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A Framework for Determining Commuter Preference Along A Proposed Bus Rapid Transit Corridor

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Abstract

Study of commuters' attitude towards public transport and their perceptions of existing service quality for different service attributes of public transport have gained immense importance in recent years for determining appropriate public transport service levels so as to retain the loyalty of existing users and for attracting potential users. Commuters' perception of service quality varies for different service delivery environments due to different urban settings, i.e., land use and traffic system, location and route characteristics, level of accessibility, fare structure, past experiences from service providers and their assessment of what is possible to be delivered. While, Level-of-Service (LOS) is a general measure to determine good, poor and acceptable service levels for various service attributes of public transport based on user perception, there is a further need to determine the minimum and maximum tolerance level of users i.e., the zone of tolerance (ZOT) and the percentage of users satisfied at different service levels which is defined here as 'user satisfaction level (USL)' for different service attributes at the route or corridor level to determine commuters' needs and preferences for that particular route/corridor which may differ significantly from other routes/corridors within the city. In addition, to ZOT and USL, it is also equally important to identify the critical service areas which need immediate improvement based on commuter preference. The present research proposes a framework to determine commuter preference for different service attributes of existing bus routes along a major corridor which could help in designing service levels for a proposed bus rapid transit (BRT) corridor.

Keywords: Commuter preference; Bus Rapid Transit; Level of Service, Zone of Tolerance; User Satisfaction Level

1. Introduction

The importance of studying commuters' attitude towards public transport and their perceptions of existing service quality for different service attributes of public transport has been established by several researchers in

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recent years for determining appropriate service levels so as to retain the loyalty of existing users and for attracting potential users (Dantas et al., 2001; Das & Pandit, 2013a; dell'Olio et al., 2011; Eboli & Mazzulla, 2011; Tyrinopoulos & Antoniou, 2008). Commuters' perception of bus transit service quality within an urban area varies for different service delivery environments due to the different urban settings, i.e., land use and traffic system, location and route characteristics, level of accessibility, fare structure, infrastructural feasibility, past experiences from service providers and their assessment of what is possible to be delivered (Dantas et al., 2001; Das & Pandit, 2013a; Zeithaml et al., 1993). While, transport planners and bus transit service providers all over the world are increasingly resorting to Bus Rapid Transit System (BRTS) as a way to improve existing bus transport service levels (Nkurunziza et al., 2012; Pandit & Maparu, 2011), commuter preference along the different corridors/routes within the proposed BRT system in an urban area may vary significantly due to the different urban setting of these corridors. Thus, there is a need to assess service quality of bus transit services for different BRTS corridors separately to determine appropriate service levels based on its user's perception.

Previous research has identified the concepts of 'Level of Service' (LOS), 'Zone of Tolerance' (ZOT) and determination of critical service area gaps for assessing service quality of bus transit services based on user perception (Das & Pandit, 2013a). While, Level-of-Service (LOS) is a general measure to determine good, poor and acceptable service levels for various service attributes of public transport based on user perception, there is a further need to determine the minimum and maximum tolerance level of users i.e., the zone of tolerance (ZOT) and the percentage of users satisfied at different service levels which is defined here as 'user satisfaction level (USL)' for different bus transit service attributes to assess the difference in commuter preference in between the BRT corridors. In addition, to ZOT and USL, it is also equally important to identify the critical service areas which need immediate improvement based on commuter preference. This research presents an overall framework to determine commuter preference for different service attributes of existing bus routes along a proposed bus rapid transit (BRT) corridor in the city of Kolkata, India that would help service providers to design appropriate service levels for the proposed BRT corridor using the concepts of Level of Service, Zone of Tolerance, User Satisfaction Level and Critical Service Area gaps.

2. Research Background

Existing literature clearly demonstrates the difference in user perception of service quality between different individuals because of the difference in socioeconomic and demographic characteristics, different travel habits and needs, different service delivery environments, different expectations of service levels and different experience with existing service providers (Andreassen 1995; Beirao and Cabral 2007; Dantas et al., 2001; Das and Pandit, 2013a; dell'Olio et al. 2011; Pandit and Das, 2013; Zeithaml et al., 1993). Berry, Zeithaml, & Parasuraman, 1990 (as cited by Eboli & Mazzulla, 2011) highlighted the importance of user perception since ''customers are the sole judge of service quality''. Therefore, while designing BRTS or any transit services, it is essential to determine the commuter perception of service quality and their preferences. Existing literature describes a number of tools and approaches to measure users' perception of service quality and to determine user preference. While the concept of Level of Service (LOS) measures the users' level of satisfaction on a given Likert scale (Correia et al. 2008; Kittelson et al. 2003), the Zone of Tolerance (ZOT) measures the gap between users' expected services and perceived services (Lobo 2009; Zeithaml et al. 1993). Level of Service refers to the users' perception of service quality measured on designated ranges of values for a particular service measure, such as "A" (highest) to "F" (lowest) (Correia et al. 2008; Kittelson et al. 2003). For example, the Transit Capacity and Quality of Service Manual (TCQSM) describes six levels of service for public transport service attributes (Kittelson et al. 2003). On the other hand, Zone of Tolerance (ZOT) measures service quality on a scale bounded by users' 'minimum acceptable service' and the 'desired service' (Zeithaml et al. 1993) wherein 'desired service' is the level of service that customers believe 'can be' and 'should be' provided while 'minimum acceptable service' is the level of service customers are willing to accept (Zeithaml et al. 1993). When perceived service quality is above the desired service quality, users' perceive it as 'above expectations'. On the other hand, when perceived service quality is lower than the minimum acceptable service, users' perceive it to be ‘unacceptable’. In addition to these, researchers have adopted a number of statistical tools like structural equation modelling, path analysis, latent variable, importance-satisfaction analysis and logit/probit models (dell’Olio et al. 2011; Iseki and Taylor 2010; Lai and Chen 2011; Martilla et al., 1977; Tyrinopoulos and Antoniou 2008) to measure the relative weights of different public transport service attributes for the users.

Commuter preference refers to the types of services and service levels that are preferred by commuters that meet their travel needs and expectations. Commuters preferences are thus best represented by both, their level of satisfaction against existing service levels for different service attributes and also their priority for different service attributes. In this research, the commuter preferences for bus rapid transit services in Kolkata, India are measured using the tools of Level of Service, Zone of Tolerance and an Importance-Satisfaction analysis. Level of Service provides a measure of users’ perception on both existing and future service quality. However, collection of user perception data in developing countries has a number of challenges, primarily because of the poor education and poor economic profile of the respondents due to which the respondents find it difficult to understand the questionnaires. Das and Pandit (2012) conducted pilot surveys on bus users in Kolkata and found that respondents preferred an ordered categorical scale over a continuous scale to rate their levels of satisfaction and importance. It was also found that a low order scale (i.e, 3 point scale) was preferred by respondents to state their level of importance in comparison to a 5 point scale used to measure users’ level of satisfaction. With these limitations in data collection, the Law of Successive Interval Scaling was found to be suitable to determine LOS scale values for transit service attributes in the context of developing countries, in which the ordered categorical scale is converted into an interval scale which could be easily interpreted by the service providers (Das & Pandit, 2013b). On the other hand, the Zone of Tolerance provides a range of service levels that service providers should target while designing transit services. The zone of tolerance (ZOT) for different services differs between individuals, between user groups and also changes over a given period of time (Lobo 2009; Zeithaml et al., 1993) and therefore needs to be revised in regular time intervals according to the changing user expectations. However, this data is often not enough for service providers to design transit services. This is because different user groups have different expectation and thus it is important for service providers to know at what service levels, maximum number of users will get satisfied. In this context, it is useful to estimate the share of users very satisfied, satisfied and moderately satisfied at different perceived service levels. With this information, service providers will be able to assess the change in the percentage of users satisfied for a given change in service level, which will implicitly have an impact on the patronage. Lastly, the importance-satisfaction analysis carried out in this research, identifies the service area gaps along the proposed BRTS corridors in Kolkata and categorizes services according to their order of priority for improvement based on their *degree of criticality* to the commuters. While a number of other methods, like structural equation modeling, logistic regression, index/impact score etc., have been employed by researchers to determine the critical services for commuters, the importance-satisfaction analysis is the simplest method that can be easily adopted and practiced in developing countries like India wherein, the user perception data are preferably collected on an ordered categorical scale as explained earlier.

3. Broad Research Framework

The first step in this research was to identify potential corridors in the city of Kolkata for implementation of bus rapid transit system (BRTS). The method demonstrated by Maparu and Pandit (2010) has been adopted in this research to identify feasible BRTS corridors in the city of Kolkata, India. In this method, passenger travel demand along existing bus routes are used to determine the main travel directions and the corridors through which these demands are catered. Next, the feasibility for implementing BRT along these corridors were examined in terms of right of way (existing and future), number of major junctions and delay, existing volume by capacity (V/C) ratio etc. to arrive at the final list of feasible BRT corridors (Pandit & Maparu 2011). The second step in this research was to identify the relevant service quality indicators for bus transit services which were identified from literature review and then validated in the Indian context through an expert opinion survey carried out across India (Das & Pandit, 2011) and further validated through a pilot bus user survey conducted on 219 bus users in the city of Kolkata (Das & Pandit, 2012). Finally, twenty two different bus transit service attributes which included both quantitative (‘service hours’, ‘bus stop nearness’, etc.) and qualitative parameters (‘bus design’, ‘security at night’, etc.) were identified and shown in Table1. In the third stage, the LOS scale values for the quantitative parameters were determined from user satisfaction data measured on an ordinal scale of “1 to 5 (1=very good/very satisfied to 5=very poor/extremely dissatisfied)” on the perceived service levels for the different bus transit service attributes using the Law of Successive Interval Scaling (Bock & Jones, 1968) using 496 user responses along 25 bus routes (Das and Pandit, 2013b). The Law of Successive Interval scaling converts an ordered categorical scale into an interval scale that can be easily interpreted by service providers. Moreover, it is most applicable when user perception data are collected through random on board surveys. In on board surveys, when groups of individuals are surveyed for different groups of service levels, then the mean satisfaction rating leads to inconsistencies in group judgments called the Arrow’s Paradox (Das and Pandit, 2013b). The ‘Law of Successive Interval Scaling’ successfully eliminates the problem of Arrow’s Paradox and provides a new way to measure the degree of agreement/disagreement amongst groups of respondents (Das and Pandit, 2013b). Using this method, five levels of service from LOS A (best) to LOS F (worst) were determined for each quantative service attribute as explained in detail in Das and Pandit (2013b). In addition, the survey questionnaire presented questions on different qualitative bus service attributes like ‘bus design & comfort’, ‘bus stop shelter design’, ‘ticket purchasing system’, ‘fare structure’, ‘safety and security’ etc. along with sub-parameters which were used to describe each of these attributes in detail as in the case of ‘bus design and comfort’ and ‘bus stop shelter design’ where respondents were asked to rate these sub-parameters as ‘absolutely essential’ or ‘essential’ or in form of different technology options which could be further prioritized by the users as in the case of ‘fare structure ‘ and ‘ticket purchasing system’. In the fourth stage, the mean ZOT bounded by the average desired service level and the average minimum acceptable service level for each of the quantitative bus transit service attributes are estimated for each BRT corridor using user perception data of the existing bus routes overlapping with the proposed BRT corridor. Next, a new measure called ‘user satisfaction level (USL)’ is introduced which is used to measure the cumulative percentage of users ‘satisfied’ and ‘moderately satisfied’ at different perceived service levels of different quantitative service attributes. This will provide guidance to transit service providers on the expected change in the percentage of users satisfied against a given change in service level. For example, the cumulative number of users who rated a particular perceived service level and levels better than that either as “1(very good/very satisfied)”, “2(good/ satisfied)” or “3(average/moderately satisfied)” within the satisfaction scale of “1 to 5 (1=very good/very satisfied to 5=very poor/extremely dissatisfied)” were considered as ‘moderately satisfied’ users for that particular service level. Similarly, the cumulative number of users who rated services either as “1” or “2” were considered as ‘satisfied’ users. Finally, USL values are expressed as the cumulative percentage of users (cumulative number of users in a particular state of satisfaction for a particular perceived service level / cumulative number of users at all states of satisfaction for the particular perceived service level and levels better than that) in a particular state of satisfaction for a particular service level. In the final stage, importance-satisfaction analysis was carried out, using users’ stated level of importance measured on an ordinal scale of “1 to 3 (1=very important to 3=not important)” for different service attributes and their stated levels of satisfaction on a “1 to 5 (1=very good/very satisfied to 5=very poor/extremely dissatisfied)” against perceived service levels. Using this method, six Degrees of Criticality was defined, unlike the conventional quadrant analysis that defines four levels of criticality. The six degrees of criticality defined in this research included ‘critical’ (those that need to be improved immediately), ‘semi critical’ (those that have moderate level of influence on users’ perceived service value and hence should be improved to increase user perception of transit service quality), ‘balanced’ (that have moderate influence on users’ perception of service quality and hence may or may not be considered for improvement by service providers, at later stages), ‘non critical’ (those attributes that have no influence of users’ perception of service quality), ‘to-be-conserved’ (service attributes that score moderate level of importance and high level of satisfaction) and the ‘overdone’ (service attributes that have performed exceeding users’ expectations). The median was used as the measure of central tendency in this research due to the use of an ordinal scale. Table 2 summarizes the different degrees of criticality for the different service attributes based on the median values of the users’ stated level of importance and satisfaction.

Table 1. Service attributes and their description

Service attribute	Description
Journey time	Passengers' perception of the quality of journey time which is influenced by the perceived difference (perceived delay) in expected journey time with other competitive modes (Unit: minutes)
Bus stop nearness	Perceived distance of nearest bus stop from a passengers' home or workplace (Unit: meters)
Waiting time	Perceived time spent by a passenger at the bus stop waiting for the next arriving bus (Unit: minutes)
Service hours	Perceived daily hours of bus service on an average working day (Unit: hours)
Crowding level	Perceived average occupancy inside bus (measured as a ratio). For eg, 1.0 = all seats occupied, 1.5= all seats occupied + 50% standees ~ 1.5 passengers per seat.
Seat availability	Passengers' perception of the possibility of getting a seat on bus (Unit: percentage of times a passenger gets a seat on bus)
Number of Mode Interchange	Number of times a passenger has to change bus to reach his final destination (Unit: number)
On time performance	Passengers' perception of buses adhering to scheduled arrival and departure timings based on past experience (Unit: percentage of times bus is on time)
Boarding-alighting time	Perceived average time passengers get for boarding & alighting at bus stops (Unit: minutes)
Ticket purchasing system	Type of ticket purchasing system: On Board from bus conductor; Magnetic chip card system which is can be recharged by users at regular intervals; Purchase of tickets from retail outlets, internet etc.
Bus design & comfort	Comfortable seat design and space; Appropriate seating arrangement & leg-space; Comfortable Standing-space layout; Appropriate design of handrails & convenient positioning for standees; Appropriate size & design of windows; Availability of sunscreen / curtain for windows; Overall ventilation mechanism inside bus; Low floor height of bus for convenience of boarding & alighting; Separate entry & exit doors; Wheelchair entry; Use of appropriate technology to reduce jerks; Availability of racks; Availability of magazines/ newspapers; Availability of music system; Availability of priority seats for elders/ disabled; Seat segregation for men & women; Bus stop arrival announcement facility; Availability of CCTV surveillance
Bus stop shelter design & amenities	Availability of seat; Availability of shade from sun & rain; Availability of amenities like newspaper, magazines; Availability of tea/ coffee; Availability of cell phone battery charging facilities; Availability of bus route details and time schedule display chart; Availability of CCTV surveillance; Availability of commercial land use in vicinity; Availability of sufficient street lighting
On board Safety from road accidents	Users' perception of safety from road accidents while travelling on board
Safety from thefts on board	Users' perception of safety & security from thefts and other crimes on board
Safety for women on board	Users' perception and satisfaction with safety measures taken for women on board
Safety & security at bus stops at night	Users' perception and feeling of safety & security while waiting at bus stops at night
Bus driver behavior	Behavior of driver, conductor and at ticket counter, driving etiquette
Driving practices	Users' satisfaction with existing bus operating & driving practices, including adherence to schedules, stooping at schedules bus stops, giving enough boarding –alighting time etc.
Bus maintenance	Users' perception of the regularity in maintenance of buses
Cleanliness	Users' perception of the regularity in cleaning buses
Bus stop shelter maintenance	Users' perception of the maintenance and upkeep of bus stop shelter amenities
Availability of Information	Users' perception of the level of information available to passengers including public announcement system on any disruption of service, route information system, change in schedules etc.

Table 2. Importance satisfaction analysis

Importance (Imp) & Satisfaction (Satis) Level	Service attribute categories based on the degree of criticality
Imp (1) + Satis (4/5)	Critical
Imp (1) + Satis (3), Imp (2) + Satis (4/5)	Semi critical
Imp (2) + Satis (3)	Balanced
Imp (3) + Satis (3/4/5)	Non critical
Imp (1/2) + Satis (1/2)	To be conserved
Imp (3) + Satis (1/2)	Overdone

4. Study Area and data collection

The study area is limited to the city of Kolkata, India having an area of 185 square kilometers and a population of 4,580,544 as per "Census 2001". The primary road network of Kolkata comprises of east-west and north-south corridors. Public transportation in Kolkata is provided by both surface and underground railway transit, trams and bus transit systems. The bus transit system in the form of buses and minibuses is operated by both government and private agencies and serves about 54% of the travel demand along 401 bus routes (Pandit and Maparu, 2011). Most of the bus routes in Kolkata are oriented towards the Central Business District. Moreover, bus transit service in Kolkata is characterized by uncoordinated and overlapping bus routes, unreliable service, rash driving and overtaking, low average speed, intermixing of non-motorized and other motorized vehicles with the buses and narrow right of way leading to traffic congestion (Maparu and Pandit 2010). Pandit and Maparu (2011) proposed a total of eight BRT corridors for Kolkata based on the existing bus travel demand. Out of these, two corridors namely the 'SCM-Gariahat-AJC-JLN' corridor with origin at Garia and destination at B.B.D.Bag and 'DH-Strand' corridor with origin at Joka and destination at B.B.D.Bag were taken up for detail analysis of commuter preference of existing bus routes along the corridor. Figure 1 shows the proposed BRT Corridors in Kolkata. In case of the proposed 'SCM-Gariahat-AJC-JLN' corridor, out of all overlapping existing bus routes, 35 bus routes (3 public, 19 private and 13 private mini bus routes) were identified to cater to the existing passenger travel demand along the corridor. Similarly, 44 existing bus routes (9 public, 27 private and 8 Mini bus routes) were identified to cater to the existing passenger travel demand along the 'DH-Strand' corridor. An extensive commuter preference survey was conducted randomly on board along four bus routes (Route No: '240', 'E1', 'S103', 'S106') along the 'SCM-Gariahat-AJC-JLN (SCM-JLN)' corridor and along five bus routes (Route No:'222', '12B', '3A', '3B/1', 'S120') along the 'DH-Strand' corridor ensuing a total of 59 and 116 completed responses respectively.

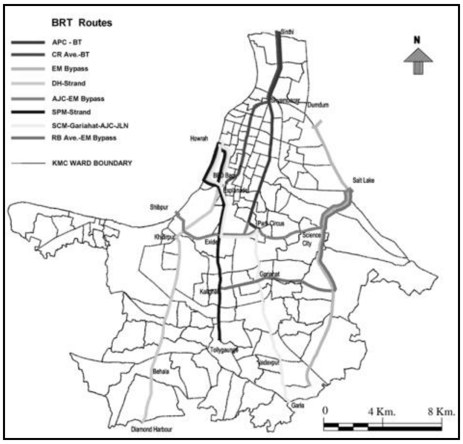


Fig. 1. Proposed BRT corridors in Kolkata (Pandit and Maparu,2011)

5. Analysis and Results

The commuter perception data on perceived service levels for different service attributes for each BRT corridor has been analyzed to categorize service areas into groups of attributes that need to be prioritized immediately and those that can be improved in later stages. Figure 2 shows the twenty two bus service parameters used in this study along with the results of the importance-satisfaction analysis on these parameters for the two BRTS corridors. 'Safety from thefts on board (theft)' was found to be 'critical' in both the corridors. In addition, 'boarding-alighting time at bus stops (B/A time)', 'bus stop maintenance' and 'cleanliness on board' were found to be 'critical' in the 'DH-Strand' corridor, while 'Safety & security at bus stops at night' and 'safety for women on board (misconduct)' were found to be 'critical' in the 'SCM-JLN' corridor. Similarly, 'bus service hours', 'bus stop nearness', 'on-time performance', 'waiting time', 'on-board safety from road accidents' and 'bus maintenance' was found to be 'semi critical' in both the corridors. 'Seat availability' and 'crowding level' were only found to be 'semi critical' in the 'DH-Strand' corridor which indicated a poor supply of buses along the corridor, whereas, both were found to be 'balanced' in the 'SCM-JLN' corridor. 'Delay in total journey time (total journey time)' was found to be 'semi critical' in the 'SCM-JLN' corridor whereas, it was found to be 'balanced' in the 'DH-Strand' corridor. 'Number of mode interchanges' in both the corridors were found to be adequate and needs 'to be conserved'.

Service parameters	DH-Strand CORRIDOR			SCM-Gariahat-AJC-JLN CORRIDOR		
	IMPORTANCE	SATISFACTION	CRITICALITY	IMPORTANCE	SATISFACTION	CRITICALITY
Bus service hours	❶	③	√	❶	③	√
Bus stop nearness	❶	③	√	❶	③	√
On-time performance	❶	③	√	❶	③	√
Waiting time	❶	③	√	❶	③	√
No. of mode interchange	②	②	^	②	②	^
Seat Availability	❶	③	√	②	③	=
Crowding level	❶	③	√	②	③	=
Boarding Alighting time	❶	❹	©	②	③	=
Total journey time	②	③	=	❶	③	√
Bus design	②	③	=	②	③	=
Bus stop shelter design	②	③	=	②	③	=
Road accidents	❶	③	√	❶	③	√
Thefts	❶	❹	©	❶	❹	©
Misconduct	②	③	=	❶	❹	©
Security at night	②	③	=	❶	❹	©
Bus driver behavior	②	②	^	②	③	=
Driving practices	②	③	=	②	③	=
Ticket purchasing system	③	③	=	②	③	=
Bus maintenance	❶	③	√	②	❹	√
Cleanliness	❶	❹	©	②	③	=
Bus stop maintenance	❶	❹	©	②	❹	√
Information	③	③	x	②	③	=

Legend

Level of Importance	SYMBOL	Level of satisfaction	SYMBOL
Very Important	❶	Very Satisfied	
Moderately Important	②	Satisfied	②
Not Important	③	Moderately satisfied	③
		Dissatisfied	❹
		Extremely dissatisfied	

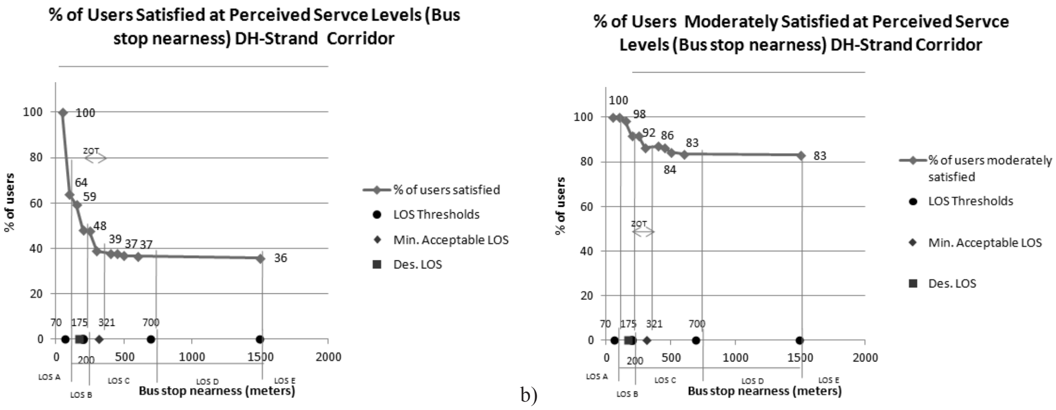
CRITICALITY	SYMBOL
Critical	©
Semi critical	√
Non critical	x
Balanced	=
To be conserved	^
Overdone	≥

Fig. 2. Importance Satisfaction analysis

In the next step, LOS scale values were determined using the 'Law of Successive Interval Scaling'for quantitative service attributes as explained in detail in Das and Pandit (2013b) for the city of Kolkata. LOS scales were also determined for some of the qualitative attributes based on 'absolutely essential' or 'essential' sub attributes identified by the users. For example, in case of 'bus stop shelter design', LOS C is described as a bus stop shelter having only the 'absolutely essential' elements, LOS B is defined as a shelter with both the 'absolutely essential' and the 'essential' elements and LOS A is defined when a shelter has both absolutely essential and essential elements and other possible additional features. Then, the mean ZOT for each of the quantitative service attributes for both the BRT corridors were computed from the mean minimum acceptable service and the mean desired service levels. Table 3 shows the LOS and ZOT thresholds for two service attributes namely, 'Bus stop nearness' and 'On-time performance' while results for other attributes both quantitative and qualitative are available with the authors but not presented here due to space limitations. Finally, USL values are computed for determining cumulative percentage of users at two states of satisfaction namely, 'satisfied' and 'moderately satisfied' at different perceived service levels for 'Bus stop nearness' and 'On-time performance' for the two BRT corridors and shown in Figure 3-6.

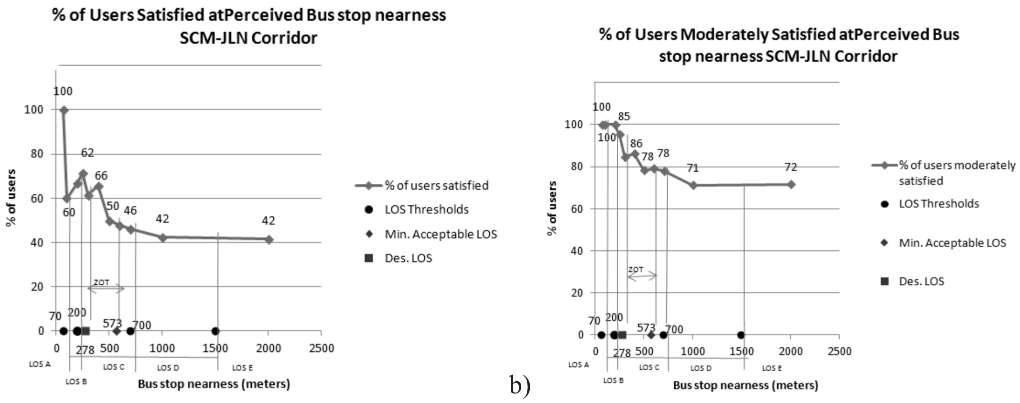
Table 3. LOS and ZOT thresholds for bus transit service attributes

Bus stop Nearness (meters)		On-time Performance (%)	
LOS	Thresholds	LOS	Thresholds
A	<70	A	>0.9
B	70-200	B	>0.9
C	200-700	C	0.9-0.5
D	700-1500	D	0.5-0.2
E	>1500	E	<0.2
ZOT (DH-Strand)		ZOT(DH-Strand)	
Min. Acceptable	321	Min. Acceptable	0.6
Desired	175	Desired	0.8
ZOT (SCM-JLN))		ZOT (SCM-JLN))	
Min. Acceptable	573	Min. Acceptable	0.6
Desired	278	Desired	0.9



a) b)

Fig. 3. (a) USL at 'satisfied' state of satisfaction for 'bus stop nearness' in the DH-Strand corridor; (b) USL at 'moderately satisfied' state of satisfaction for 'bus stop nearness' in the DH-Strand corridor

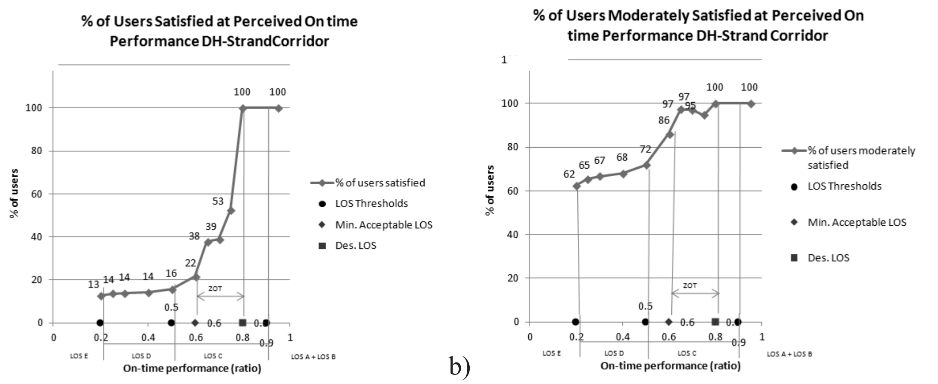


a) b)

Fig. 4. (a) USL at 'satisfied' state of satisfaction for ''bus stop nearness' in the SCM-JLN corridor; (b) USL at 'moderately satisfied' state of satisfaction for 'bus stop nearness' in the SCM-JLN corridor

Figure 3 and 4 shows the LOS, ZOT and USL values for 'bus stop nearness' for the 'DH-Strand' and 'SCM-JLN' corridor respectively. The results show a difference in the ZOT and USL values in these two corridors for the two states of satisfaction. For example, the users of the 'SCM-JLN' corridor show a higher tolerance (minimum acceptable service level) i.e., 278-573 meters for 'bus stop nearness' compared to 175-321 meters for the users of the 'DH-Strand' corridor. While, traditionally, the LOS level of 'C' has been considered appropriate for service delivery, the present research shows that, the range of ZOT could be different than this level in different corridors. On the other hand, the percentage of commuters 'moderately satisfied' and 'satisfied' at the minimum acceptable level of service ('bus stop nearness') are 86 and 38 percent respectively in the 'DH-Strand' corridor and 79 and 48 percent respectively in the 'SCM-JLN' corridor. The higher percentage (48%) of users 'moderately satisfied' even at a lower minimum acceptable service level (573 meters) for 'bus stop nearness' at the 'SCM-JLN' corridor compared to the 'DH-Strand' corridor confirms the need for USL in addition to ZOT and LOS for determining appropriate service levels in the proposed BRTS corridors. The different user composition and land use and urban setting of the two corridors results in the difference in ZOT and USL values which also highlights the need for considering different service levels for different service parameters in different BRT corridors. Figure 5 and 6 shows the LOS, ZOT and USL values for 'on-time performance' for the two corridors. Similarly, other service parameters were also analyzed.

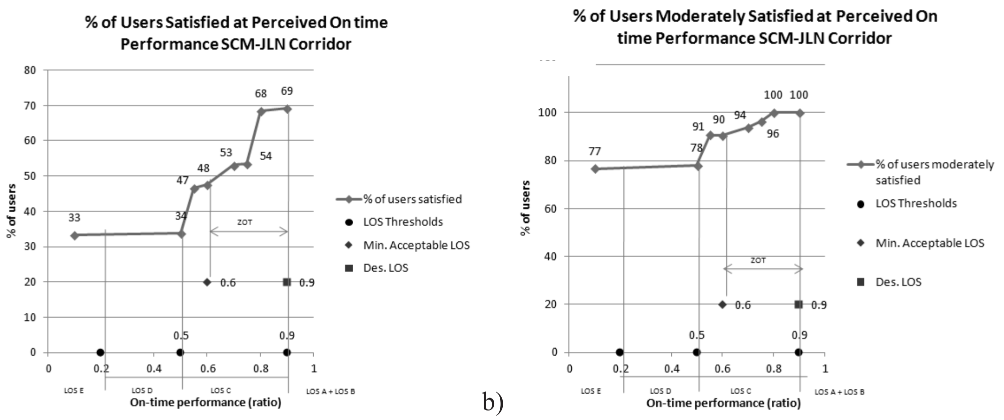
a)



b)

Fig. 5. (a) USL at 'satisfied' state of satisfaction for 'on-time performance' in the DH-Strand corridor; (b) USL at 'moderately satisfied' state of satisfaction for 'on-time performance' in the DH-Strand corridor

a)



b)

Fig. 6. (a) USL at 'satisfied' state of satisfaction for 'on-time performance' in the SCM-JLN corridor; (b) USL at 'moderately satisfied' state of satisfaction for 'on-time performance' in the SCM-JLN corridor

6. Conclusion

The proposed methodology to determine commuter preference would help service providers to design appropriate service levels for existing and future public transport services along different bus routes or BRT corridors. ZOT boundaries and USL values for different service attributes could be used for designing the schedules, frequency, etc. for the proposed BRT corridors. Further, causal relationships between service level and the percentage of users satisfied could be developed to estimate the change in the percentage of users satisfied for a given change in service level. The results also highlighted the different requirements or commuter preferences for different routes or corridors which could be used to design route or corridor specific service levels.

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