Title: Usage patterns of public transport as a starting point for thinking through gendered conceptualizations of Delhi

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Abstract

This paper adapts a use approach to contribute to the growing focus on women's issues in transport, by asking when and in what proportion women are traveling on public transportation in Delhi, India. First, it asks when women are traveling on the city's two dominant modes of public transport—bus and metro—and how this compares to men traveling by the same mode. Given Delhi's size and the predominance of informal employment, do we find patterns of peak and non-peak travel behavior in either or both populations? Second, we ask what proportion of passengers are women and how does this change according time of day and mode. Our purpose is not to be conclusive but rather serve as a starting point for future research on questions related to transport exclusion, particularly around gender and time of day.

1. Introduction

1.1 Women and transportation

Early literature on women's travel behavior in respect to daily commuting was pioneering for its ability to identify links between social norms, employment, where, when, and why women traveled to. These studies were predominately situated in the global north in geographies with suburban typologies and nuclear family structures concentrated in the global north revealed that women's travel patterns and behaviors were significantly different than men's. For example, Rosenbloom's 1978 editorial argued that as women's employment demands and aspirations change so also does their travel behaviors: "Women's changing behavior is calling into question the accuracy of our planning models…that is why the study of women's travel issues is not only legitimate but necessary,"(1978: 350). Fundamental to Rosenbloom's critique of transport planning was how and what data is collected. This paper starts not with the observation of women's changing behavior in Delhi but rather the assumption that women adopt travel behavior to dominant socio-cultural norms and real and perceived fears of using public transport due to issues of gender-based harassment. Similar to Rosenbloom however, the purpose of this research is to address the clear lack of data on public transport use in urban India and gender disaggregated data in general.

Research related to women's issues in transport continue to support Rosenbloom's early findings: women continue to take shorter trips, in terms of both distance (Turner and Niemeier 1997; Hjorthol and Vågane 2014) and length of time (Hamilton and Jenkins 2000). In nuclear family structures with two adults working, it is the woman who tends to take up paid employment closer to home (Neto and Paez 2014).

Although research that questions the relationship broadly between gender and mobility in the global south is increasing, there remains a serious lack of actual data documenting women's travel patterns these geographies—for example cities of extreme population densities, a predominance of informal employment, cities where mass transportation networks are still in nascent stages of development, and cities in which patriarchal norms and values are explicit and can manifest in the form of gender-based harassment in public. Studies investigating relationships between gender and mode choice in India have relied on large scale, existing data sets in which gender is just one of many variables to be analyzed (see for example: Srinivasan et al 2008; Manoj and Verma 2015; Manoj et al. 2015; Srinivasan and Rogers 2005; Badami and Haider 2007). What is missing from this data is how travel decisions, especially pertaining to mode and time of day, manifest in terms of percentage and proportion of women we see on public transportation.

Das and Pandit (2012) found that women are willing to wait longer for public buses than men, further supporting evidence that women are more likely than men to use non-motorized forms of transportation, cheaper options, and public transportation (GTZ 2007; Mahadevia and Advani 2016; Motte et al. 2016; Peters 2001; Sietchiping et al. 2012). Qualitative research reveals that issues of safety and security—that is travel free of accident or gender-based harassment—factors largely into the travel decisions of women (Dunckel-Graglia 2013; Smith and Clark 2008; Gardner 1995).

1.2 Use approach- gender and transportation,
There seems to be little evidence of research that questions the of proportion of women using public transportation according to time of day, and even less analysis as to whether this might be one entry point into tangible evidence of fear-based exclusion, a form of exclusion that stems from issues of gender-based harassment (Jain and Parida 2014; Hamilton and Jenkins 2000; Smith and Clarke 2008). Looking at who is using public transportation, where and when is an attempt to move beyond the preoccupation with the journey to work and think of how social structures and norms cannot be isolated from the physical environment and the infrastructure available.

Like Hall (2004), we are interested in how gender is conceptualized within urban societies (Hall 2004) and how this conceptualization manifests spatially in different locations viz a viz public transport and transport networks. For example, in geography in which private transport dominants, finding that the majority of bus passengers are women is indicative of their relative 'transport poverty' as it indicates a lack of access to private vehicles or that their commutes are not as valued as the family member that does have access to the car. However, in a context where the majority of residents do commute by bus transport, a higher proportion of women users could have a very different meaning. A 2013 World Bank report on gender and public transport in the Kathmandu Valley found that a high level of public transport passengers were women at any given time. The report noted that, unlike India, Nepal has a high female workforce and women are comparatively independent and free to travel; they "have not felt constrained mobility for several decades and not in the way that others in the region may have experienced," (2013, p. 11). If we know from existing media reports and minimal academic literature that women in the

region, particularly North India, do indeed face constrained mobility, the next step is to monitor and document the various ways in which this constraint occurs. This paper thus provides preliminary evidence that time of day does impact women's use of public transportation in Delhi, India.

We begin by providing a context for understanding the Delhi's urban form as well as gender relations, followed by an overview of the research undertaken, the key findings, and possible implications these findings have for understanding how fear-based exclusion in Delhi operates. The research methodology and findings suggest relevance not only for Delhi but other cities in which the question of accessibility from a gender perspective exists.

1.3 Gender and socio-economic characteristics of Delhi
Historically, urbanization brings increased mobility to women, with one clear example being employment opportunities outside the home. It is also thought that amidst the diversity of cities, gender ideologies alter and, in many instances, gender inequalities can lessen (McIlwaine 2013; Tacoli and Satterthwaite 2013; Government of India 2013). Although the nature of urban life allows for more visibility among a greater diversity of people, this visibility can be at odds with embedded patriarchal values. Indian cities are experiencing a rise in the number of women coming to the city for opportunities such as higher education and employment as well as marriage and to accompany family members (National Sample Survey, 2011)). As McIlwaine points out, as women become more visible in the urban environment, they risk even greater levels of violence as existing norms regarding where women should be are disrupted and men try to reinforce their dominance in society (2013).

This dominance became particularly salient in December of 2012 when a young, female medical student was fatally gang-raped while onboard a bus in Delhi. The key convict admitted to have perpetrated the crime to 'teach a lesson' to the victim for roaming around the streets late in the night (2015). The incident received widespread national and international attention. This was not a sole incident and several similar cases have been reported regarding women being molested and raped while in transit (NPR 2013; Bhatt et al. 2016; Joseph 2014). This points at not just the social problem of sexual dominance but also the security that public transport and the urban domain, in general, offer to women commuters. It is notable that this is not a problem just with India as several other cities in Asia and the West (Ceccato and Newton (eds) 2016) grapple with harassment of women in transit.

A study of women in Delhi by the ILO (2008) found that 'safety and mobility concerns' are the third most important factor impeding women's work participation. The Female Work Force Participation Rate (WFPR) in Delhi stands at 5.8 percent against the urban India average of 13.8 percent and the national average of 25.6 percent of women and 51.7 percent of men in the workforce (Government of India 2011; NSS 2009). As the WFPR covers only formal workers it is difficult to truly gauge how many women are working in Delhi. Nevertheless, a small study of informal woman workers by Anand & Tiwari (2006) revealed that these women in particular "lack mobility in the city due to gender-based

restrictions, inferior access to transport means, a high dependence on low-quality public transport, and a lack of availability of affordable modes of travel". More recently, Jain and Parida (2014) reported that even women working in the formal sector face various forms of social exclusion due to limited mobility choices.

1.4 Urban structure and transportation in Delhi
Delhi is an ancient city with roots dating as far back as 3000 BC. Today it is known as the National Capital Territory of Delhi and spans across 1483 square kilometres. The urban structure of Delhi may imagined as a mosaic of planned and unplanned pockets of development, keeping in mind the city has ancient roots, dating as far back as 3000 BC. Many parts of Delhi have developed organically and, unlike cities and suburbs in the West, the majority of Delhi's residential neighborhoods (known as colonies), regardless of income, are mixed use, with fruit and vegetable sellers, religious institutions, and general shopping within a one or two kilometer radius of one's residence. Although the population density of Delhi stands at approximately 15,000 people per square kilometer, or about seven times that of New York City, public policies that limit floor area ratios in attempt to decongest and preserve the historic city (Pucher et al 2005) force the city to sprawl outward, expanding Delhi's existing polynucleus form.

Until the completion of stage two of the Delhi metro in 2012, buses were the primary source of public transportation. In their 2007 study, Badami and Haider found that overcrowding and unreliable service were key problems faced by bus users. Average speeds were 10.5 km per hour. Traffic laws were rarely observed or enforced, footpaths (sidewalks) either non-existent or clogged with parked cars or two wheeler users who would weave between road and footpath to avoid the traffic, bus stops were (and continue to be) poorly marked with buses rarely stopping at them. In short, one could say a transportation crisis was mounting.

While the idea for a metro transit had been floated since the 1960s, construction became a reality in 2006. The current metro network is predominately a ring and radial system with the north-south and east-west lines operational. Stations are on average 1.3 kilometers distance from each other. With Phase II and now Phase III underway, most major areas of Delhi are being serviced. That said, first and last mile connectivity remains a known issue for Metro users. This is why the Delhi Metro Rail Corporation (DMRC) is expanding its Metro Feeder Bus service. It is estimated that the metro has a ridership of up to two million daily (DMRC; Times of India 2014) but no detailed data regarding ridership of either bus or metro is publicly available.

2. Purpose of Research
2.1 Need for study
In 2011, Delhi Metro Rail Corporation (DMRC) introduced a number of gender inclusive policies. This included reserving the last car of the metro for women only. Women go through a separate security check to enter the metro and, in busy stations, guards stand outside the car doors to ensure order but also that men are not entering the women's section. Women's helpline numbers are clearly displayed inside and outside the train and strict fines

are imposed for male passengers who attempt to enter the women's cabin. These initiatives stand in contrast to the city's bus service, which continues to struggle to provide not only route services but also safety and security to passengers.

Although there is debate as to whether or not separation of men and women is the best way to tackle gender inequality (Rao 2014) the women only cars remain incredibly popular with metro users (NPR 2013; Tara 2011) and a salient reason why women choose to take the metro over other available forms of transportation. However, bus fares are considerably less when considering cost per square kilometer. Ticket prices for the metro vary from eight to 30 rupees while bus fares are between five and 15 rupees (Roy 2017). Bhatt's 2016 found that cost is the predominant factor in choosing one's mode choice regardless of gender. Knowing that globally, women earn less than men, the cost of transport is inherently more expensive to use irrespective of mode. Are women willing to spend more to use the metro and if so, what are the reasons? Might her mode choice change according to time of day? That is, if there is real and perceived danger of traveling after dark, do women chose to take the metro over the bus for the additional security features it offers? Going back to proportion of women users, if fewer women use the bus at night this further deters women from using it. That is a lower proportion of women on a mode will, in turn, foster an even lower number of users.

To our knowledge, no research has been done to empirically assess the impact DMRC's gender inclusive policies have on the ridership of women. Furthermore, with the exception of Jain and Parida (2014), no gender disaggregated travel data has been done on a massive scale to see what proportion of public transportation users in Delhi are women, their purpose of travel, the time of day they travel, and how this compares to their male counterparts.

Both the Delhi metro and the public buses operate on a kilometer-traveled basis, with the cost per km being higher for the metro than the bus. Bus users have the option of purchasing an unlimited monthly pass at a reduced rate—an option not available to metro users. Based on this information alone we question whether the Delhi metro is prohibitively expensive. Second, for women with a certain degree of financial choice, to what extent do the gender inclusive policies of the Delhi metro, particularly the presence of security personal, women only cabins, CCTV, and women only helpline numbers, influence the decision to spend more for a trip that can otherwise be made by bus? These questions, while extremely difficult to answer, became the motivation for this preliminary study. Although this paper doesn't answer these questions definitively, it provides preliminary data on what mode women are using and in what proportion according to time of day and geographic location.

The decided purpose of this research was to look at the users of public transportation at certain transportation hubs in Delhi in terms of absolute numbers and then draw comparisons between genders, time of day, and mode used. Based on the pre-existing literature, policy documents, and previous research undertaken by the authors, the following research questions were developed:

    I.   What are the percentages/proportion of men and women using Delhi's two dominate forms of public transportation?

        a. How do these percentages change according to gender and mode of transportation?
II.   How do these percentages/proportions change according to the time of day?
        a. Do we find peak travel times according to gender and mode of transportation?

2.2 Methodology

As an exploratory study with a constrained research budget, ased on the research budget, it was decided that five transit points in Delhi would be chosen and monitored for one weekday from 6am-11pm, or the service hours of the Delhi metro. As this study aims to understand comparative use of bus and metro by women and men, only metro stations with a bus stop with 150 meters of the station and supported buses networks that operated similar routes to the particular metro line of that were considered. While this is not a robust proxy, the logic was that presumably, a person could either choose the bus or the metro to travel in the direction he or she needed to go.

The second criteria was to try to get a sample of stations that would reflect the diversity of Delhi; the key was to find stations that represented different land use contexts and socio-economic demographics. Ultimately, a central business district, a south central upscale shopping area, and peripheral residential and mixed use areas in east, west and north Delhi were chosen (see Figure 1). Further criteria for site selection included:

- The metro station could not be used as pedestrian underpass. That is, one could not use the metro station as a way to cross the street. This is an important criteria as crossing major intersections can be time consuming and dangerous for pedestrians. Many 'subways', that is pedestrian underpasses are present in the city and several metro stations also serve as pedestrian underpasses meaning individuals enter and leave the metro station without ever using the metro.
- Station could not have a line interchange.
- Station could have no more than six entrances.
- Each station should represent different urban characteristics of Delhi (e.g. a location that was predominately formal sector employment, a mixed use high income area, mixed use middle, mixed use lower income).

Preliminary research was done by visiting a number of stations from each of Delhi's nine districts. Eight stations were selected and detailed maps were drawn in AutoCAD to gauge the feasibility of sending counters to the station. The number of stations that fit our criteria was eventually reduced to five: Barakhamba Road, Khan Market, Pitampura, Tilak Nagar and Laxmi Nagar.

Khan Market, in the central New Delhi District, was conceived as a plotted residence cum shop scheme for refugees from Pakistan in the 1950's. Since then it has transformed to one of the most expensive shopping markets in Delhi, with all floors getting converted to retail shops, restaurants, bars, and service shops. Surrounded by high income housing with prominent office areas within 5-10 minutes of drive, it is frequented by tourists, students, and people working in neighboring office areas.

Laxmi Nagar, in the east, lies in one of the densest districts of Delhi. It is an unauthorized colony characterised by three to four story plotted development. The Metro Station is located on Vikas Marg, a major arterial providing intracity, east-west connectivity. Properties along Vikas Marg are mainly retail establishments and private tutoring centers (common in India to supplement formal schooling). Internal streets opening onto Vikas Marg are very narrow, abutting properties are usually composed of small, informal commercial shops on the ground floor with residential on upper floors.

Barakhamba Road is one of the arms of Connaught Place, the Central Business District of Delhi. Barakhamba Road predominantly consists of high-rise office buildings housing public and private sector corporate establishments.

IMAGE 1: National Capital Territory of Delhi with the Delhi Metro Network and Study Locations
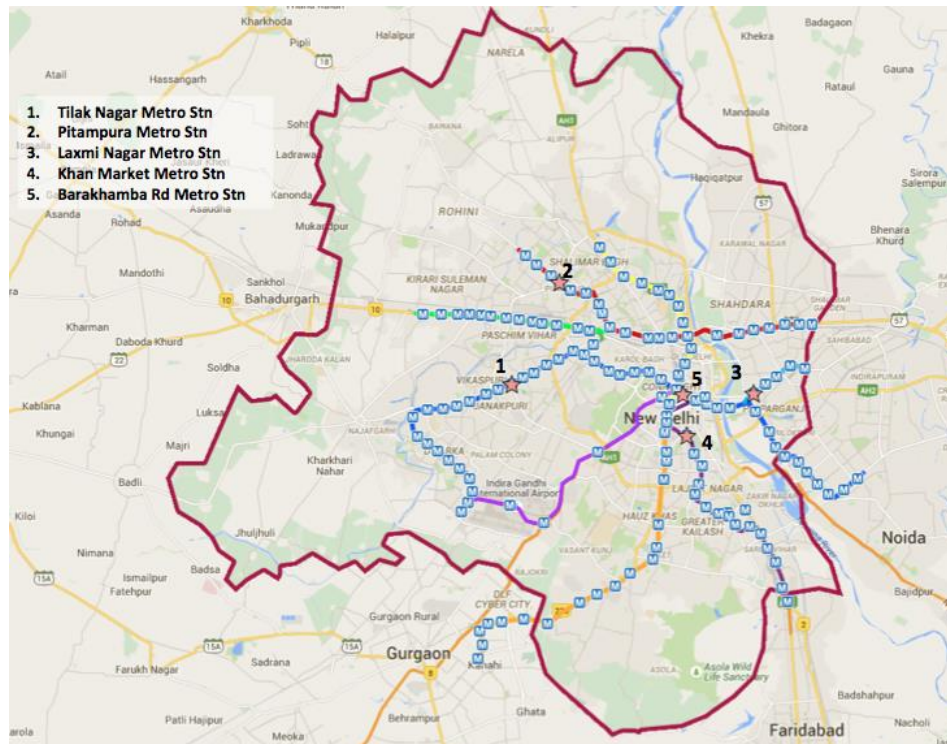
Source: Compiled by Authors

Tilak Nagar lies in one of the densest districts of Delhi. Tilak Nagar. Started as a refugee colony set up by the Ministry of Resettlement in the 1950's. The colony has grown in unauthorized fashion overtime. The street abutting the metro station is a notified commercial street with a mix of retail and service shops.

Pitampura lies in the Northwest district of Delhi. Pitampura is a planned neighborhood

developed by the Delhi Development Authority in the 1980's which is evident outside the station where primary schools, religious institutions, and retail is found along the main road, Lala Jagat Narayan Marg and residential societies are located on the smaller, arterial roads adjacent to the station. There is a public park in walking distance from the metro station and private hospital and district court within a one-kilometer radius.

2.3 Bus/metro commuter count
Two manual counters, one for men and one for women, were positioned at every entrance of the metro station and at the bus stop on either side of the road. Therefore, a station with three entrances would have six manual counters. Manual counting is a popular method for collecting data in India. Each counter was to mark the number of individuals exiting and entering the metro station/boarding or alighting the bus. Two locations were surveyed in one day and bus and metro counts for each location were done simultaneously. Counts were categorized according to the hour of operation. At the end of the survey week, these counts were then entered into an Excel file for analysis.

To accompany the manual counting, a brief intercept survey was designed with the hopes of shedding more light on the travel of women bus and metro users. This short questionnaire was only administered to women through a systematic random sample selection spread evenly across the day. Questions were restricted to whether or not the purpose for the trip was for employment, the origin and destination of the trip and whether or not another mode was available to make this trip. An equal number of samples was chosen for bus and metro. The intercept was conducted on Thursday and Tuesday to capture data unaffected by weekend travel activity.

3. Findings
As stated the primary purpose of this research was to look at a cross section of differences: proportion of women and men using bus and metro, if and how peak times change according to mode and gender, and influence of the built environment. While many of our assumptions, such as the assumption that women will stop using public transportation earlier than men, proved to be true, the data did reveal unexpected findings. These have been organized into three sections. Section I looks at the basic proportion of men and women using bus and metro in the select study sites, Section II discusses how the percentage of users changes according to day, focusing on comparison 'peaks' for women and men, bus and metro. The last section discusses the potential impact geographic location and built form seems to play on the percent of women passengers.

3.1 Percentages and proportions of men and women using bus and metro
Combining data from all locations for the entire day, a total of 126381 men and 54537 women, or about 181 thousand used metro. Although the metro has a much higher carrying capacity, proportionally, we do not find significant difference between the number of women using bus and number of women using metro. If we are to go off the DMRC website which claims to have about two million commuters daily than we have a nine percent sample of Delhi's metro trips. For bus services, a total of 70088 men and 33437 women users were counted. As there is no publically available data regarding the number of DMTC

passengers and interviews with transport officials suggest that this data might not exist at all, it is not possible to calculate the accuracy of our sample.

The commuter count figures translate to 32 percent of bus users and 30 percent of metro users being women. While existing studies tend to talk about modal split of men and women from a defined geographic area, our finding is an indicator of the overall visibility of women in public transport, and useful for the broader discussion of women's visibility in urban public space and urban accessibility more generally. This finding is important because anecdotal evidence suggests that presence of a substantial percentage of women encourages other women to use public transport, especially after nightfall.

The data also revealed that the proportion of men using metro and bus at these locations is 1.8:1 whereas for women it is 1.6:1. Hence, proportionally men are using metro more than bus. This result supports existing research suggesting that women use less time efficient modes due to their affordability (Bhatt 2016; Jain and Parida 2014; GTZ 2007).

3.2 Use of bus and metro according to time of day
As mentioned, it is expected that the proportion of men and women using public transport would vary by the time of day with an explicit interest in whether or not we see peaks in the data and how this compares across gender and mode. Figure 1 and 2 elucidate this point and the following conclusions can be drawn:

- The percentage of women using public transport varies from 20-40% whereas that of men varies from 60-80%. Hence, men are always in majority.
- As the day progresses, the percentage of men shows an upward trend and vice versa for women. This may be due to a variety of reasons (see discussion).
- The dotted trend lines show that the percentage of women using bus falls more sharply than that for men.
- There is a very sharp, equally rapid, decline in percentage of women users on both the modes after 8:00 PM, the time by which it was fully dark year round in Delhi.

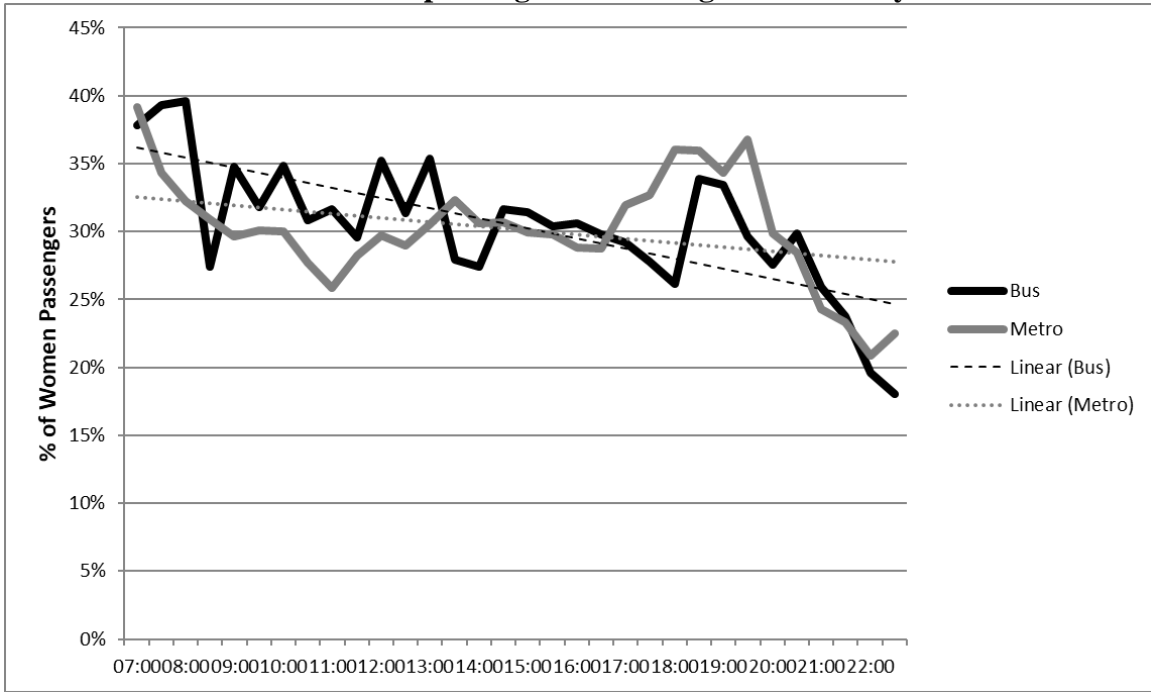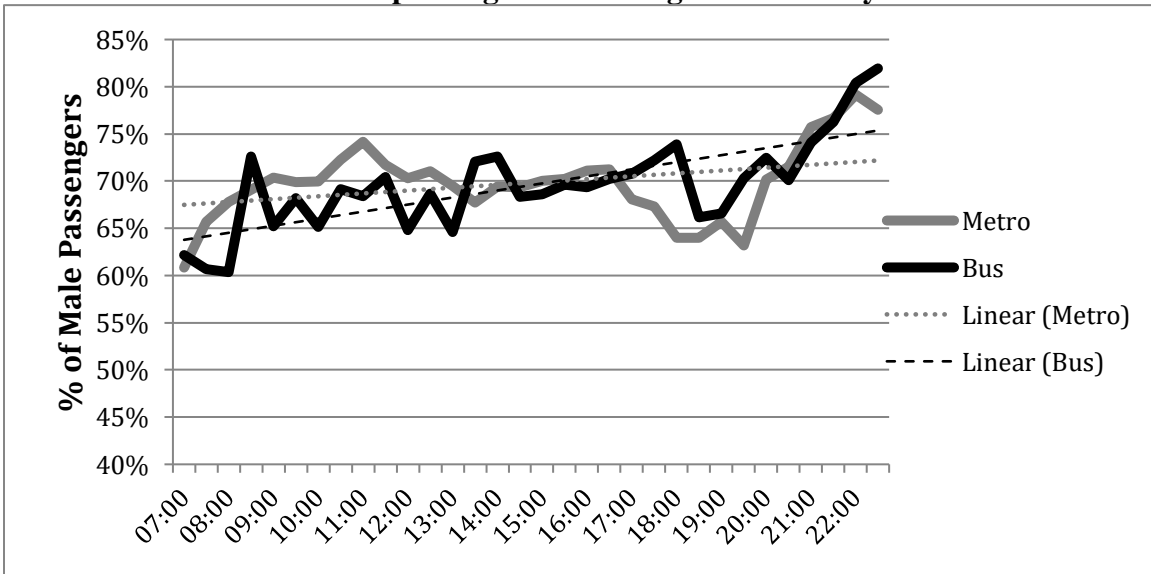**FIGURE 1: Percent of women passengers according to time of day and mode**

FIGURE 2: Percent of male passengers according to time of day and mode

3.3. Peak and Non Peak Patterns for Men and Women

The motivation for looking into peak times is rooted in three reasons. First, do we even see peak travel behavior? Although Delhi's metro is 'world class' in respect to network coverage, efficiency, and frequency the city is dissimilar from places like London, Tokyo, and New York in respect to regulated land uses, formal sector employment, building

regulations, and social structures. Second, given that only one-tenth women, against their male counterparts, are employed in formal settings, do women's travel patterns follow peak and off-peak trends? According to our hypothesis, as also suggested by literature (GTZ 2007; Astrop et al. 2006), women make more trips during off peak hours, while men display more classic morning and peak travel behavior.
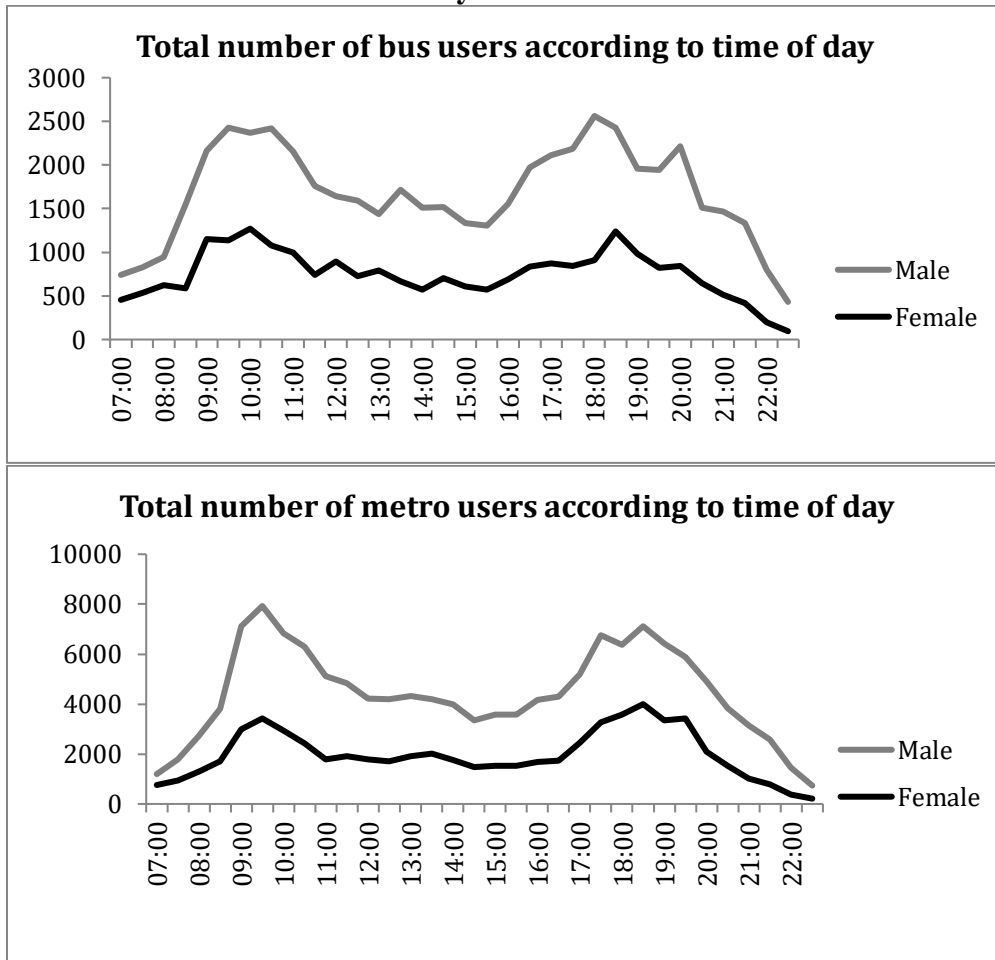
Table 1 reveals that men and women are more similar than dissimilar in their travel behavior and that women show similar peaks regardless of mode. That is both men and women, irrespective of transportation mode, show a propensity for 'peak' travel. Using the boarding and alighting data, for all stations and stops, the peak hour of travel was calculated for male and females according to mode by adding the number of passengers in consecutive half hour intervals. The morning peak hour for male and female metro users is 9 to 10 AM. For bus users, the peak hour for both males and female is from 9:30 to 10:30 AM. In the evening, females travelling by metro have a peak between 6 to 7 PM while males have a peak at 6:30 to 7:30 PM. Female bus users show a peak at 6:30 and again at 8PM.

TABLE 1: Comparison of peak travel times and percent of daily trips in peak hour, according to gender and mode

	Metro			Bus		
	Male	**Female**	Male-Female	**Male**	**Female**	Male-Female
9:00- 10:00	13.4%	11.8%	+1.7%	8.5%	9.5%	-1.0%
9:30: 10:30	13.2%	11.7%	+1.5%	8.9%	10.0%	-1.1%
18:00- 19:00	12.0%	13.9%	-1.9%	9.3%	9.0%	0.3%
18:30- 19:30	12.1%	13.5%	-1.4%	9.3%	9.3%	0.0%

Table 1 also shows that male metro users have higher percentages in the morning peak hours than females, but the opposite is true in the evening. Again, knowledge of Delhi and existing literature on gender and employment can shed light on this finding. Women metro riders may be more distributed during the morning hours because of non-employment based tasks that are performed such as household tasks and caregiving. In the evenings, women display greater peak travel behavior because of the need to return to these non-employment-based responsibilities, preparing the evening meal, for example. Equally important is the issue of safety and security; most women in Delhi do not feel safe traveling after dark.

FIGURE 3: Mode and time of day

Total number of bus users according to time of day

Total number of metro users according to time of day

As predicted, we see more prominent peaks among both female and male metro users than those using the bus. Female bus users show a peak at 9AM while male bus users peak at 9:30AM. Both female and male metro users have a morning peak while male bus users show the most prominent peak at 6PM. Both female and male metro users display an evening peak of 6:30PM. This supports one hypothesis that women and men using the metro are more similar than dissimilar in their travel behavior. The logic behind this hypothesis is based on the cost of the metro. Higher user fees would require higher incomes, which would lend itself to employment in the formal sector. Furthermore, the formal sector is more likely than the informal sector to have standard working hours.

Going back to our research methodology, we deliberately chose metro stations that represented areas of the city that had a predominance of formal or informal structures, employment and so on. While Figure 3 shows the combine averages of all five site selections, if we do look at each site individually we find the clearest example of 'peakish' behavior of women metro users at Barakhumba Road, an area dominated by formal employment and building typologies but the same does not hold true to women bus users.

Both women and men show two evening peaks. Counter intuitive to our hypothesis, female bus and metro users show evening peaks that are later than those of men. Women bus users' peak at 6:30PM and again at 8PM. This is especially true for female metro users, where the two peaks are toward the right side of the graph, while for men they are toward the left. We believe one explanation for this is the prominence of women in the service/retail sector, who would be leaving around 7:30 or 8PM in order to avoid traveling after dark.

3.4 Influence of geographic location and trip purpose
Of the five survey locations, central and non-central stations are strikingly dissimilar. While Barakhamba Road and Khan Market are central stations offering a mix of high-end shopping/retail and office activities. Laxmi Nagar, Pitampura and Tilak Nagar lie outside the center, have mixed use development with all income groups. These areas are characteristic mixed use areas with a diversity of housing typologies, dominated by middle to lower income families, with a diversity shopping options (e.g. markets, home-based retail), religious institutions, and services reflecting the socio-economic needs of the neighborhood. That is to say that in these areas one finds a higher level of informality, such as unauthorized development, hawkers, illegal parking, retail shops that are extensions of a residence etc. One finds that this type of land use/residential demographic is visibly higher in the non-central, peripheral stations.

FIGURE 4: Percent of female users according to station
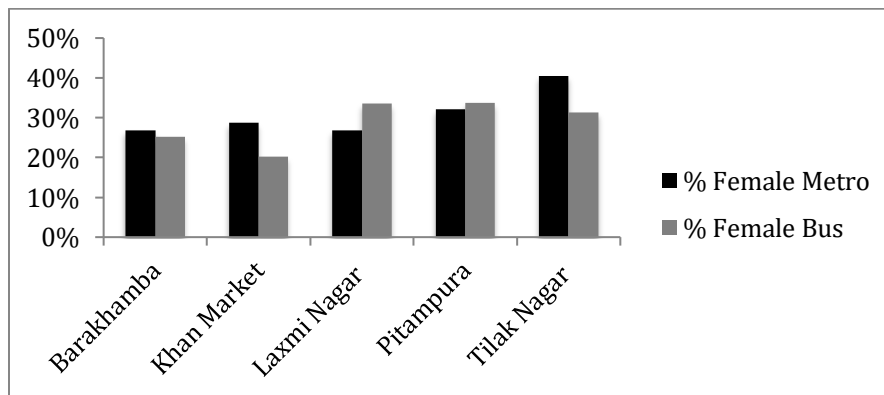
In terms of usage by women, the key difference between the two types of stations is that the peripheral stations have a higher percentage of women users in general. It should be noted that the graph above talks about the proportion of women using each station. The actual quantum of women may be higher on Barakhamba Road metro, owing to the larger scale of the business area. This paper only highlights the nature of difference in the proportion of women using bus and metro at various locations. The reasons behind these differences need a more detailed insight into trip purpose, mode choice factors and perceptions about safety and comfort. Although, it is beyond the scope of this paper to

detail the reasons behind the difference in usage of the two modes, a set of possible reasons could be listed based on a preliminary understanding of the intercept survey.

- Of the central stations, Barakhamba Road is primarily a white-collar work destination with many government and private sectors offices. Given the low work participation rate of women, especially in the formal sector, it is likely that the proportion of men using public transport in this area is higher.
- Khan Market, the other central station is a high-end shopping center. Except for the female shop and restaurant servers, it is highly unlikely that most women visiting this place would travel without private modes. Our findings indicated that this is one of the least used stations amongst the five selected.
- Non-central stations with highly mixed use and high level of informality remain active from morning until late night. This informality, although technically not legal, renders an unofficial form of surveillance to these non-central stations, which women might find reassuring. Keeping in mind Jane Jacob's theory that 'eyes of the street' contributes to safety, we imagine that Barakhumba Road and Khan Market, with its high end commercial nature and high income residential status have little informality and thus little street life. The streets around public transport are desolate after dark. Even the authors of this paper experienced a certain degree of disconcert while visiting these central stations at night for the purpose of this study.

In three of the areas surveyed, women were, proportionally, using metro more than bus. However, in the two other areas, the proportion of bus user was much higher so that overall, women in Delhi still seem to be using the bus more than the metro.

Figure 4 is a broken down representation of the relationship between geographic location in the city and percent of women using each mode. In the case of Laxmi Nagar and Pitampura, both of which are quite a distance from central Delhi and display the highest degree of mixed use and lower income residential colonies, it is quite possible that the metro does not service the routes these women require or that the cost of using the metro is prohibitively expensive.

In this paper, findings mostly from the count data have been discussed, however, one aspect of the intercept questionnaire data contributes to our observed trends. Trip purpose data is shown in Table 2 to explain how station location and travel behavior may be linked.

Table 2 indicates that the metro captures travel for work purposes much more than bus, with the exception of Barakhamba Road, which is the only station to be dominated by work purposes for both modes. This helps us better understand the 'peak' behavior found in Table 1 and Figure 3. Table 2 also corresponds with the district level census data; stations such as Barakhamba Road and Khan Market are in the NCT district with the highest percent of female workers (Central District), followed by Tilak Nagar (West District).

TABLE 2: Trip purpose of women

	Bus		Metro	
	Work	**Non Work**	**Work**	**Non Work**
Barakhamba Road	83%	17%	54%	46%
Khan Market	40%	60%	76%	24%
Pitampura	40%	60%	55%	45%
Tilak Nagar	46%	54%	56%	44%
Laxmi Nagar	40%	60%	52%	48%
Total	50%	50%	59%	41%

4. Implications of Findings

Although small scale and exploratory, focusing on the percentage and proportion of women using public transport at certain metro stations and bus stops in Delhi is one entry into a spatial and temporal conceptualization of the city according to gender. It is a starting point for empirical evidence of gender affects visibility and exclusion. The percent of women using public transport (at a particular time) may, in fact, be another factor that impacts how other public transport users perceive that mode. Jain and Parida (2014) reported that more than 80 percent of the women surveyed had been a victim of one or the other form of harassment while using public transportation in Delhi, evidence of Reuters 2017 finding that Delhi was the most unsafe city for women globally. For example, while conducting one to one interviews, certain women indicated that after dark, when bus occupancies are very high and lighting both on the bus and at the stops is poor, it is very difficult for women to board and compete for space in buses crammed with men. Additionally, poor lighting means higher risk of being grouped or touched by male passengers. Both bus and metro have nearly the same proportion of women on average (approximately 32 and 30 percent, according to our findings), but as the day progresses and night falls, buses lose favor with women more rapidly than metro, which is consistently lit within the compartment, on the platform, and outside the station. Furthermore, it is hypothesized that the continuous presence of both male and female security personal in the metro station could add to feelings of personal security. Given the finding that reported crimes against women in Delhi have risen over 50 percent since 2012, (Chachra 2016) helps contextualize just how important these features within and around the metro station can be for women.

Based on the existing evidence, we can hypothesize that if the percent of women using a mode of public transportation is very less, it may create an atmosphere where the women using that mode may feel insecure and usafe, further reducing the attractiveness of that mode. For example, if a bus only has two women and 30 men at 9:00 PM, women may not feel comfortable and look for alternative modes or choose not to travel at all. In most of the metro stations surveyed, women and men were more similar in terms of time of day peaks than bus users. As we know that the metro is more costly to use we can find links between our findings and existing literature on incomes; as the incomes of women increase, differences in travel behavior between genders decrease. Men and women using the metro might be more likely to employed in the formal sector, and thus traveling at fixed times of day.

Women show pronounced peaks in the morning and evening and this coincides with male peaks. With the majority of women travelers on metro giving work as the travel purpose, this seems to make sense. However, these travel trends do not mean that women do not have strong off peak travel needs. A study by Anand and Tiwari (2006) shows that low income women engaged in informal work often travel very close to their homes and are more likely to travel at off peak times (Astrop et al. 1996). Furthermore, with the exception of a recent study by Manoj and Verma (2015) and Mahadevia and Advani (2016), travel patterns of women engaged in non-economic work (house work and child rearing) has rarely been captured in India.

More research must be done on all these aspects of this pilot study, but by presenting data on the percent of women using public transportation according to time of day we offer a starting point for thinking about gender accessibility and inclusivity in urban India, viz a viz transportation. As the concept of the inclusive city is gaining traction in global policy discourse, particularly with the introduction of the Sustainable Development Goals, it is important to consider how these percentages compare in cities across the world. For example, we know that 64 percent of Philadelphia's bus and subway users are women (Saksa 2015), and the national average of public transportation ridership in the US is around 55 percent women, (APTA 2007). While the higher percent of women users could be an indication of gender inclusivity, it could also be a sign of women's lower earning power in respect to men and the need to take public over private forms of transportation.

It is recognized that the majority of metro users were once bus users. Given the gender inclusive policies of the metro, the well-documented existence of gender-based harassment on buses in India (ASSOCHAM 2012; Bergen 2013; Good and Montano 2007; Mitra-Sarkkar 2009), and informal interviews conducted with women public transportation users, it seems that women would easily chose metro over bus if given the opportunity. Again, knowing what we know from these sources, it seems that the fare of the metro coupled with issues of first and last mile connectivity are two important reasons why women continue to use the bus over the metro.

The survey conducted for the 2014 study in Delhi (Jain and Parida) revealed that when public transportation is well-marked (e.g. formal bus stand with signage), has frequent service, and is located in a populated, mixed use environment with continuous activity and ground level shop frontages, community surveillance is promoted and women feel safer. This was corroborated by the research conducted for this paper. Areas that are in the central city, like Barakhamba Road, may seem very accessible as most public transportation services converge here. However, the meaning of accessibility for women has an added dimension of safety and security. Stations in exclusive business districts which become desolate at certain times of the day may not be accessible at all times for women due to these factors. On the other hand, stations such as Laxmi Nagar and Tilak Nagar, with their vibrant markets, saw women using metro even very late in the night. Hence, activities should be planned to keep such areas surrounding bus stops and metro stations busy at all times of the day. This can help make sure that no part of the city seems off limit for women an any given time. To make public transportation systems more inclusive, planning of mixed land uses in close proximity to stations is an important lever. That would be a major

win against social exclusion for women and a design strategy that is consistent with tool that seems almost universal in value.

Even with millions being invested into new metro systems, bus fleets, and application-based technologies, issues pertaining to gender inequity are still present in the majority of the world's cities. Addressing transportation inequities is an incredibly complex task; but women (and men) of all socio-economic backgrounds stand to benefit from the provision of good quality, reliable, and well-connected public transport.

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