Gender Inequity in Transportation in Kenya - World Bank

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APPROVAL PAGE

This report is being submitted as my senior project in the Department of Mathematics.

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INTRODUCTION: Preface and Acknowledgements

Through an ever-existing crisis of gender inequity around the world, a compelling example of it can be seen in the transportation system in Kenya. Some previous examples have shown evidence of disproportionate burdens placed on men and women in various countries such as Argentina [1] and in Nigeria [2]. A study addressing the ease of job accessibility from transportation methods [3] showed a cyclic downturn of opportunity for impoverished individuals, which may coincide with disparities in gender. The World Bank has collected transportation data from Kenya, and provided access to students like myself to be able use mathematical tools to draw inferences. My role in the project was to scrape the data and map out trends and the relationships between statistics.

The World Bank has compiled data given by a bus rapid transit survey (BRT survey), the Japan International Cooperation Agency (JICA survey) and Urban Public Transportation Users (PT users) to find intriguing trends. The topic I focused on was the difference in travel behavior between women and men in terms of education and healthcare. I studied the purposes of travel, average travel time by travel mode (public transportation, driving, walking, etc.), average time spent walking, average fare by travel purpose and same and different zonal travel by travel mode.

Kenya has various modes of transportation. There are passenger cars and bus public transportation. In addition, there are also matatus and boda boda. Matatus are privately owned minibuses that operate like taxis for many people or groups. Boda boda are privately owned bicycle and motorcycle taxis, similar to matatus, but obviously cannot carry as many people.

In Kenya, education is much different than it is in the United States. Most children don't go further than primary school, which is comparable to elementary school in the US. This is likely due to the fact that education is only funded publicly until the end of primary school. After that, the lack of public funding for education leaves many impoverished families discontinuing education for their children after primary school. Income does correlate with "school internal efficiency measures" (enrollment, repetition, dropout rate, survival rate, cohort wastage, achievement, transition rate) [4]. In education after primary school, income plays an important part in enrollment, which is likely due to only primary school being publicly funded.

The healthcare system in Kenya is both publicly and privately owned. Most of it is in the public sector, with private firms and church organizations filling up the gaps. Public sector mainly deals with preventative care (vaccines, etc.). Health care appears to be offered equally for men and women, but women use it more and report worse health in the same age groups as men. In this paper, I will study how travel for health care is related to gender inequity.

I'd like to thank a few people who helped me along with the project. Elise St. John helped me connect with the World Bank. Akiko Kishue provided insight into how my work extends to the official World Bank project. Laila Zaidi and Sawyer Koelsh cooperated with me and shared ideas for the project. I also want to show my gratitude for Dr. Joyce Lin for helping me find the idea for my senior project and for helping me along the way at every step.

METHODS

I was given three data sets, which I will refer to as BRT, JICA and PT, that were collected from self reported surveys of women and men in Nairobi. In my analysis, I wanted to compare data sets from women and men to see if I could find a statistically significant difference between data sets. Using statistical t-tests between continuous variables, dependent on the disparity of values and sample sizes, the t-tests are able to detect the significance of a difference in values. Using a confidence level of 99%, any t-tests that result in less than 1% probability will be concluded as a significant difference.

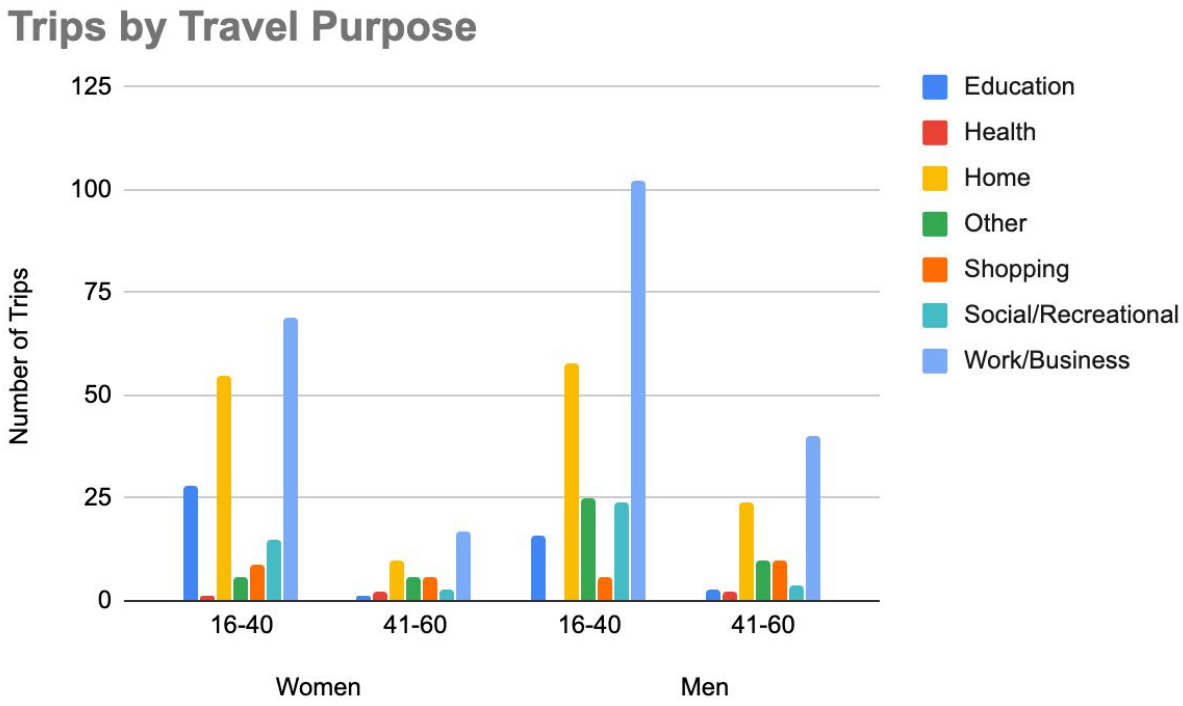
BRT:

BRT contained data on travel purpose, travel mode, time spent travelling and a separate section with GIS data detailing regular travel routes. Only the GIS data was not concerned with differences between women and men. For the purpose of this study, I did not use the GIS data due to the lack of distinction between travel routes and gender. The excel spreadsheet contained many pages of raw data sets, of which I will show the charts produced by analyzing the raw data.

The first four pages of raw data in BRT detailed the gendered differences in travel purpose by age group. The travel purposes were Education, Health, Home, Shopping, Social/Recreational, Work/Business and Other, while age groups were divided into 4 categories: under 16, 16-40, 41-60 and over 60. Unfortunately, due to poor sample sizes in the under 16 and over 60 groups, my focus was directed on the 16-40 and 41-60 age groups.

- Trips by Travel Purpose:

The first page highlighted the discrepancy between the number of trips taken. My analysis is dictated towards differences between travel for education and for health.

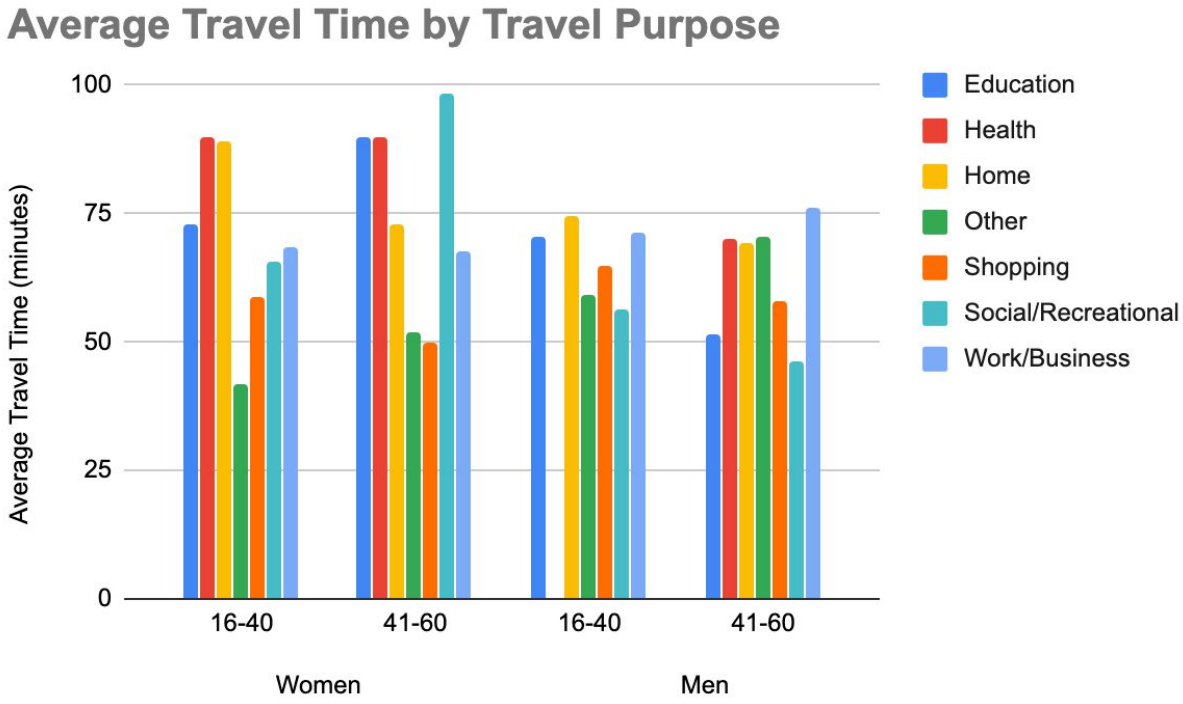


By running a Two-Proportion statistical test on all women and men, regardless of age group, we can conclude that women travel more than men with 99% confidence, as the p-value returned by comparing proportions of the number of trips spent for education was $0.0041 < 0.01$. More interestingly, when we control for the different age groups, the 16-40 group shows that women travel more than men with p-value $0.0039 < 0.01$. In the 41-60 age group, there was no significant conclusion of a difference in behavior with respect to traveling more for education as the p-value returned $0.6056 > 0.01$.

When comparing travel for health we will use the same statistical test used for differences in travel for education. In the 16-40 and 41-60 age groups, we cannot conclude with 99% confidence that women travel differently than men because of the p-value being $0.4420 > 0.1$ for the 16-40 group and $0.3944 > 0.1$ for the 41-60 group.

- Average Travel Time by Travel Purpose:

The second page highlighted the difference in average travel time. Once again, my focus is geared towards travel for education and for health.

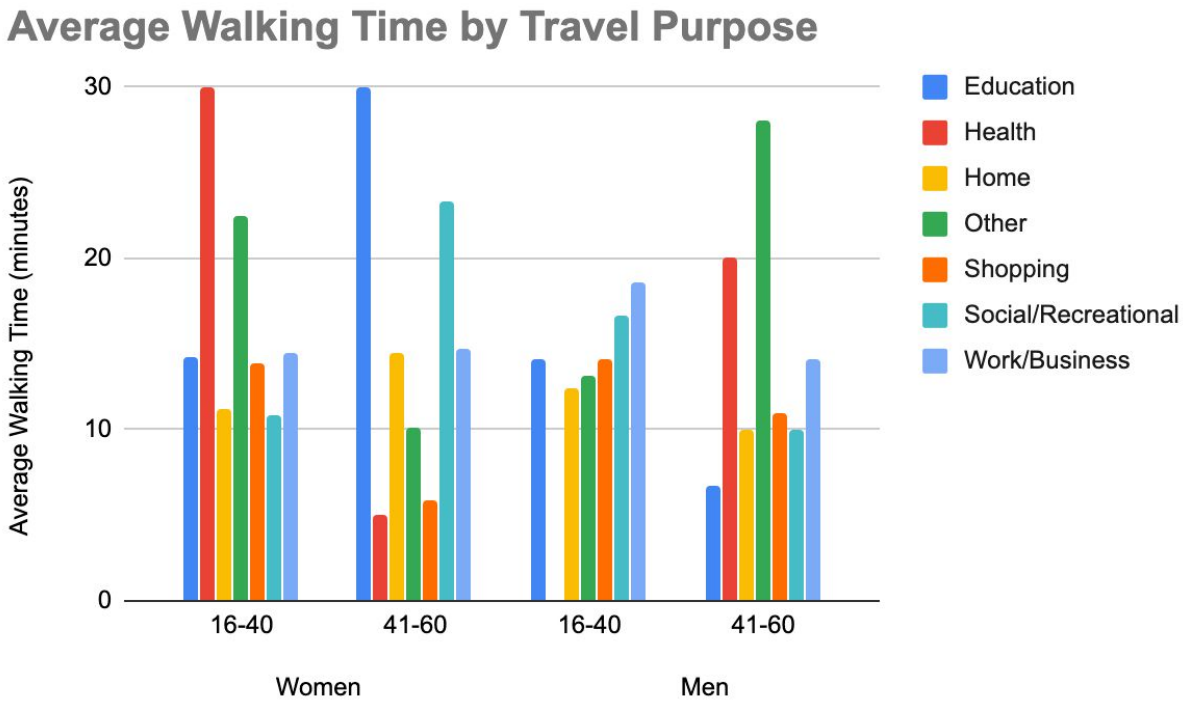


For this analysis, I used a One Way ANOVA analysis. By comparing the travel time for education between all age groups, there was not enough evidence to conclude with 99% significance that women travel more for education than men with F-statistic p-value 0.3404 > 0.1. When controlling for the 16-40 age group, the F-statistic p-value returned is 0.7043 > 0.1, so there is not enough evidence to conclude a difference. There was no way to get an ANOVA analysis of the 41-60 age group as there were not at least 5 women and 5 men traveling for education in the study in that age group. For any indication, the difference in means of average travel time were 90 minutes on average for women and about 52 minutes on average for men.

A similar problem occurred with traveling for health between men and women. A One Way ANOVA test would be a convincing way to show a relationship, but there weren't enough participants in this category to find any conclusions. We are just left with comparing means between gender and age group. For the 16-40 age group, women averaged 90 minutes traveling for health, and men had no members reporting average times for travel in this age group. When referring to the 41-60 age group, women averaged 90 minutes, while men averaged 70 minutes. Any meaningful analysis of the quantitative data for travel for health is nullified by the lack of an adequate sample size, but the raw averages are still available. For future references, I will still mention the averages provided by the raw data.

- Average Time Spent Walking:

The third page focused on average travel time spent walking.

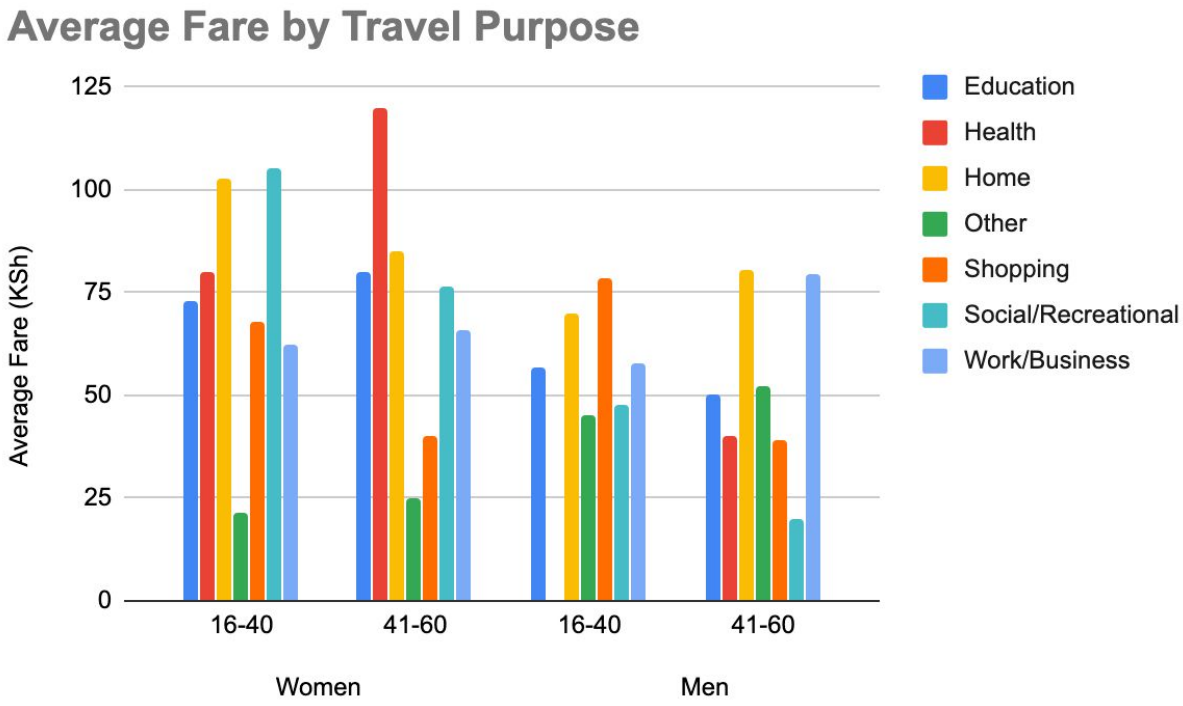


This data set also used quantitative variables, so I aginused a One Way ANOVA analysis. With respect to average walking time for education between all age groups, there was not enough evidence to conclude with 99% significance that women walk more for education than men with F-statistic p-value 0.4910 > 0.1. Looking more specifically at the 16-40 age group, the F-statistic p-value is 0.9386 > 0.1. Just like with average travel time, there was no way to use an ANOVA analysis for the 41-60 age group. The actual averages of walking times of each were 30 minutes on average for women and about 7 minutes on average for men.

With regard to travel for health, the same problem holds as was before. In the 16-40 age group, women walked on average 30 minutes, but there were no men reporting on average walking times in this age group. In the 41-60 group, women averaged 5 minutes of walking for health, while men averaged 20 minutes.

- Average Fare by Travel Purpose:

The fourth page evaluated the average cost of travel in Kenyan Shillings (KSh).



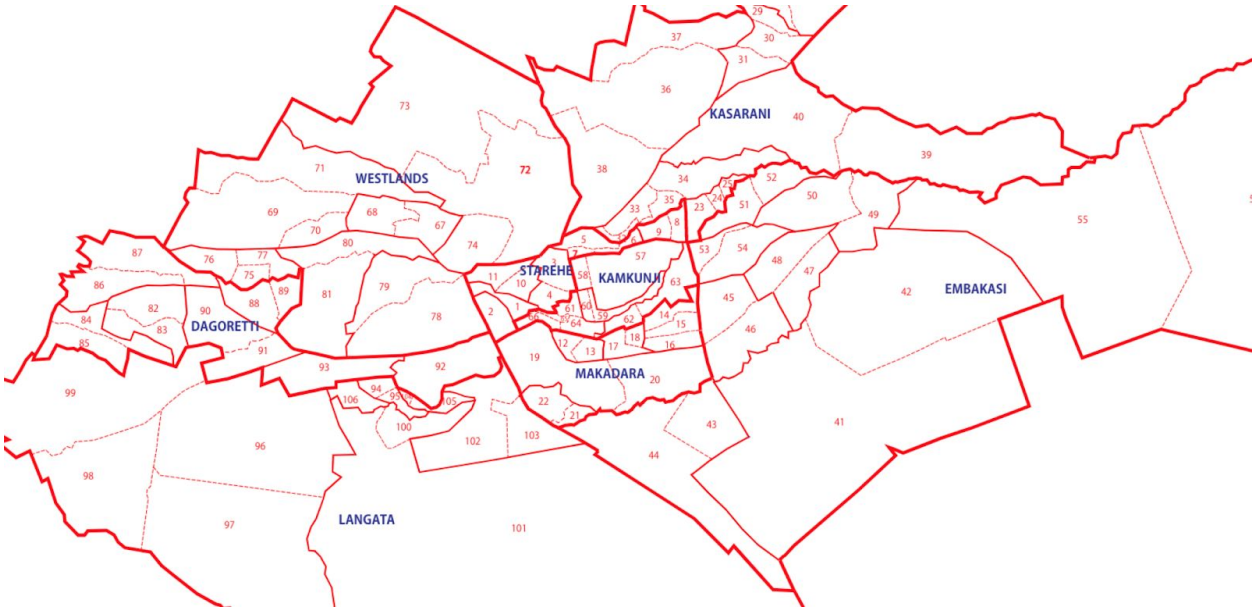
A more interesting analysis can be found when comparing the average fare for education between women and men. By running a One Way ANOVA test, when comparing women and men, regardless of age group, the p-value returned is 0.0522 > 1. Comparatively to the other p-values returned by my analysis, this is the first instance of a weakly significant conclusion. Unfortunately, with 99% significance, we cannot conclude a difference in average fare cost between women and men. When isolating for the 16-40 age range, the p-value comes out to 0.1250, while still low, is not enough to conclude a significant difference between average fare spent for education.

When traveling for health, in the 16-40 age group, women spent on average 80 kSh, with no men reporting on travel spending for health in this age group. In the 41-60 group, women spent on average 120 kSh, while men spent on average 40 kSh.

The remaining three pages described differences in women and men with respect to travel mode, rating of transportation service, and top considerations of travel mode with age group (the same as the previous data sets).

JICA:

JICA was composed of data regarding zonal travel disparities. Many of the charts also grouped data by income group, allowing further analysis. JICA also contained data about travel with or without children. These data sets are concerned mostly with differences between women and men's travel behavior when it comes to trips within and between zones (see map below).

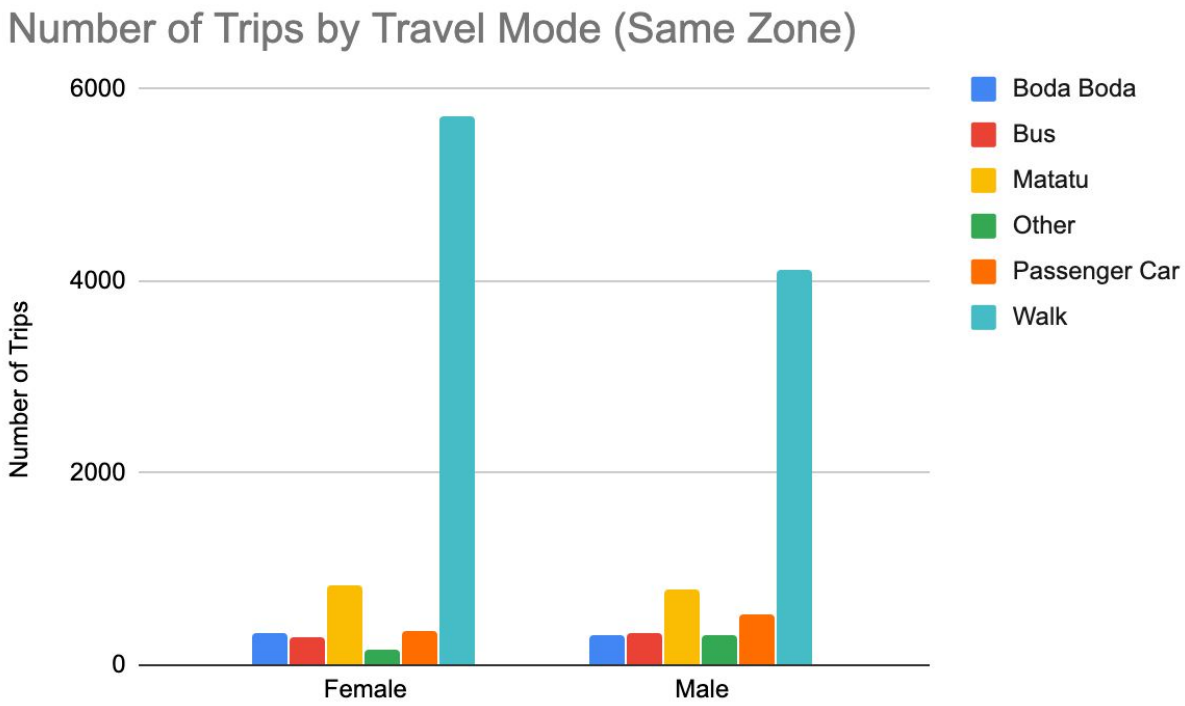


Map of Nairobi with districts and regions

Most of the lower dumber districts (1-20) denote the more urban areas of Nairobi. Starehe, Kamkunji and Makadara make up the center of the city. There is a major hospital located in zone 44, and educational facilities such as universities, small colleges and trade schools are spread out across Nairobi, centered around the inner city.

- Trips by Travel Mode (Same Zone):

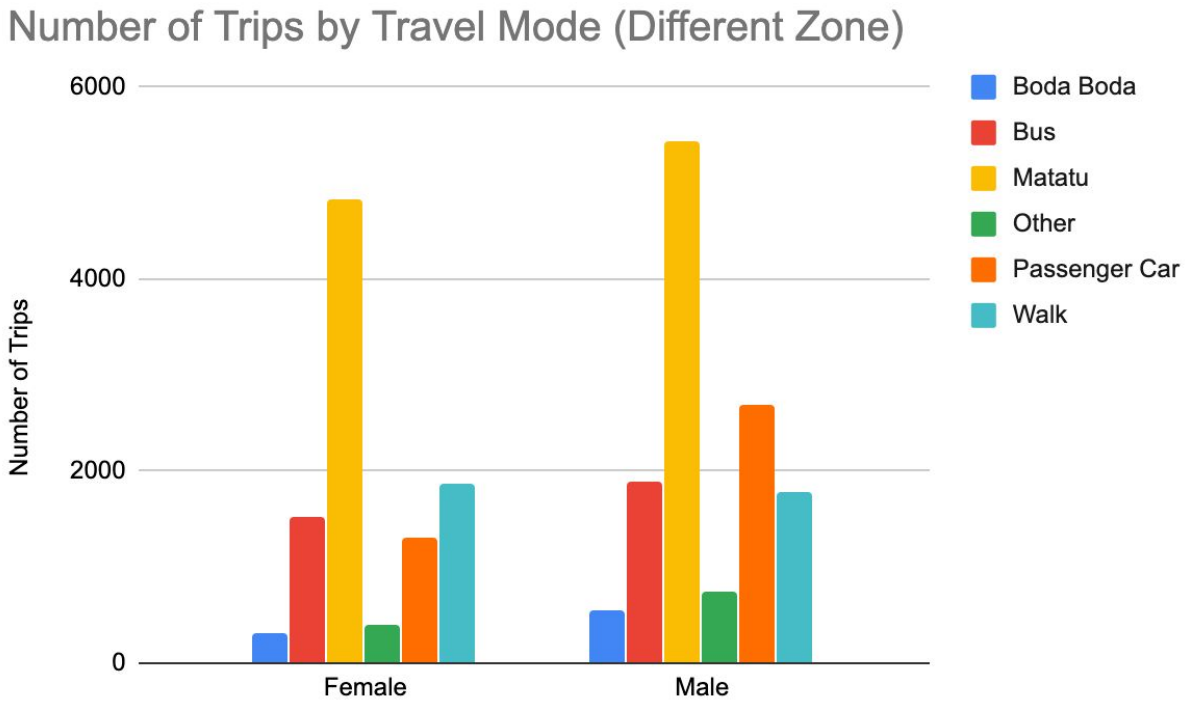
The data set I found most appropriate to my analysis was about the number of trips by travel mode, and comparing the proportions of travel mode for both men and women, isolating each to draw conclusions.



Using a Two-Proportion statistical test, there were several conclusions to be made from this data set in each of the categories of travel mode. We can conclude with 99% significance that women walk more than men in the same zone with p-value $< 0.0001 < 0.01$. Also, we can conclude with 99% significance that men use passenger cars more, than women with p-value $< 0.0001 < 0.01$. We can conclude with 99% significance that men use the bus more, p-value $< 0.0001 < 0.01$. The final conclusion is that men use matatus more, p-value $= 0.0071 < 0.01$. From this data set, there was no significant evidence to conclude a difference between usage of boda boda between men and women, p-value $= 0.1997 > 0.01$. Since the "other" category did not specify what mode of travels were included there, it is not necessary to analyze this.

- Trips by Travel Mode (Different Zone):

When concerned about travel between zones, women and men tend to show somewhat different behavior. The data below was part of a larger data set that included both same zone and different zone travel, but I have them separated to emphasize what is being analyzed.



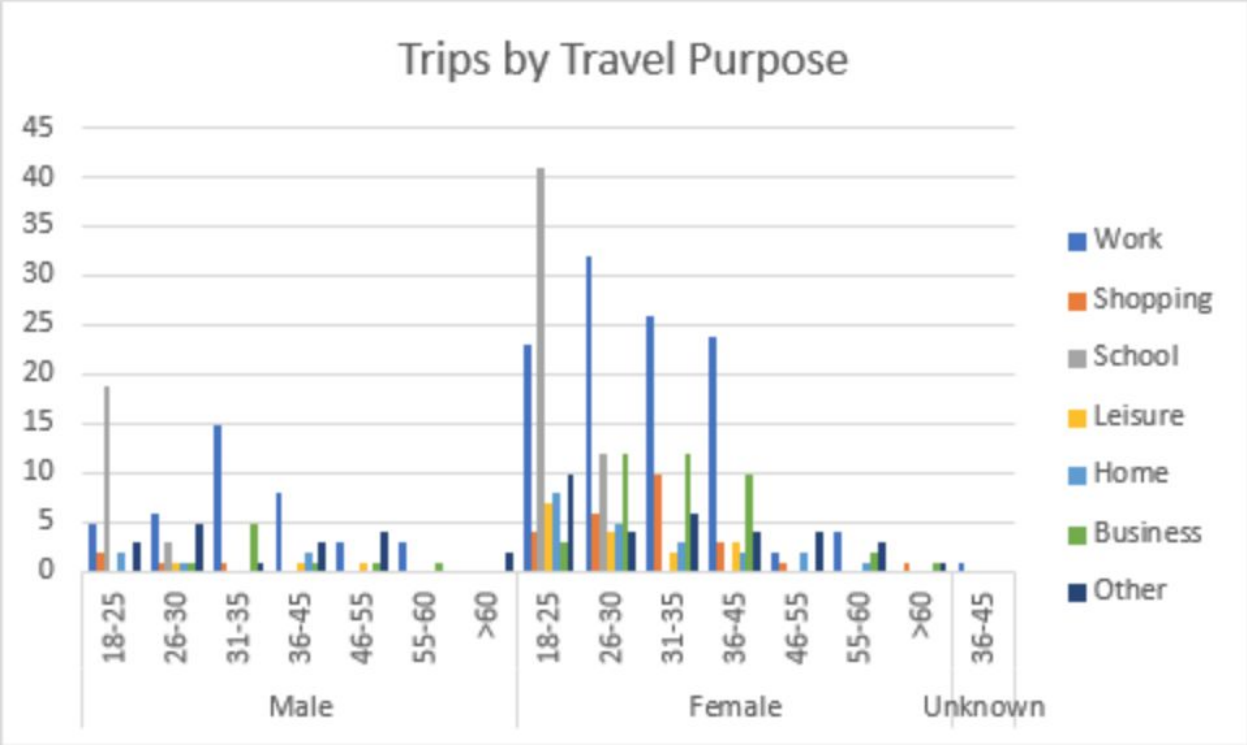
Utilizing the same Two-Proportion statistical test, we can conclude with 99% significance that women walk more often between different zones, p-value < 0.0001 < 0.01. Men use passenger cars more, with 99% significance and p-value < 0.0001 < 0.01. As well, women use matatus more, p-value < 0.0001 < 0.01. The last significant conclusion is that men use boda boda more, p-value < 0.0001 < 0.01. Only there was no significant difference in usage of the bus between women and men, with p-value = 0.4523 > 0.01. In the same vein as the same zonal travel, the “other” category is not necessary to analyze.

PT:

PT was similar to BRT, but had an extra layer of depth by including “peak” and “off peak” time ranges for travel behavior. It also contained an interview questionnaire guide, which is how the data was collected.

- Trips by Travel Purpose:

The data I used from PT detailed the number of trips by travel purpose. This was similar to another data set from BRT, with slightly different parameters for travel purpose, notably excluding travel for health. The following data set is used to compare travel for education analysis from “Trips by Travel Purpose” in BRT with another data set from PT. Only data for travel for education exists in the 18-25 and 26-30 age groups in PT, so by combining those data sets, we can hope to generalize significance for the 16-40 age group from BRT.



There is no significant difference between travel for education in men and women in the 18-25 and 26-30 age groups combined, ($p = 0.0703 > 0.01$). There was also no significant difference in the 18-25 and 26-30 groups isolated, with p-values = 0.0716 and 0.9821 respectively, both greater than 0.01.

ANALYSIS and RESULTS

The first category I analyzed was trips by travel purpose. From my analysis in BRT, we conclude that women travel more for education in all age groups. There was also no significant difference in travel between men and women for health. But, in my analysis of PT, there was no significant difference between travel for education in the 18-25 and 26-30 age groups combined. Comparing this result to that of the 16-40 age group in BRT, we find some contradictory results.

Both studies have women making more trips for education than men, so these discrepancies in statistical significance could be due to the low sample size used by PT. To settle this discrepancy, I will trust the analysis of BRT more due to its significantly larger sample size. The notable conclusion to be made from this is that women travel more frequently for education than men, but as I have found in the other analyses, this may be a problem due to women's means of transportation. With women traveling more frequently for education, inadequate access to convenient transportation will place a larger burden on women's ability to commute.

The average travel time by travel mode category as well as the next couple had some issues regarding sample sizes. The average travel time, average walking time and average fare between women and men with regard to education yielded no significant differences. One thing to note, however, was that the average fare category came out with a very low p-value, but not low enough for the admittedly strict level of significance I used for this study. This could prove to be an interesting category to look into in the future as there was a large difference in means, but the sample size was quite small.

The major issue of these categories was that in the 41-60 age group for education and the entire health category, there was not a sufficient sample size to allow a One-Way ANOVA test to determine a difference. Even without a significant difference, the means of the groups where a One-Way ANOVA could not be done are heavily skewed towards women traveling longer for education and health. Since women use health care more, that could explain why the amount of spending is much higher for women than for men. Clinics are concentrated in the city, with a couple others only slightly away from the city. The lack of sample size makes any current analysis indecisive, but still sheds light on a potential area to examine in a future study. This could be a significant factor in cost for women with children travelling to the city from the slums for preventative care and regular checkups. There isn't much to conclude statistically in these categories, but it does give potential insight to issues that haven't been examined closely enough yet.

When examining the type of transportation used within same zone travel, many interesting conclusions can be made. From my analysis, I found that women walk more than men within the same zone and men use passenger cars, the bus and matatus more than women in the same zone. The only

conclusion with no significant difference in travel was on boda boda, where women and men use it at similar rates.

These differences in behavior with respect to travel mode explain the differences in means of transportation. With women walking more within the same zone, this means that women likely are not traveling far from home, with walking times shown to be similar between men and women. So women walk more frequently, yet have similar walking times per trip. Men also use more expensive forms of transportation such as passenger cars, which is indicative of either more disposable income or further commutes for work. A difference in means of transportation can limit women's ability to access jobs only attainable with certain access to transportation, which may be a key factor in gender inequity across Kenya.

Now considering travel between zones, there were some more eye-opening discoveries. Women walk and use matatus more, while men use passenger cars and boda boda more, and women and men use the bus at similar rates.

Travel between zones is generally further than within a zone, so the fact that women are walking more frequently even in this category also indicates women are less capable/willing to use more expensive means of transportation like passenger cars. Just like travel within the same zone, for women wanting to travel between zones for school or for healthcare, there is a significant difference between women and men's means of transportation, thus limiting women's ability to access certain parts of the city. Lacking means or financial resources to travel efficiently minimizes women's ability to find jobs outside of their reasonable travel distance that could potentially pay better or have better working conditions than jobs within their travel distance. Just like with travel in the same zone, this may be one of the factors that explains gender inequity in Kenya.

CONCLUSION

To conclude, shedding more light into gender inequity through empirical means provides a stronger argument for real, systemic change to be made. As stated from the beginning of this paper, the purpose of this project was to detect any discernible differences between travel behavior of women and men. The results of my analysis show with 99% confidence that women walk more and use less expensive means of transportation, regardless of distance of travel (within the same or to a different zone), which severely limits their mobility. With regard to average travel time and average fare, women travel on average 20-40 minutes longer and it is likely that women also spend more, but the sample size was too small for both categories to make a concrete general conclusion. What these averages suggest is that future studies can gather more data to further analyze the large discrepancies. These results effectively show some of the gender based biases affecting mobility present in transportation in Nairobi, which most likely exist throughout all of Kenya and other countries around the world.

REFERENCES

[1] Gender, Travel and Job access: evidence from Buenos Aires; Tatiana Peralta Quiros, Shomik Raj Mehndiratta, Maria Catalina Ochoa; February 2014

[2] Gender differences in intra-urban travel behaviour: a preliminary survey in Ibadan, Nigeria; Asiyanbola R. Abidemi

[3] Spatial Distributions of Job Accessibility, Housing Rents, and Poverty in Nairobi, Kenya; Shohei Nakamura, Paolo Avner; November 2018

[4] Income and "school internal efficiency measures", International Journal of Educational Administration and Policy Studies; Julius Maiyo: https://files.eric.ed.gov/fulltext/EJ1077793.pdf

[5] Bus rapid transit survey (BRT); World Bank

[6] Japan International Cooperation Agency (JICA survey); World Bank

[7] Urban Public Transportation Users (PT users); World Bank

[8] Two-proportion and One-Way Anova tests; Rossman Chance Applet:

http://www.rossmanchance.com/applets/