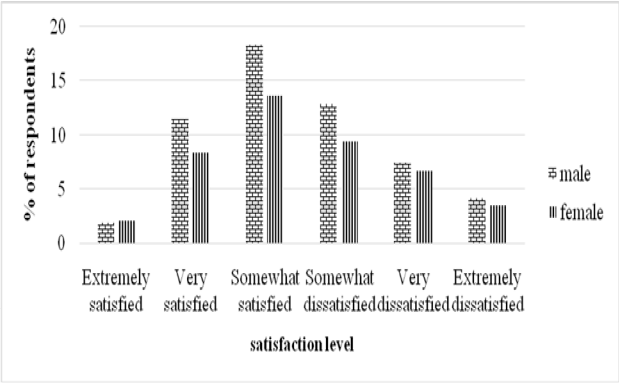


Fig. 1. Study locations of selected cities of India

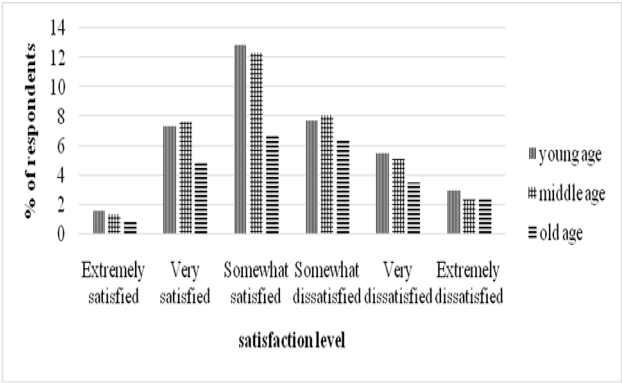
Table 1. Distribution statistics of demographic variable of surveyed respondents

Variable	Description	Total data	
		Frequency	Percentage (%)
Gender	Male	1535	56.2
	Female	1195	43.8
Age	Young (15-35)	1039	38.1
	Middle(35-55)	1011	37
	Old(>55)	680	24.9
Platoon size	1	1797	65.8
	2	474	17.4
	more than 2	459	16.8

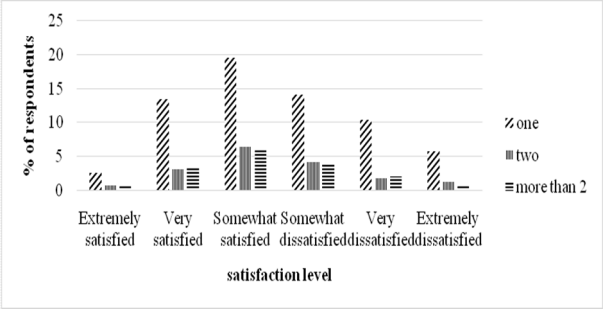
The percentage of each category for different demographic variables such as gender, age and platoon size are represented using bar charts as shown in Fig. 2.



a) Overall satisfaction responses with respect to gender



(b) Overall satisfaction responses with respect to age



(c) Overall satisfaction responses with respect to platoon size

Fig.2. Overall satisfaction responses with respect to demographic variables

4. Result and Analysis

Responses were collected using questionnaire which was given on six point scale ranging from extreme satisfaction to extreme dissatisfaction. Ratings given to all the questions under a particular parameter were calculated as score of that particular parameter. As, the outcome variable having more than two categories, the multinomial logit model (MLM) is used in this study. In multinomial logit model, the odds ratios of independent parameters are not same across the response category. For each category of outcome variable the model developed is different.

The perception data collected at the three facilities from all the cities are analyzed to develop pedestrianôs service level model. Using likelihood ratio, the data fitness to model was known. Two values for -2loglikelihood is computed i.e. one is for intercept only (without using any parameters) and the other one is for final model (with all independent variables). The values from each model are subtracted from one another. The resulting value is Chi-square, which resembles good model fit with higher Chi-square value with significance <0.05. Values for model fitting criteria and likelihood ratio test for three facilities are shown in Table 2.

Table 2. Fitness of user perception data to the model for sidewalks using MLM

Facilities	Model	Model Fitting Criteria	Likelihood Ratio Tests		
		-2 Log Likelihood	Chi-Square	Degrees of freedom	Sig.
Sidewalk	Intercept Only	3929.859			
	Final	3424.341	505.518	85	0
Signalized Intersection	Intercept Only	2202.89			
	Final	1999.316	203.574	70	0
Un-signalized intersection	Intercept Only	3929.859			
	Final	3424.341	505.518	85	0

In order to get the probabilities of different service categories of sidewalk facilities 70% of the pedestrian perception data has been used for model fit purpose. Applying MLM technique equation (1) gives the following results;
For

$$\text{Satisfaction level 1: } S_1=\frac{p(1)}{p(1)}=e^{0.686-1.587*T-0.809*S-0.59*C-0.27*M-0.725*A} \quad (4)$$

$$\text{Satisfaction level 2: } S_2=\frac{p(2)}{p(6)}=e^{11.038-0.829*T-0.295*S-0.142*C-0.272*M-0.641*A} \quad (5)$$

$$\text{Satisfaction level 3: } S_3=\frac{p(3)}{p(6)}=e^{8.631-0.321*T-0.041*S-0.432*C-0.103*M-0.374*A} \quad (6)$$

$$\text{Satisfaction level 4: } S_4=\frac{p(4)}{p(6)}=e^{6.402-0.232*T-0.181*S-0.494*C-0.132*M-0.006*A} \quad (7)$$

$$\text{Satisfaction level 5: } S_5=\frac{p(5)}{p(6)}=e^{6.535-0.363*T-0.156*S-0.249*C-0.084*M-0.099*A} \quad (8)$$

To measure the probability of each category,

Probability of satisfaction level 1: $p(1) = \frac{S_1}{1+S}$ (9)

Probability of satisfaction level 2 $p(2) = \frac{S_2}{1+S}$ (10)

Probability of satisfaction level 3 $p(3) = \frac{S_3}{1+S}$ (11)

Probability of satisfaction level 4 $p(4) = \frac{S_4}{1+S}$ (12)

Probability of satisfaction level 5 $p(5) = \frac{S_5}{1+S}$ (13)

Probability of satisfaction level 6 $p(6) = \frac{1}{1+S}$ (14)

Where $S = S_1+S_2+S_3+S_4+S_5$

Before getting the value of S, satisfaction value S_1 has been calculated by taking the averages of pedestrian perusing the option extremely satisfied with the facility. Similarly the averages of satisfaction values S_2, S_3, S_4 and S_5 has been calculated. Then S is calculated by the summation of all satisfaction values. Probability value of satisfaction level 6 is same for all responses as it is the reference category. For each pedestrians response calculate all probabilities of satisfaction level. The maximum probability among them is the predicted probability of satisfaction level and the corresponding category is the predicted category for that response. Pedestrian perception values show that the mid value of PLOS is 3.5. For the categorization the ranges of PLOS are taken are shown in Table 3.

Table 3. Ranges of PLOS categories for pedestrian facilities

PLOS Category	Ranges	Facility Condition
A	<1.5	Excellent
B	1.5-2.5	Good
C	2.5-3.5	Average
D	3.5-4.5	Inferior
E	4.5-5.5	Poor
F	>5.5	Terrible

For validation purpose taking the data of Vijayawada city, analysis shows that the average service level of the city is 3, which represents the PLOS category ócô. Also from the results it has been found that the average probability of PLOC ócô is 0.362. Detail values of the probabilities and categories for sidewalks of Vijayawada city is shown in Table 4.

Table 4: Predicted category of each sidewalk for Vijayawada city

Sidewalk	average probability of satisfaction level	average service level of facility	Predicted category
Benz circle road	0.3473	2.93	C
DV Manor road	0.3307	3.27	C
Govt. hospital road	0.314	3.27	C
Nirmala convent road	0.3827	2.73	C
Prasad V Potluri road	0.3927	2.8	C
Ramesh hospital road	0.3627	2.93	C
Indira Gandhi stadium road	0.4033	2.53	C

Similarly analysis has been carried out for all the three facilities applying the perception data of nine cities. The coefficients of each parameter for each category of satisfaction level, for all the 3 facilities (Sidewalks, Signalized intersections and Un-signalized intersections) are shown in Table 5. These models give different intercepts of independent variables for each category, which implies the odds ratio is different across the response category.

Table 5. Coefficients of each parameter for each satisfaction level using Multinomial logit model

		sidewalks		signalized intersections		Un-signalized intersections	
Satisfaction	Variables	Coefficients	Sig.	Coefficients	Sig.	Coefficients	Sig.
Excellent (PLOS A)	Intercept						
	traffic	-1.587	0	-1.605	0	-0.228	0
	safety	-0.809	0	-0.328	0.034	0.622	0
	comfort	-0.59	0.049	-0.07	0.021	-0.633	0.049
	maintenance	-0.27	0.009	0.651	0.039	0.405	0.044
	aesthetics	-0.725	0	-0.315	0.002	-0.155	0
Good (PLOS B)	Intercept	11.038	0	9.945	0	4.743	0
	traffic	-0.829	0	-1.073	0	-0.407	0
	safety	-0.295	0.024	-0.436	0.007	0.319	0.024
	comfort	-0.142	0.004	0.272	0.044	-0.046	0.034
	maintenance	0.272	0.013	0.894	0	0.182	0.029
	aesthetics	-0.641	0	-0.513	0.002	-0.078	0
Average (PLOS C)	Intercept	8.631	0	1.638	0	2.32	0
	traffic	-0.321	0.034	-0.508	0.014	-0.368	0.034
	safety	-0.041	0.003	-0.142	0.049	0.163	0.04
	comfort	-0.432	0.002	0.13	0.004	-0.074	0.002
	maintenance	0.103	0.004	0.523	0.004	0.421	0.037
	aesthetics	-0.374	0.001	-0.239	0.002	0.028	0.001
Inferior (PLOS D)	Intercept	6.402	0.001	3.571	0	2.118	0.001
	traffic	-0.232	0.004	-0.289	0.002	-0.342	0.04
	safety	-0.181	0	-0.29	0.001	0.246	0.019
	comfort	-0.494	0.001	-0.006	0.007	0.318	0.001
	maintenance	-0.132	0.045	0.218	0.022	-0.044	0.045
	aesthetics	0.006	0.004	0.003	0.008	-0.074	0.03
Poor (PLOS E)	Intercept	6.535	0.001	2.82	0	6.623	0.001
	traffic	-0.363	0.033	-0.473	0.03	-0.182	0.033
	safety	-0.156	0.002	-0.267	0.022	-0.005	0.048
	comfort	-0.249	0.001	0.132	0.047	0.102	0.014
	maintenance	0.084	0.043	0.327	0.002	0.184	0.013
	aesthetics	-0.099	0.044	-0.283	0.001	0.01	0.041

The predicted service categories of different cities using the proposed probability models for three facilities are shown in Fig.3. Sidewalk analysis for Cuttack city shows that 22% of pedestrians rate the facility as of good service level where as 75% have given average rating and 3% of poor rating. The poor service quality is due to the presence of heavy traffic with no specified sidewalks in the commercial areas. In Ranchi city 13% of participants have given the rating of LOS E (poor facility) and 2% given as LOS E (terrible condition). This occurs because, vending activities covers the most part of the sidewalks so that walkers has to use main carriage way while moving and have to face conflict with the vehicles. In other cities nearly about 15% of participants have given rating as good and 70% given rating as average service levels.

While considering about signalized intersection in Raipur city pedestrians got highest 23% of good service quality than other cities. In Jamshedpur city 30% of pedestrian feels that they were getting inferior service quality at signalized intersections and 65% were having average kind of service. Un-signalized intersection data analysis shows that the cities are neither having excellent service nor poor or terrible service quality. But most of the cities were offering average kind of service. In Cuttack and Ranchi cities according to 60% of pedestrian, un-signalized intersection are providing inferior service quality. For Vishakhapatnam the 50% of participants have given average rating whereas for Vizianagaram the percentages of ratings were 8.9%, 51.1% and 40% for good, average and inferior service quality. It has been found from the analysis that any of the pedestrian facilities are not providing excellent service levels; which explains that pedestrians expect better facilities for walking purpose.

(a) Percentage of pedestrian satisfaction for each category of sidewalks facilities

(b) Percentage of pedestrian satisfaction for each category of signalized intersections

(c) Percentage of pedestrian satisfaction for each category of un-signalized intersections

Fig. 3. Percentage of pedestrian satisfaction using Multinomial logit model

4. Conclusion

Analysis in the current study shows that variables like traffic influence, safety, comfort, maintenance and aesthetic are having significance effect on satisfaction level determination as p-value are around 0.000 for the three facilities (sidewalk, signalized intersection, un-signalized intersection). During perception survey, from the total 2730 participants 1535 are male, 1039 are of young age (15-35 age), and 1797 pedestrians were walking single. Demographic data analysis shows that male pedestrians were 7% more satisfied than female where as younger pedestrian are 2% more satisfied than middle and old age. Also it has been found that 45% of the participants have given average ratings to the different pedestrian facilities. It is noted that satisfaction levels of single pedestrian always is in higher range than the pedestrian moving in group. This was may be due to 66% of the total participants are isolate walkers.

From the analysis it has been observed that very less number of pedestrian facilities were offering very high satisfaction level or extreme dissatisfaction among users. This is occurring may be due to the reason that study areas taken in this study are of mid-sized cities having population size less than a million. In these cities there are not

severe problems as perceived by the pedestrians as of now. Under do nothing situation over a period of time will reduce service level further and will also add to pedestrian displeasure on road facilities. 43% of total participants have given opinion that due to heavy vehicular flow and illegal turns of vehicles; pedestrian faces more difficulties. 38.4% pedestrians perceived that illegal on-street parking and vending encroachment covers the maximum space of the sidewalks so that reduced space is left for walker. According to views of 43.2% of participants, activities of some aggressive drivers creates dangerous environment for other road users. Pedestrian service measures evaluated using the model developed in this study can provide an easy understanding about the condition of the walking facilities. Roadway designers can use the service measure to improve the quality or to provide any alternate design to achieve better facility.

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