RESEARCH ARTICLE

Equity in public transport — a case of Bangalore's city bus transport

Deepak Baindur[*] **and Pooja Rao**

Indian Institute for Human Settlements, No. 197/36, 2nd Main Road, Sadashivanagar, Bangalore 560 080, India

Abstract: In most urban areas, buses are the most heavily used form of public transportation[1] and more so in Indian cities where buses make up for over 90% of public transport ridership[2]. In the selected Indian metro cities, where formal bus based PT systems are operated by public agencies, they are over-reliant on state support to sustain operations as fare box collections are inadequate in spite of having relatively high ridership. The main challenge for all this is to achieve long term financial sustainability of public transport systems while providing good quality and affordable bus services.

This paper investigates internal and external factors that led to the steep and recurrent fare increases in the Bangalore city bus services in the period from 2012–2014 which are operated by Bangalore Metropolitan Transport Corporation. In order to estimate the impact of the recent bus fare increases that have had on the economically weaker sections of the society dependent on these services, the paper presents the results of a random sampling survey study carried out in a central locality in the city that has a large slum area.

The key findings throw light on the various ways in which the low income bus users have adapted to reduce their travel costs through changes in travel behavior, travel pattern and modal shifts. The cost of the behavioral changes through lost opportunities and the cost of the modal shifts of the persons earlier favoring public transportation draw attention to the significance of public transport fare policies. Furthermore, the management and operations of the BMTC agency show scope for improvement which can translate into better revenue generation and consequent reduction in fares.

Keywords: public transport, bus fares, travel behavior, affordability

*Correspondence to: Deepak Baindur, Indian Institute for Human Settlements, No. 197/36, 2nd Main Road, Sadashivanagar, Bangalore 560 080, India; Email: baindurdeepak@gmail.com

1. Introduction

Increased urbanization and rapid motorization in Indian cities are causing challenges of ever increasing disparity between redistribution of economic opportunity and growth. As motor vehicle activity increases and as transport infrastructure increasingly caters for personalized motor vehicles, other transport modes such as walking, cycling and public transit which are relied on by low-income groups and the poor are adversely affected[3]. In Indian metropolitan cities such as Delhi, Bangalore, Mumbai, Kolkata and Chennai, this situation is further worsened by already high population densities, poor transport infrastructure, and lack of affordable housing for the poor, forcing them to relocate to city's peripheral regions. Consequently, this scenario has further marginalized the poor from access to desired destinations and opportunities. The direct consequence is that their social welfare is negatively impacted. Low-income groups

without a private vehicle are also associated with weaker social ties and small social networks. Hence, affordable public transit is critical to meet basic living needs and enhancing quality of life among city's low income population.

In Indian metropolitan cities, bus based public transit are the primary public transit mode that attract a major modal share except for Mumbai where suburban rail attract a higher mode share. Bangalore has one of the better run city bus transport systems in the country. It is operated by the Bangalore Metropolitan Transport Corporation (BMTC), a wholly owned company of the Karnataka state government. BMTC is the sole public bus transport provider in Bangalore, serving urban, suburban and rural areas through a mix of services to suite different commuter segments and their specific travel needs. BMTC services, carries about 5 million passengers each day, which is over 50% of the approximately 8.5 million population of Bangalore[4]. Comparing BMTC's operations with other State Transport Undertaking (STU)'s operating in other metro cities in India, BMTC is the largest STU in the country owning a bus fleet (of roughly about 6,700 buses in 2015). The ordinary bus fleet constitutes around 80% of the total fleet and therefore constitutes the bulk of the BMTC services. The agency provides an intricate and high network of routes (approx. 2,500) within the metropolitan region. The routes that were developed on requests of commuters for point to point connectivity have resulted in replication which the BMTC is aware of and has initiated action in rationalizing routes and developing a more structured direction oriented bus routing network.

Presently, there does not seem to be any structured fare policy that guides fare setting and collection methods in BMTC. BMTC follows the traditional bus fare charging structure based on stage system with a telescopic structure, i.e., fares increase proportionally to the distances traveled although the cost per marginal unit of distance decreases as the trip length increases. Fares change with each stage which is approximately 2 km although they can be shorter on particular routes. Fare revisions in BMTC's ordinary services are guided by notifications released by the state government under the provisions of the Motor Vehicles Act, 1988 (Subsection (1)(i) of Section 67)[5]. These notifications set the maximum rates of fares for ordinary service stage carriages in the state. According to the fare revision notifications, fares can be changed only when the combined burden of diesel price in-

crease and rise in Dearness Allowance rates for the agency's permanent staff exceeds the agency's total financial burden by Rs.11 crore (a crore = 10 million) in a year. BMTC has adopted the Association of State Road Transport Undertakings formula for fare revision which is as indicated in Annex 1[6]. However, state government approval is required for implementing ordinary bus fare hikes. Procedurally, the agency makes fare change proposal to the Principal Secretary of Transport who then seeks the final approval from the State Transport Minister to implement the proposed fares. For other services offered by BMTC, the agency is independent to set its own fares.

BMTC conducts a financial review twice a year to determine whether a change in the fare structures (per passenger km) is necessary. Since BMTC has the liberty of distributing the quantum of fare increase between different types of services such as ordinary, deluxe, express, and luxury, the agency tries to minimize the impact of large fare hikes especially for ordinary services. In the last decade, BMTC fare rate changes indicate that price per km of bus transport in Bangalore increased by about 75% in the period 2002–2011. During that period, BMTC fares changed 11 times roughly once a year on average. Until 2011, the BMTC bus fares were gradual and tactfully revised for 2nd stage onwards keeping the base fares relatively untouched. In addition, fare hikes were limited to a maximum of 2 revisions in a year as it was a politically sensitive issue (Figure 1).
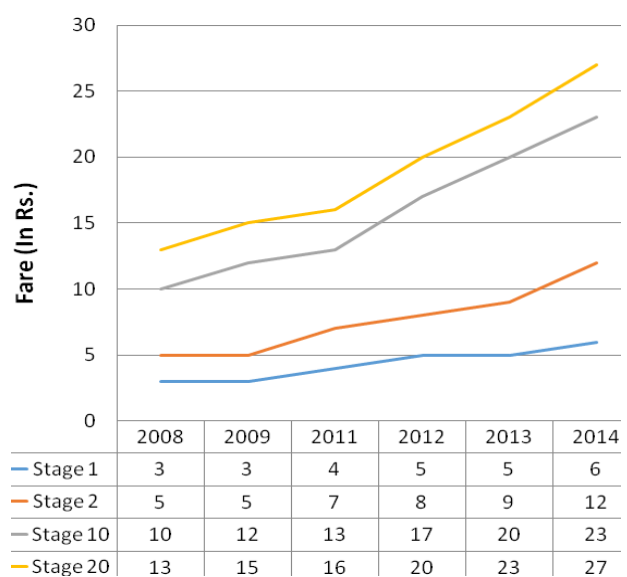

	2008	2009	2011	2012	2013	2014
Stage 1	3	3	4	5	5	6
Stage 2	5	5	7	8	9	12
Stage 10	10	12	13	17	20	23
Stage 20	13	15	16	20	23	27

Figure 1. Increase in BMTC's ordinary fares from 2008 to 2014 (Source: Newspaper articles and BMTC notifications).

From 2011–2014, the BMTC bus fares increased by 70%–80%, which was 5 times higher on average across all services and stages from 2011 rates. From the 3-year period (2008–2011) evident in Figure 1, BMTC fare hikes increased between 20% and 30% while in the latter 3-year period (2011–2014), the fare increased around 70%, thereby triggering strong public reactions. The rate hikes were not uniform across all stages. Fare increases in higher stages have been much steeper as seen in Figure 1. BMTC agency justified the fare revisions by declaring that "unprecedented" increased in diesel prices and staff costs in the period of 2011–2013 incurred a loss of around Rs.130 crore for the BMTC.

BMTC's ordinary bus services are popular amongst the economically weaker segments of the city's population as they provide a wide service network across the city and also the cheapest transport mode available in the city. The recent fare hikes were strongly opposed by the public resulting in public protests and negative media coverage. However, these abrupt and steep fare hikes have not been overturned by the agency or the state government. This research focuses on the understanding of the impact of the recent ordinary bus fare hikes on the travel behavior of its commuters especially for the economically weaker sections (EWS) of the society. In order to address this question, the following objectives for this case were identified:

- To understand their travel needs, affordability and preferences for using PT by EWS commuters
- To understand the target group's perceptions of BMTC services and fare structures
- To identify possible adaptation strategies (change in activities and travel behavior) to minimize travel costs

The paper is structured in the following way. The next section conducts a brief literature review on the issue of transport equity and international experiences on the impact of bus fare hikes on the low income commuters. The next section explains the methodology employed in identifying the vulnerable bus commuters, conducting the primary surveys and analyzing the data. The next sections deal with the analysis and results of the surveyed data that provide insights on the commuters and their travel behavior. The paper ends with conclusions indicating the limitations of this research and way forward. In addition, it indicates the use of this research to better understand the behavior of urban transit commuters.

2. Literature Review

Transport equity refers to the distribution of costs and benefits and whether that distribution is considered appropriate and fair[7]. Most practitioners and decision makers sincerely want to achieve equity objectives; however, in assessing transport equity, there are various types, impacts, measurement units and categories of people to consider. Vertical transport equity with respect to income and social class type investigates transport affordability and the impact of transit fare structures on low income communities. A large and growing literature addresses the subject of equity[8,9]. Studies have applied the concept of transport equity to issues such as pricing road congestion[10,11] and public transit covering transit investments[12], finance[13], time-of-day pricing[14] and distance-based fares[15].

Several studies have investigated equity in transit fare policies. Cervero *et al*.[16] investigated new pricing policy proposals submitted by three transit agencies in spring 1980. They found that the 3 proposals for fare increases across-the-board appeared promising in terms of revenue yield, but were more regressive than existing structures, redistributing disproportionately more income away from low-income, transit-dependent users.

Deakin and Harvey[10] articulated the need to be cognizant of the equity implications of fare changes' policies. They noted that public transit price increment is a serious concern for low-income people who have a limited ability to 'choose' to pay the higher costs and hence would be priced out of travel options. Higher transit costs fares are a worry for moderate income people, especially those who have little flexibility about when or where they have to travel and hence might have to devote a larger share of their monthly income to transportation.

The TCRP's Report 94[17] observed that, in the United States, transit agencies face the threat of legal challenges to propose the fare increments in several cities. Hence, many transit agencies, especially those in other large cities, need to pay greater attention to equity concerns in considering possible fare changes. These observations seem to be replicated in Bangalore where BMTC is threatened by public interest litigation and negative media coverage on the increments of bus fare from public interest groups. Although this may not have influenced BMTC's partial rollback in 2014 of hiked bus fares, it has certainly put political pressure to not do the same in the future.

The Census of India 2011 published district wise

travel distance data from home to workplace by travel mode[18] for all districts in India. Travel distance data for Bangalore urban provide a good empirical base for comparison with other survey data, although travel distances can greatly vary depending on locations of study delimitation e.g., in city center or its periphery. Other studies that analyze urban mobility in Bangalore district are the Bangalore Mobility Indicators 2008 and 2011 studies[19,20], which were conducted by the Karnataka Government to track the progress of various interventions initiated in Bangalore and highlight issues like congestion and accessibility at different locations in the city. Since 2011, Bangalore's mobility indicators have not been updated in spite of the city's sustained rapid expansion and population growth.

3. Methodology

Equity in transport can be examined by looking at the distribution of its impacts by location in the region (e.g., central city vs suburbs), by gender of the traveler, by race and ethnicity, and so on. In doing so, we developed the following methodology to identify the location, target group and carried out field surveys and interviews:

- Selection of a study area with a sizable slum population within the city
- Identification of the bus riders belonging to the EWS groups in the selected study area
- Evaluation on the needs of commuters with a focus on bus fare structures, services, fare collection methods and affordability
- Identification of adaptations made by bus commuters with respect to their daily activities and travel behavior to minimize their travel costs

The survey had to cover BMTC ordinary bus commuters from lower income group. Hence, we decided to identify slum localities in the city. Various sources showed different distribution, location and sizes of slums in Bangalore. The source that we used for gathering slum data was the National Slum Dwellers Federation (NSDF) that provides both the demographics of the slums listed and also the location and boundary in the NSDF's GIS database. According to the NSDF's database, Bangalore had 312 slums in 2014, relatively dispersed across Bangalore. In selecting the location for conducting the survey, we selected a ward closer to the city center that had a slum area as well as organized and unorganized commercial establishments within the ward.

Based on these criteria, Srirampuram area in central Bangalore was selected as the study area (Figure 2). This decision had several advantages. First, the area has a sizeable amount of slum population, workers (in one of the largest city malls (Mantri mall) and in randomly selected small businesses in the area) and bus commuters (including a few commuters changing buses) in the area. Second, the BMTC bus provides good accessibility to this ward with at least 250 BMTC bus routes plying and at least 6 bus stops in the Srirampuram ward within 500-meter walking distance from any location within the ward, thereby increasing the probability of finding low-income commuters relatively easy. Third, the location would allow us to capture both the low-income group (slum dwellers) and the lower middle income group (labor and staff in commercial establishments within the ward).

The goal was to capture mainly bus commuters that belonged to the low- or lower-middle income group. The method employed to capture the bus commuters, was through location sampling / intercept point sampling, i.e., sampling at the bus stops in the ward, inside the identified slum settlements and Mantri Mall using a combination of random sampling and snowball method. In Mantri Mall, the housekeeping and the sales staff were targeted for the surveys. In addition, metro construction workers, food outlet employees, staff of the Indian oil petrol station at Srirampuram were also approached for the interviews. A total of 65 sample surveys were taken from 19–21 November 2014. Sample surveys were conducted entirely through semi-structured interviews at bus stops and within commercial establishments with randomly identified respondents. Referrals were used in Mantri Mall in order to identify the staffs that were using public transport.

4. Survey Results and Analysis

The population of Bangalore has been growing at over 3% per annum since its independence[21,22]. The city had a population of 1.6×10^5 in 1901 has reached 9.62 $\times 10^6$ in 2011, of which 1.4×10^6 population live in slums spread across different parts of the city[4]. The sex ratio is 916 females for every 1000 males. With a decadal growth rate of 46%, Bangalore was one of the fastest growing cities in India[4]. The average population density has risen from 2,985 to 4,393 persons/km^2 between 2001–2011[22]. The average monthly income of the urban poor of Bangalore is Rs.7,191/= with a monthly expenditure of Rs.6,481/=. Majority of the households' expenditure are for food items (48%), health
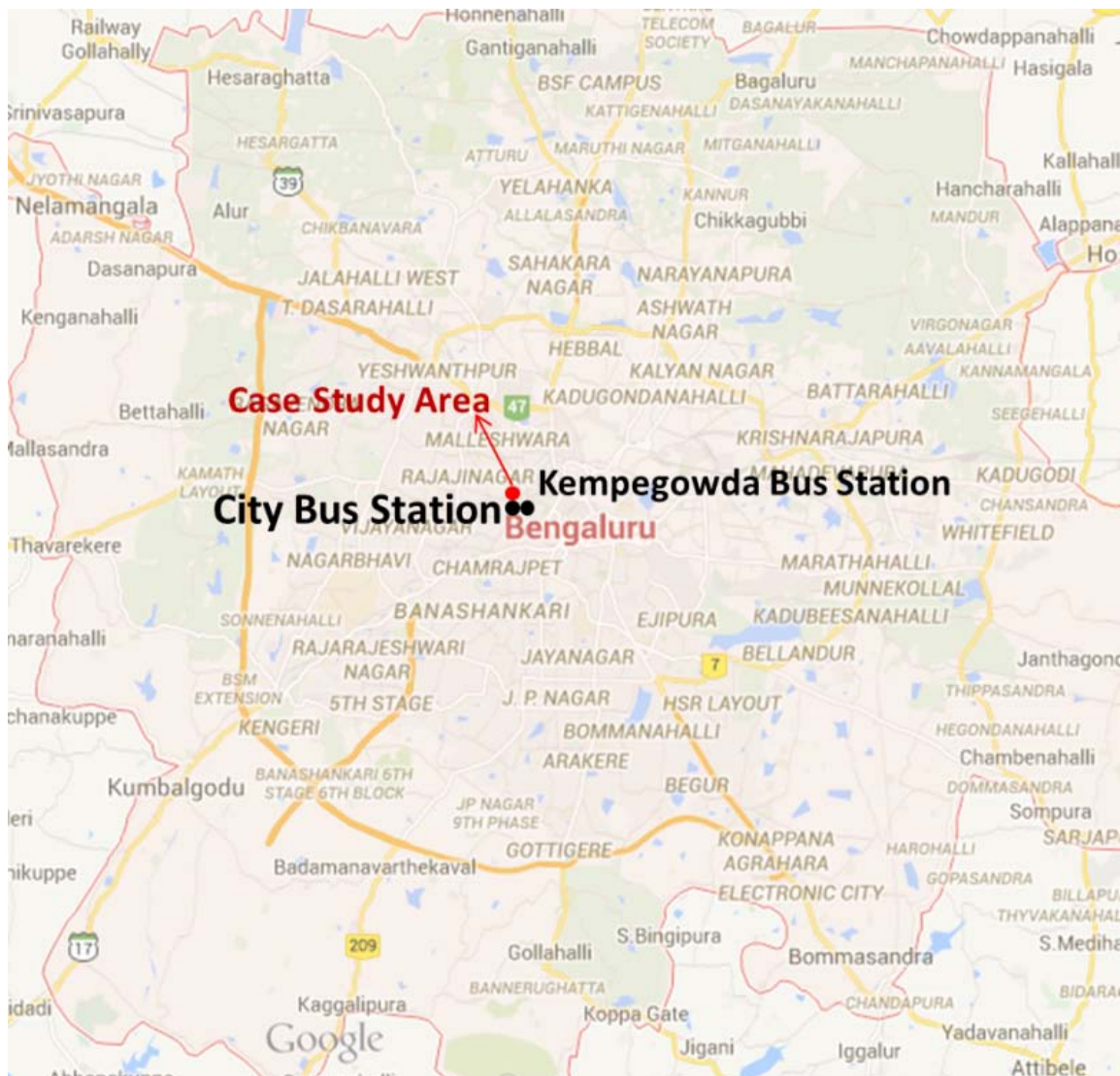
Figure 2. Location of Srirampuram ward in Bangalore city (Source: Google Maps)

(6%) and education (4%). Their spending on transport conveyance (8%) and rent (10%) in Bangalore is much higher than other parts of India on average for these services[22]. Bangalore Urban district modal split according to 2011 Census data indicated that bus-based transport (28%) and walking (29%) constituted the main modes of transport, with 2 wheelers' transport (23%) as the dominant private mode of transport for the urban population (Figure 3).

The survey respondents constituted 63% women and the rest were men (Figure 4). In addition, most of them were employed in jobs which had daily fixed timings. There were few of them, who worked on call-based jobs and thus did not have to travel every day to a particular place of work. More than half of the respondents were in the age group of 20–30 years
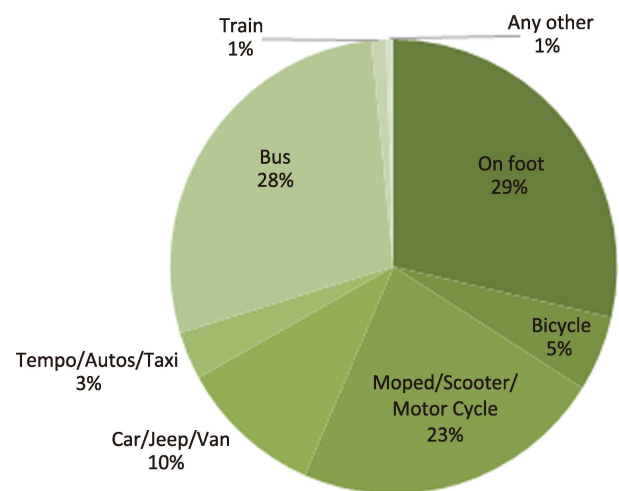

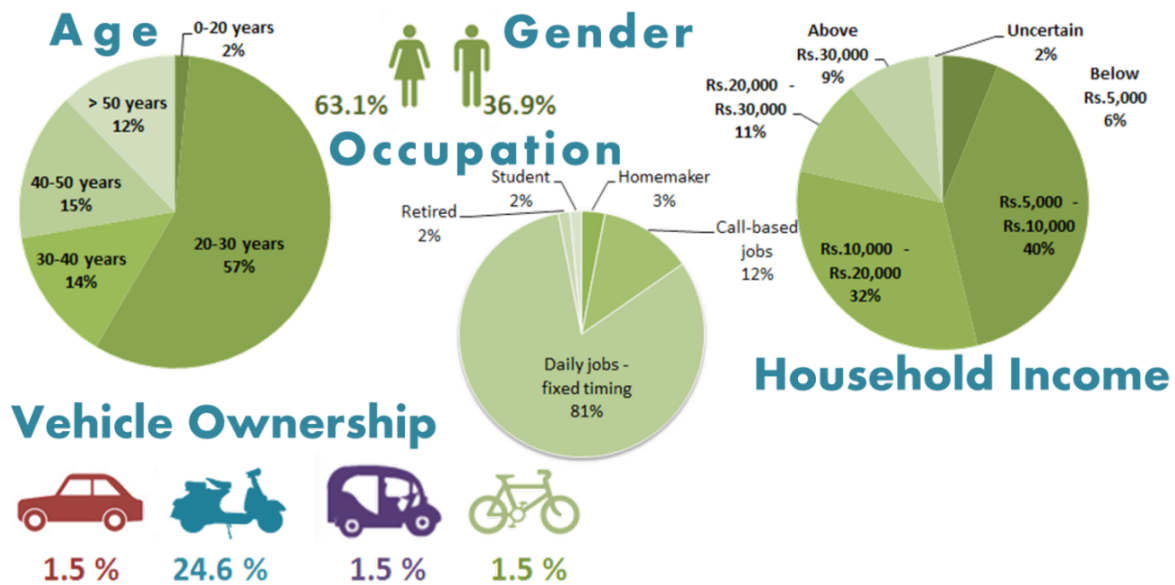**Figure 3.** Modal split of Bangalore Urban district.

Figure 4. Demographic profiles of the survey respondents.

(Figure 5). All the commuters who were under 20 years of age were found to have student passes. The only issue observed was that the bus passes were issued to college and school students, which after much delay thereby, forcing the student commuters to pay the ticket fare for the initial months.

One-third of the respondents had a monthly household income in the range of Rs.5,000 to Rs.10,000 per month while the other one-third had in the range of Rs.10,000–15,000 per month. More than 75% of the respondents had their monthly household income less than Rs.15,000 per month (Figure 4). The vehicle ownership was correspondingly low with only one-fourth of the respondents' households owning a two-wheeler transport. This was primarily because the interviews were conducted on those who traveled by bus and thus such individuals did not own any vehicle.

Most of the respondents were commuting to and from

their workplaces on a daily basis. The remaining respondents were mostly the elderly, traveling for the purpose of social visits. Only around 32% of the respondents had monthly passes which represented their bus travel's fare while more than 60% of them bought tickets each time they travel (Figure 5).

4.1 Travel Distance

In this section, the travel distance results indicated the distance that respondents traveled from their residence to workplace by bus mode. From our survey, it was observed that the majority of the interviewed respondents (almost 70%) traveled less than 10 km on a daily basis (Figure 6). There was a sizable workforce (~22% of respondents) who traveled between 10 and 15 km daily for work. However, there were a number of them who traveled more than 20 km, while very few of the respondents traveled up to 40 km for their work trips,
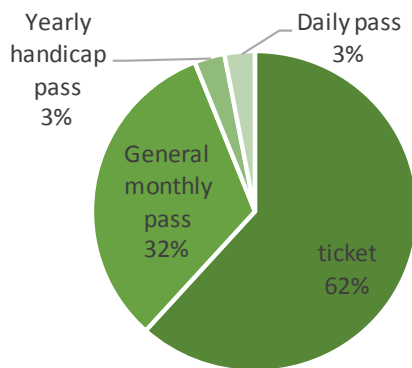

Figure 5. Bus fare payment method of surveyed respondents.
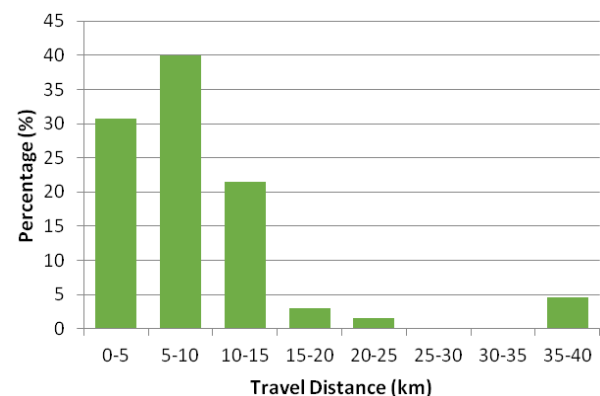

Figure 6. Daily travel distances of the respondents by BMTC bus.

of which constituting around 4%–5% only.

Those who traveled long distances were constituted of regular work based commuters and occasional social commuters. Regular work based commuters traveling long distances did so because of the availability of direct or convenient bus connections between home and workplace. Very few respondents complained that even though the bus services were not good, they were forced to travel long distance from neighboring villages and have to make more than one interchange in search of employment. While occasional bus commuters who were traveling for long distances preferred to travel during weekends, holidays or during off-peak hours on week days to reduce their travel's time and travel in comfort.

The bus-based travel's distance data from our survey was compared with Census 2011[18] data in order to determine whether there was similarity or not, in the frequency distribution using a chi-square test (Table 1). For a significance level of 0.05, the results indicated that both the datasets were similar, thereby validating our travel distance survey results.

4.2 Travel Expenditure

Urban transport expenditure is a major financial burden to many commuters, particularly for lower income households. Figure 7 illustrates monthly transport expenditures relative to total monthly household income by income class. Lower income households spent a far higher proportion of their income on transport than wealthier households, indicating that these costs are regressive. The financial burden is significantly affected by the type of transport system in an area. Low-income households generally looked for employment within walking or cycling distance thereby avoiding travel costs. Retrospectively their accessibility to economic opportunities gets limited. In most cases, the other members of the household also incurred travel expenses, which also add to their total travel expenditure. From our survey results, it was apparent that low-income households spent at least one-tenth of their incomes on transport but this percentage reduced to less than 5% as household incomes increase to Rs.30,000 per month. House rental also constituted a major part of their household expenditure. Although a small proportion of respondents were living in their own homes, the majority were living in rented places. It was observed that the lowest income category were either living in accommodation provided by the employer or had their own homes. For the respondents with a monthly income of Rs.5,000–Rs. 10,000, up to 40% of their average salaries were spent for renting a place closer to their workplace. Most of them tended to share rental homes to keep their travel expenditure low. Due to high rental rates especially those houses that are closer to the city center, the respondents claimed to have no choice but to spend so much money for house rental. For a few respondents, almost none of their money was saved after spending on food, transport and rental home.

Nearly 38% of the respondents that commute by ordinary BMTC buses claimed that they spent much on monthly passes, but are forced to use other modes of transport which appeared rather frequently (Figure 3). This is mainly due to the recent hikes in ordinary bus fares combined with poor frequency of buses after their duty hours (such as late nights and during off-peak periods) on specific routes or cancellation of bus schedules during public holidays or Sundays; putting inconvenience to the regular commuters. In these circumstances, they are forced to use other available transport modes such as hiring auto-rickshaws or traveling by private buses, BMTC A/C buses or sometimes even inter-city trains for their mobility

Table 1. Chi-square test result

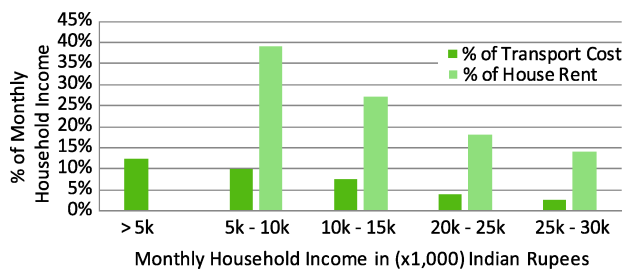|	Travel distance by bus mode					
	0–5 km	5–10 km	10–20 km	20–30 km	30–50 km	> 50 km
Expected	31%	32%	23%	7%	5%	2%
Observed	31%	40%	22%	2%	5%	0%
Difference (Obs−Exp)	0%	8%	–1%	–5%	0%	–2%
Difference^2	0	64	1	25	0	4
Difference^2 / Expected	0.00	2.00	0.04	3.57	0.00	2.00
Obs. Chi Square	7.62					
D.o.F	5					

Figure 7. Proportion of monthly household income spent on transport and rent for different income class.

needs. This seems to happen, at least a couple of times each week and thus their monthly travel expenditure goes significantly higher than the monthly bus pass charges. This additional expenditure varies from Rs.300 to almost Rs.1,200 per month thereby increasing their travel expenditure to as high as Rs.2,200/= per month (Figure 8). Due to these reasons, there is a high propensity for such commuters to opt for private two-wheeler transport whenever their economic condition improves.

Only 33% of the commuters have their monthly passes issued for their travel fares while more than 60% of them traveled using the tickets they have bought. It can be seen that most of the commuters who did not own the monthly passes, would either travel in a single bus trip without any transfer or just traveled for short distances. Only commuters whose travel distances were greater than 15 km or traveled by more than one bus per trip opted for the monthly bus passes since it is feasible to do so. As the majority of respondents purchased bus tickets for their journeys, most women respondents complained of fare pilferage by bus conductors. The most common complaint was that bus conductors refused to return the balance money when higher denomination currency was given.

It was observed that the majority of the respondents traveled to or from the nearby areas situated at the north-west part of Bangalore, of which has a good bus connectivity to Srirampuram area. The commuters from South-West part of Bangalore also formed a sizeable
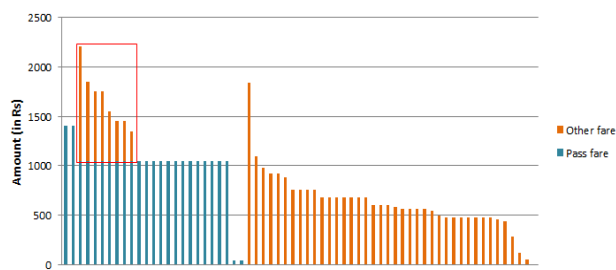

Figure 8. Travel expenditure of the respondents.

group and entered Srirampuram area for employment. However, few of the respondents traveled to and from the neighboring towns of Bangalore to Srirampuram as direct bus services existed and it was convenient for them to travel even though the rate of bus frequencies were poor.

In the Srirampuram slum settlements, large proportions of women were either homemakers or involved in work which was done from home. On the other hand, the men in the slum settlement worked in the garment industry, local shops, incense stick production, laundry work, etc. that are within 10–12 km from their homes. Others were engaged in skilled and semi-skilled activities such as plumbing, masonry, carpentry etc. that require them to travel to different destinations in the city. For these activities, they preferred to use private transport or auto-rickshaw as information of BMTC bus network was rather complicated and not well-communicated to the public. Moreover, it gives them point-to-point transport whenever they need to travel to their workplaces.

4.3 Gender and Age — Geographic Distribution

All the commuters who traveled long distances from or to the nearby towns were young men in their mid 20s age group. The older commuters also tended to travel long distances, however, they traveled occasionally for social/religious/health-related visits and did so in the off-peak hours. A few women commuters who have to travel longer distances were also the occasional commuters or having very limited waiting time for the buses. All interviewed women respondents worked or stayed within 10–15 km radius of Srirampuram for obvious reasons of safety, security as well as to limit their travel times (Figure 9).

The majority of the commuters traveled on a daily basis, i.e., >5 times in a week. The infrequent travelers, as indicated earlier, were generally older commuters and on social visits. There were a large number of people, who traveled on a daily basis, but their destinations changed based on the location of work. This was mostly found in the case of persons whose occupations were as painters, masons, housekeeping, technicians, etc.

4.4 Traveling and Waiting Time

The waiting time of the commuters is not dependent on the geographic location of their origins/destinations but on the BMTC schedules on their specific routes. Most of them have a waiting time of less than 10 minutes.
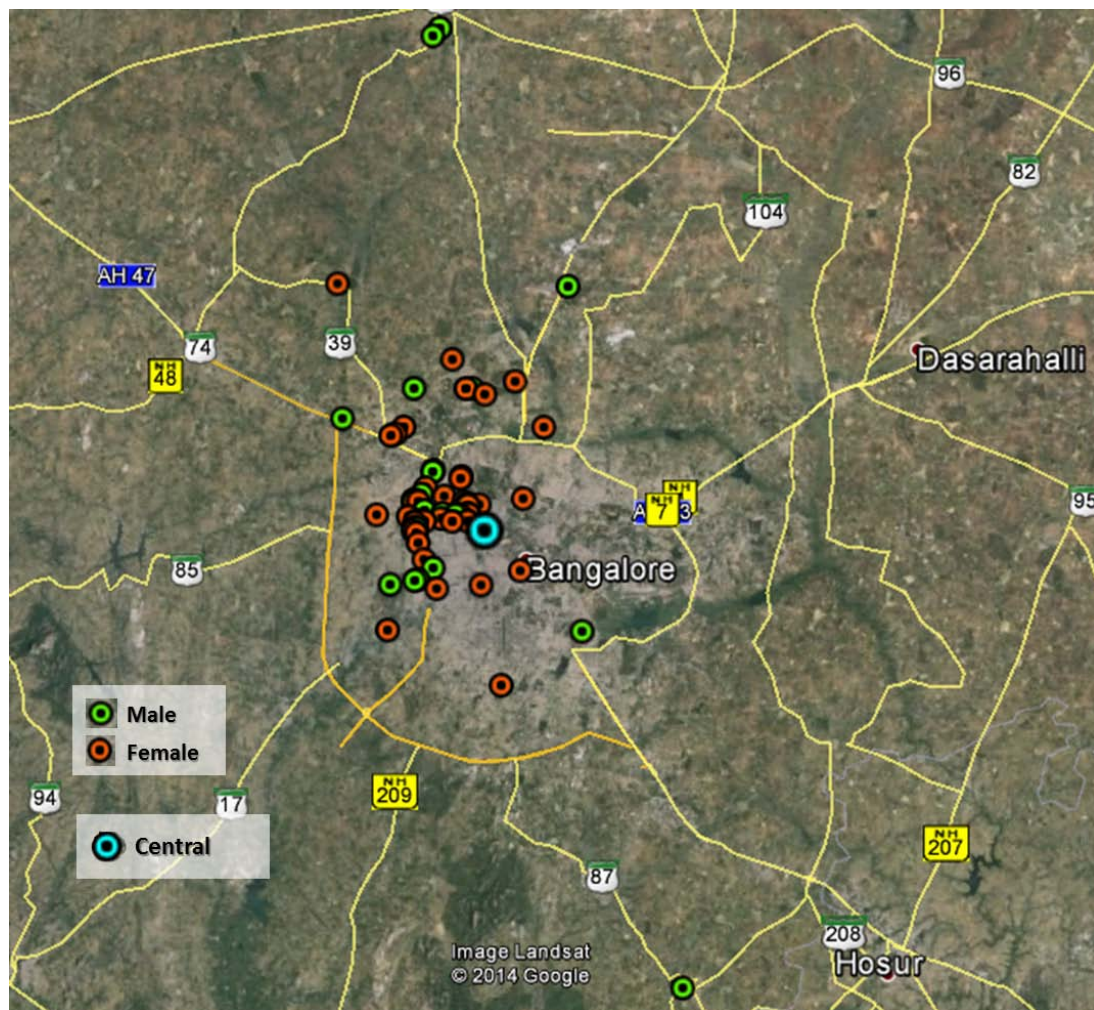
Figure 9. Geographic distribution of respondents based on gender.

However, several commuters have to wait up to 50 minutes for the direct bus to arrive. In many cases, respondents preferred bus transfer and therefore traveled to Kempe Gowda, i.e., the main city that occupies bus stations besides being a major transit hub for bus in the city center. Here, they transferred to one amongst the many connecting buses available to their workplaces or homes, thereby reducing long waiting times for a direct bus. The total travel time (commuting time + waiting time) of the respondents is at least one hour. Almost 30% of them traveled for 2–3 hours every day. A few of them even spent up to a total of 6 hours on traveling (Figure 10). If you consider factors such as value of time along with the higher bus fares, the additional cost of traveling by private vehicles especially the two-wheeler transports, then you will get compensated easily.

There is a general perception amongst planners and decision makers that people do not like bus transfers
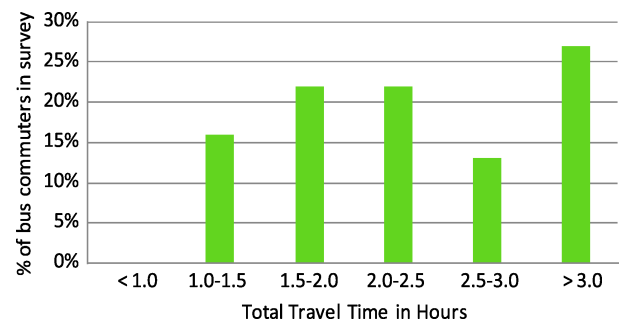

Figure 10. Distribution of relative frequency of total traveling time of the respondents.

and therefore they tend to avoid adding more buses due to issues of convenience, longer waiting period and the need to pay a transfer penalty. From our survey, it was observed that this is partly true. The majority of the respondents (64%) used direct buses primarily because direct services presently exist although bus schedule frequencies vary from high to infrequent

services in several localities in the city. Figure 9 shows that majority of the respondents living in the North to West of Srirampuram used direct services indicating that there could be a denser network and probably with better frequency of direct bus services to Srirampuram from these directions. Since Srirampuram lies within 2–3 km from the main city's bus station, most northbound buses have to transit within this area.

4.5 Propensity to Shift Transport Modes

It was empirically observed from our survey that there is a general propensity of bus users to shift from NMT to public transport as well as to paratransit and private transport with the increased in the household incomes. The income thresholds that trigger the transport's mode shift slightly vary with gender. Modal shift takes place at slightly lower thresholds for working men than working women. During interviews, it was empirically observed that working women preferred to use public transport rather than other modes of transport due to safety and security reasons even when they can afford to drive a motorized two-wheeler (M2W). There seems to be a perception amongst working women that BMTC buses are safer than traveling by NMT, auto rickshaws, private taxis or even self-driven private transport especially when it is dark or lonely.

Even when the household incomes improved and increased, the working women generally used the public transport rather than rode a M2W, whereas the male workers have more tendencies to shift to a M2W as soon as they can afford a vehicle. The women workers also considered the option of a shared auto rickshaw much more than men, who preferred to purchase and use a M2W. Besides that, it was reported during interviews that in many households with working women, the male members that own private vehicles often drove to their college or for working trips in order to drop or pick up working women to or from their workplaces.

5. Conclusion

Through this study, we were able to have better understanding of the traveler's behavior and city bus transport usage by gender and particularly the low-income workers from a neighborhood within the city. From the findings, it was evident that the network and affordability of city bus transport provides vital access to livelihoods in the city. The bus network forms the determinant in identifying employment opportunities

for the majority of the respondents. This study validates the findings of the Bangalore Mobility indicators study that the average travel distance in the city is 10–12 km as the majority of the ordinary bus commuters in the survey traveled at these distances to reach their workplaces. Whichever neighborhoods that are well connected by frequent and direct bus services, those population travel to each other neighborhoods in order to fulfill their social and economic needs. On the other hand, young male commuters are willing to travel long distances in search of employment even it is up to 25–30 km in each direction if there are options for public transport that are either direct or with a maximum of one interchange. This indicates that whenever the bus services are made convenient (by providing direct connectivity) the propensity for higher mobility amongst the low-income population residing in these neighborhoods is observed. On the other hand, low-income working women invariably opted for employment within 10–12 km radius from their residences for certain reasons namely, safety, security and added responsibilities of running a family at home after working hours. For women, BMTC services are perceived as the safest transport mode in the city compared to intermediate public transport or private two wheeler transport. In the absence of city bus transport, they formed small groups with known acquaintances and hired IPT services to reach their homes. From this study, it is evident that women travelers formed a captive bus commuter segment with general perception on city bus as a safe and secure transport mode that need to be enforced by the bus agency. The findings of this research provided valuable insight to urban transport policy makers and particularly, city bus agencies on the impact of their decisions on bus ridership, mobility and access of economic opportunities to socio-economically weaker sections of the urban population. This paper also introduces a novel methodology to understand the travel geography, travel purpose and ridership profile of commuters that will provide valuable information to the transit bus agencies in redesigning their routes, schedules and communication strategies for the sustainability of their bus ridership and increasing its mode share in Bangalore. A drawback of this study was the inability to compare the travel behavior of low-income workers located near the city center with those residing in city periphery. This will be the scope of further research.

In conclusion, the public transit network plays an

important role in providing employment opportunities to the city's neighborhoods, especially for the economically weaker sections of the society who cannot afford other transport means. Although long direct bus routes to the city center provide subsidized access to jobs for population residing on the outskirts of the city, it also results in increased mobility and consequent increased in per capita travel distances and overcrowded public transport infrastructure. Furthermore, it could perpetuate public demand for subsidized transport and connectivity to areas even further away from city center, which may not be an interest for long term sustainability of city bus transport.

Conflict of Interest and Funding

Acknowledgements

References

1. Gómez-Ibáñez J A and Meyer J R, 1993, The international experience with transport privatization, in *Going Private,* Brookings Institution Press, Washington, D.C.

2. Pucher J, Korattyswaropam N, Mittal N, *et al.* 2005, Urban transport crisis in India. *Transport Policy*, vol.12(3): 185–198.

3. Badami M, Tiwari G and Mohan D, 2004, Access and mobility for the urban poor in India: bridging the gap between policy and needs. *Paper Presentation at the Forum on Urban Infrastructure and Public Service Delivery for the Urban Poor Organized by the Woodrow Wilson International Center for Scholars, Washington, D.C. and National Institute of Urban Affairs, New Delhi*, viewed July 11, 2015.

4. *Census of India: Provisional Population Totals,* 2011, viewed July 8, 2015, <http://censusindia.gov.in/2011-prov-results/indiaatglanc e.html>

5. Singh V, Puvvada V, PC L, *et al.* 2008, *Study on Traffic and Transportation Policies and Strategies in Urban Areas in India*, viewed December 1, 2015, <https://casi.sas.upenn.edu/sites/casi.sas.upenn.edu/files/i it/GOI%202008%20Traffic%20Study.pdf>

6. *UNDP: Subject Module on Financing, Fare Fixation, & Cost Benefit Analyses*, 2012, viewed July 8, 2015, <http://wricitieshub.org/sites/default/files/Presentation-Fi nancing-Fare-Fixation-Cost-Benefit%20Analysis.pdf>

7. Litman T, 2005, Guidance for incorporating distributional impacts in transportation planning, in *Evaluating Transportation Equity*, Victoria Policy Transport Institute, Canada.

8. Altshuler A, 1997, *The Urban Transportation System: Politics and Policy Innovation*, The MIT Press, Cambridge.

9. Friedman L S, 2002, *The Microeconomics of Public Policy Analysis*, Princeton University Press, UK.

10. Deakin E and Harvey G, 1996, Transportation pricing strategies for California in *An Assessment of Congestion, Emissions, Energy and Equity Impacts, Final Report*, California Environmental Protection Policy, California.

11. Richardson H W and Chang-Hee C B, 1998, The equity impacts of road congestion pricing, in *Road Pricing, Traffic Congestion and the Environment: Issues of Efficiency and Social Feasibility*, Edward Algar Pub, Northampton, UK: 247–262.

12. Deakin E, FerrelL C, Mason J, *et al.* 2002, Policies and practices for cost-effective transit investments: recent experiences in the United States. *Transportation Research Record*, vol.1799: 1–9. http://dx.doi.org/10.3141/1799-01.

13. Wachs M, 2003, Improving efficiency in transit finance, in *Brookings*, Brookings Institution Press, Washington, D.C.

14. Watkins T M, 1984, *The Equity Impacts of Time-of-day Transit Pricing*, University of California, Berkeley, CA.

15. Mohan L, 1979, *Evaluation of Ridership, Revenue and Equity Implications of Distance-based Fares for Transit Systems*, State University of Albany, New York, USA.

16. Cervero R B, Wachs M, Berlin R, *et al.* 1980, *Efficiency and equity implications of alternative transit fare policies*, Urban Mass Transportation Administration, Office of the Secretary, U.S. Department of Transportation, viewed December 3, 2015, <https://babel.hathitrust.org/cgi/pt?id=umn.31951p01092 4552;view=1up;seq=1>

17. Transit Cooperative Research Program, 2004, *Fare policies, structures and technologies: update*, viewed July 8, 2015, <http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_94.pdf>

18. Government of India: Ministry of Home Affairs, 2011, *B-28 'Other Workers' by distance from residence to place of work and mode of travel to place of work — 2011*, viewed March 31, 2015, <http://www.censusindia.gov.in/2011census/B-series/B_28.html>

19. Urban Mass Transit Company Limited, 2011, *Bangalore mobility indicators 2010–11: final report*, viewed July 8, 2015, <http://gubbilabs.in/micp/sites/default/files/documents/files/BMI,%202012.pdf>

20. Wilbur Smith Associates, 2009*, Bangalore mobility indicators 2008: draft final report*, viewed March 5, 2015, <http://www.urbantransport.kar.gov.in/bangalore%20mobility%20indicators-2008.pdf>

21. KUIDFC, 2007, *Comprehensive traffic and transportation plan for Bangalore*, viewed July 8, 2015，<http://www.kuidfc.com/WEBSITE/WebPage.nsf/f37b2300a8f98a4d65256e2a002623ee/369ec208b4b06201652578e0002f2470/$FILE/EXECUTIVE%20SUMMARY%20(R..pdf>

22. Society for Participatory Research in Asia, 2014, *Bengaluru Study Report 2014: government led exclusion of the urban poor — a greater contributor through a lesser recipient*, viewed October 13, 2014, <https://terraurban.files.wordpress.com/2014/01/bengaluru-study_april-2014.pdf>

Appendix A. BMTC's Fare Revision Formulae

A.1 Fare Revision on Account of Increase in Diesel Prices

$F (DPA) = (F – D) + [(RPD/BPD) \times D]$, where

F (DPA) = Revised fare in terms of Paisa per passenger kilometer

F = Average cost per passenger kilometer at the time of previous fare revision

D = Diesel cost per passenger kilometer at the time of previous fare revision

RPD = Revised price of diesel

BPD = Basic price of diesel when the last fare revision was permitted

A.2 Fare Revision on Account of Rise in Dearness Allowance (DA) Rates

$FR = F + [CPKM (L)/CPKM] \times P \times F/100$, where

F = current fare per kilometer

FR = Revised fare paisa per passenger kilometer

CPKM = Total cost per kilometer at the time of previous fare revision

CPKM (L) = Staff cost per kilometer at the time of previous fare revision

P = Percentage increase in staff cost due to DA increase over the staff cost at the time of previous revision