APPROVAL

This is to certify that the dissertation entitled "Analyzing the factors affecting gender disparity in mode choice based on trip distance and trip purposes in terms of developing country perspective", **by Khadiza Najneen Priyanka** has been approved fulfilling the requirements for the Bachelor of Science Degree in Civil and Environmental Engineering.

Supervisor:

Moinul Hossain, Ph.D.

Professor

Department of Civil and Environmental Engineering

Islamic University of Technology (IUT)

Board Bazar, Gazipur, Bangladesh.

DECLARATION

I declare that the undergraduate research work reported in this thesis has been performed by me under the supervision of Professor Dr. Moinul Hossain. I have taken appropriate precautions to ensure that the work is original and has not been plagiarized. I can also make sure that the work has not been submitted for any other purpose except for publication.

Khadiza

Khadiza Najneen Priyanka

ID: 170051029

May, 2022

turnitin

Similarity Report ID: oid:22779:17369424

PAPER NAME

Analyzing the factors affecting gender disparity in mode choice based on trip distance and trip purp

AUTHOR

Khadiza Najneen Priyanka

WORD COUNT

3798 Words

CHARACTER COUNT

21225 Characters

PAGE COUNT

27 Pages

FILE SIZE

582.1KB

SUBMISSION DATE

May 20, 2022 12:04 AM GMT+6

REPORT DATE

May 20, 2022 12:05 AM GMT+6

15% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 13% Internet database
- Crossref database
- 8% Submitted Works database
- 3% Publications database
- Crossref Posted Content database

Excluded from Similarity Report

- Bibliographic material
- Cited material
- Quoted material
- Small Matches (Less then 8 words)

Analyzing the factors affecting gender disparity in mode choice based on trip distance and trip purposes in terms of developing country perspective

Prepared by:

Khadiza Najneen Priyanka

ID: 170051029

Bachelor of Science in Civil and Environmental Engineering

Supervised by:

Moinul Hossain, Ph.D.

Professor

Department of Civil and Environmental Engineering (CEE)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

Organisation of Islamic Cooperation (OIC)

Board Bazar, Gazipur, Bangladesh.

May, 2022

APPROVAL

This is to certify that the dissertation entitled "**Analyzing the factors affecting gender disparity in mode choice based on trip distance and trip purposes in terms of developing country perspective", by Khadiza Najneen Priyanka** has been approved fulfilling the requirements for the Bachelor of Science Degree in Civil and Environmental Engineering.

Supervisor:

Moinul Hossain, Ph.D.

Professor

Department of Civil and Environmental Engineering

Islamic University of Technology (IUT)

Board Bazar, Gazipur, Bangladesh.

DECLARATION

I declare that the undergraduate research work reported in this thesis has been performed by me under the supervision of Professor Dr. Moinul Hossain. I have taken appropriate precautions to ensure that the work is original and has not been plagiarized. I can also make sure that the work has not been submitted for any other purpose except for publication.

Khadiza Najneen Priyanka

ID: 170051029

May, 2022

ACKNOWLEDGEMENT

All praises to Almighty Allah for blessing us with the precious opportunity to complete the research work. Humble gratitude to my parents for their immense support and strength to carry out the work without any disruption. It is a privilege and honor to acknowledge my sincere and deepest sense of gratitude to my respected Supervisor Dr. Moinul Hossain, Professor of Civil and Environmental Engineering of (IUT) for his untiring efforts, inspiration, invaluable guidance and constructive criticisms throughout the period.

Special thanks to Dr. Md. Asif Raihan, Accident Research Institute (ARI), Bangladesh University of Engineering and Technology (BUET) for giving us his valuable time and utmost guidance in correcting our shortcomings and providing us with helpful feedback.

We would also like to express gratitude to all of our departmental faculty members and staff for their help and support throughout our undergraduate period. We are also thankful to our friends, seniors, juniors and batch mates of our department and well-wishers for their valuable suggestions and cordial assistance.

ABSTRACT

Improved transportation facilities are necessary for ensuring the participation and accessibility of women for ensuring women empowerment and gender equity all over the globe including developing country. Socio-economic characteristics, such as income, education level, etc., and trip characteristics, such as; frequency, purpose etc. were found to have significant impacts on boarding and alighting experience of women in their daily mobility pattern. The role of women contribution in the society has been changing than that of the traditional norms, they are moving out of their houses to carry out the duties in order to contribute to the society. Although their mobility, use of transit has been increasing day by day, their need of customized policy still remains unaddressed. Through literature review, it was found that the developed countries have tried to address these issues in their policy making. However, the perspective is far different in developing countries in terms of factors affecting the mobility as well as trip purposes. Based on their response a Bayesian model was developed to identify the key factors resulting the gender differences in mode choices by using GeNIe and policies were recommended.

Key words: Women, transportation, mobility, trip purpose, trip distance, safety and security, Bayesian analysis.

CONTENTS

CHAPTER 1

1 INTRODUCTION

1.1 Background

The role of women contribution in the society has been changing than that of the traditional norms, they are moving out of their houses to carry out the duties in order to contribute to the society. Although their mobility, use of transit has been increasing day by day, their need of customized policy still remains unaddressed. Through literature review, it was found that the developed countries have tried to address these issues in their policy making. However, the perspective is far different in developing countries in terms of factors affecting the mobility as well as trip purposes. This paper aims to address the gender based differences in mobility in developing society. This paper identifies the factors affecting the mode choice based on trip distance and trip purposes varies based on gender differences in developing society. Unlike previous papers, the field studies in this paper includes gender based differences in mode choices in both short and long trips in urban and suburban region in developing society. A questionnaire survey was performed on 1602 respondent across different locations of Dhaka city, Gazipur, Narayanganj and Tangail in Bangladesh. Based on their response a Bayesian analysis was developed to identify the key factors resulting the gender differences in mode choices and policies were recommended.

1.2 Problem Statement

Very few statement about the gender based commuter cyclist route choice, stated preferences, cycling facilities in terms of adverse traffic conditions. (Garrard et al., 2008).

A gendered based study is required considering larger number of variables such as-personal, environmental, cultural and economic determinants of cycling in countries with lower bicycle transport mode share and also to identify the characteristics of urban environment with female friendly infrastructure. (Garrard et al., 2008).

The gendering of driving and mobility needs a quantitative approach in terms of socio-cultural practices (Siren & Hakamies-Blomqvist, 2006).

Socio-demographic considerations such as gender, occupations, education, vehicle ownership are taken into consideration while deciding the modes for short trips (Khan & Habib, 2021).

In order to have perspective about women's mobility issues in urban areas at a network level in BRT corridors or other public transit modes, a detailed gendered disaggregated data is needed. (Malik et al., 2020)

Car-ownership, income, education should be incorporated to find out the influence on public transportation usage behavior (Fu & Juan, 2017)

The role of sustainable transportation system such as bicycle for lower income women and associated insecurities in terms of confidence, local culture and changes in mobility patterns (Mark & Heinrichs, 2019)

In UK, female are more likely to use public transport than that of male as male uses personal vehicles (Policy, 2021). Whereas in developing country female are less willing to use active transport (Baig et al., 2021). So, there is a cultural, geographical and demographic differences than that of developed ones.

1.3 Purpose and Objective

The preferred travel mode for a woman on short trips was analyzed. If it was different than that of existing infrastructure and whether it is the same or different for both cases was studied.

Despite being equally educated, the women employment rate is low in developing countries like Bangladesh. And the rate of women footsteps outside the home is noticeable. The number of women using public transport is not up to the mark. The study will determine whether women are shifting near the workplace, so they don't need to travel on public transport. Or the travel mode generally for women's workplace, which distance is more than 5km or long

1.4 Scope of the Study

Very few study have been made about gender perspective on mode choice in terms short and long trips **specially** in developing countries where the parameters of service quality differ from that of developed ones in terms of infrastructure.

1.5 Organization of the thesis

Through literature review, the study gap was found out about the need of research in developing country about women's mobility. A questionnaire was formed based on literature review and technical knowledge about transportation. Afterwards, questionnaire survey was conducted across different location in Dhaka city, Gazipur, Tangail and Narayanganj which covered both rural and urban society. A Total of 1602 participants answered the questions. These data were processed though GeNIe academic and based on the outcome policy was recommended.

CHAPTER 2

2 Literature Review

During transportation planning and policy, women's necessity and experiences are not represented adequately which is very different than that of men(America, 2021)

Through prioritizing NMV lane there is a potential of promoting women's cycling as well as for safer pedestrian facilities drone surveillance can promote green mobility (Porter et al., 2021).

Gender disparity is commonly observed in case of active commuting in terms of developing country as female are less mobile than male due to the influence of essential social factors like- safety and security, infrastructure and attitudes (Baig et al., 2021)

Due to traditional norms the travel pattern of women is very different than that of men. They tend to travel shorter distance and carry out various household shopping as well as carry the goods and children which greatly affects their mode selection(America, 2021)

Women are more likely to take shorter trips as they have to stop for doing different household chores, collecting children from schools, taking care of elderly people in family

Transport planning and policies needs to be modified based on potential gender differences with respect to their daily mobility and travel patterns (Havet et al., 2021)

The female who drive to work has well-being losses due to congestion are willing to pay to avoid congestion hence higher speed associated with lower wages (Dilmaghani, 2021)

Passengers with higher education and income caring more about comfort, punctuality and efficiency were more likely to choose high-speed railway (HSR) and plane; passengers caring about travel expense were more likely to choose ordinary train (Wang & Yan, 2020)

In urban mobility, gender differences in mode choices and share of active transport to school in daily mobility has been observed (Montoya-robledo et al., 2020)

The influence of socioeconomic characteristics, land use and travel time considerations on mode choice for medium- and longer-distance trips (Khan & Habib, 2021)

The conservative society promotes private car as the primary mode of mobility for women due to various social factors such as – social, cultural, economic, political and urban factors (Badawi & Aboelmakarem, 2021)

Travel time and income affects mode choice of women and they tend to select cheapest mode over time efficient mode (Pablo et al., 2017)

During peak hour, there are more chances of being harassed as the public transport are mostly crowded (Natarajan et al., 2017)

Women mostly prefers flexibility, safety and security over fare and travel time(Pablo et al., 2017)

During women's mobility accompanied by children and goods, they prefers car over public transport because of the adequate spacing inside public transport for carrying goods and children (Kawgan-kagan & Popp, 2018)

There are few factors affecting the mode choice of women in terms of budget, safety and socio-demographic context which often affects their participations and contribution to the socio-economic developments (Mark & Heinrichs, 2019)

Geographical context as well as demographic indicators impacts the transportation planning which shows a differentiated mobility patterns of women based on metropolitan cities, urban and rural areas as in rural areas the young working forces migrate to cities in search of work resulting the elder citizens staying there who barely goes outside and are engaged in household chores (Xu, 2020).

Despite the existing database from different surveys, the needs of female passengers are often ignored which hinders the comfort, safety, security in their mobility (*Safe transport modes for women can only mean better connectivity / 14*, 2021)

Car ownership and having a driving license may change the mode choice of women in urban area and affect their mobility experience(Siren & Hakamies-Blomqvist, 2006).

In urban areas, the vehicle choice largely depends upon the purpose and destination of travelling hence affects the mobility pattern (Khan & Habib, 2021)

Elderly women use non-driving mode of transportation than men for having fewer driving license, higher dependency on mobility on their family which often leads to poorer mobility than men resulting unfulfilled travel needs and restricted mobility (Siren & Hakamies-Blomqvist, 2006)

The unplanned and underdeveloped section of the city in which public transportation design are not taken into consideration may hugely impact their access to healthcare. (Mark & Heinrichs, 2019).

In a study based on Melbourne city, on busy arterial roads the provision of on-road lanes may not be attractive enough to increase the female commuter cyclists (Garrard et al., 2008).

In urban areas, increased use of private cars increases congestion, reduces productivity, wastes time, increases injury and fatality as well as less provision to non-motorized vehicles hampering sustainability by emitting more green-house gases (Polk, 2003)

In order to improve mobility, the use of smartphones for map orientation can contribute to gender equity by improving access and choice (Mark & Heinrichs, 2019).

CHAPTER 3

3 Methodology and Data

3.1 Introduction (Overall workflow)

This paper addressed the study gap about the differences in the necessity of infrastructural point of view as well as unaddressed necessity of women in policy making. Through rigorous literature review of existing studies across the globe, the study gap was found out and then a questionnaire survey was performed in different zones in Dhaka city. The main was to collect data from age groups and diversified demographic characteristics. Then processing the data, it was evaluated though GeNIe2.5 Academic version and the result were interpreted. Policy was recommended based on the outcome.

3.2 Methods

Bayesian network can be framed utilizing three principles; an expert can layout the network where the dependencies between the parent and child nodes can be intellectually defined, or otherwise, applying the structural learning technique, or combining structural learning and expert opinion. In this study, GeNIe2.5 Academic Version was used for structure and parameter learning. GeNIe implements Expectation Maximization (EM) algorithm for parameter learning which can deal with both complete and incomplete datasets.

A sensitivity analysis was conducted with the objective to visualize and quantify the impacts of parameters' variations on the target node. The color of the bar indicates the extent of change in the target node state; the red color symbolizes negative changes, and the green color stands for positive changes.

3.3 Study area and data

Our study area consisted of various locations across Dhaka city, Tangail, Gazipur and Narayanganj in Bangladesh. 1602 people answered the questionnaire survey which was segmented as follows- demographic characteristics (such as- age, income, profession etc), trip distance and choices and factors affecting the choices and so on. The questionnaire survey was prepared based on literature review as well as transportation judgement.

We were interested in gender based differences in mode choice based on trip distance and trip purposes in the sensitivity of income, nature of job, education level.

CHAPTER 4

4 Analysis and Result

4.1 Introduction

Data file was imported in GeNIe academic from the csv folder of data base. After learning the parameters network was developed. The PC algorithm is used and the obtained network is modified according to the correlation between variables, literature review, and engineering judgment. Utilizing the built-in EM algorithm for parameter learning, marginal probabilities of all nodes are generated.

The tornado diagram, sensitivity analyses as well as well evidence and target were set to find the changes in the network.

4.2 Descriptive Statistics

From the obtained 1602 data, few variables were considered including trip purpose, fare, mode choice selected, gender, education level, factors affecting mode choices and so on.

It was found that among the trip purposes, trips related to education and job had the highest percentage for travelling and they chose non-motorized vehicles for movement in the shorter distance. The factor responsible behind the selection was safety and security. While the other factors like comfort, fare, availability didn't play any major role behind their selection.

4.3 Model output and Explanation

The PC algorithm is used for structure learning from a complete data set. The obtained network is modified according to the correlation between variables, literature review, and engineering judgment. Utilizing the built-in EM algorithm for parameter learning, marginal probabilities of all nodes are generated.

The color of the bar indicates the extent of change in the target node state; the red color symbolizes negative changes, and the green color stands for positive changes.

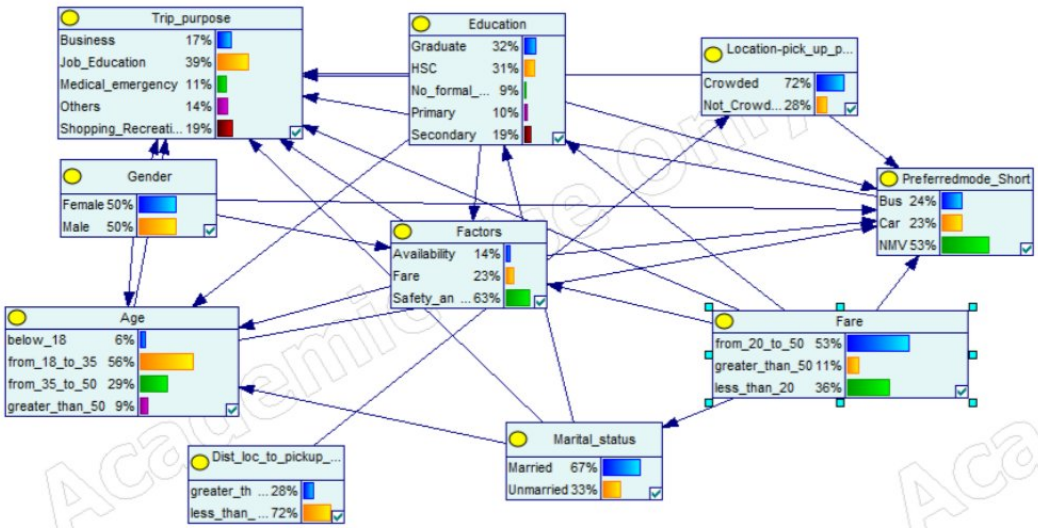


Figure 1:Model Development

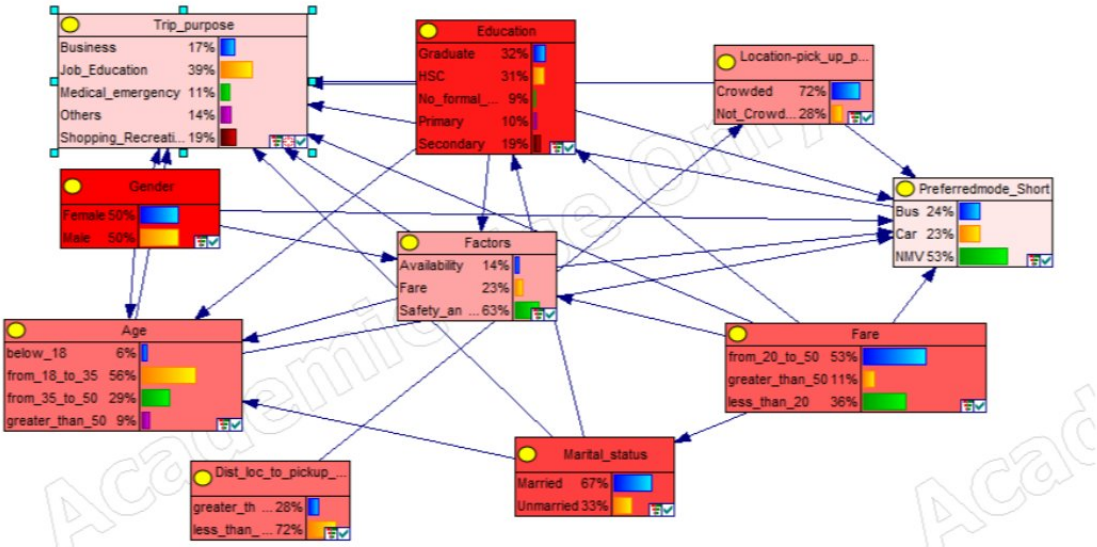


Figure 2: Sensitivity Analysis (Target- Trip purpose)

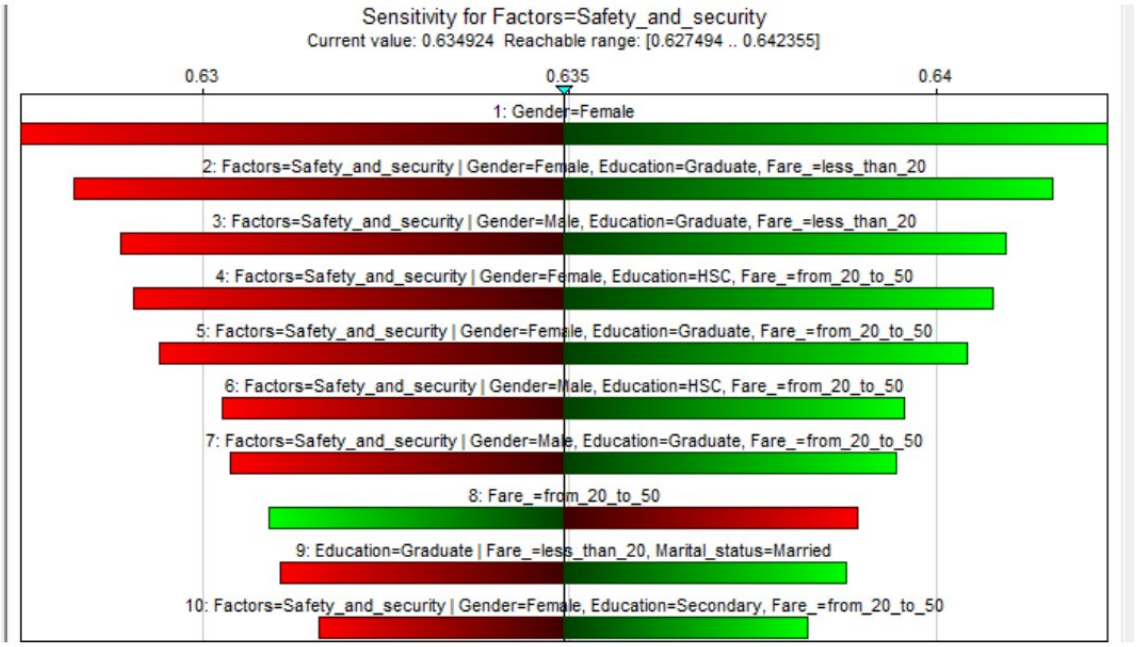
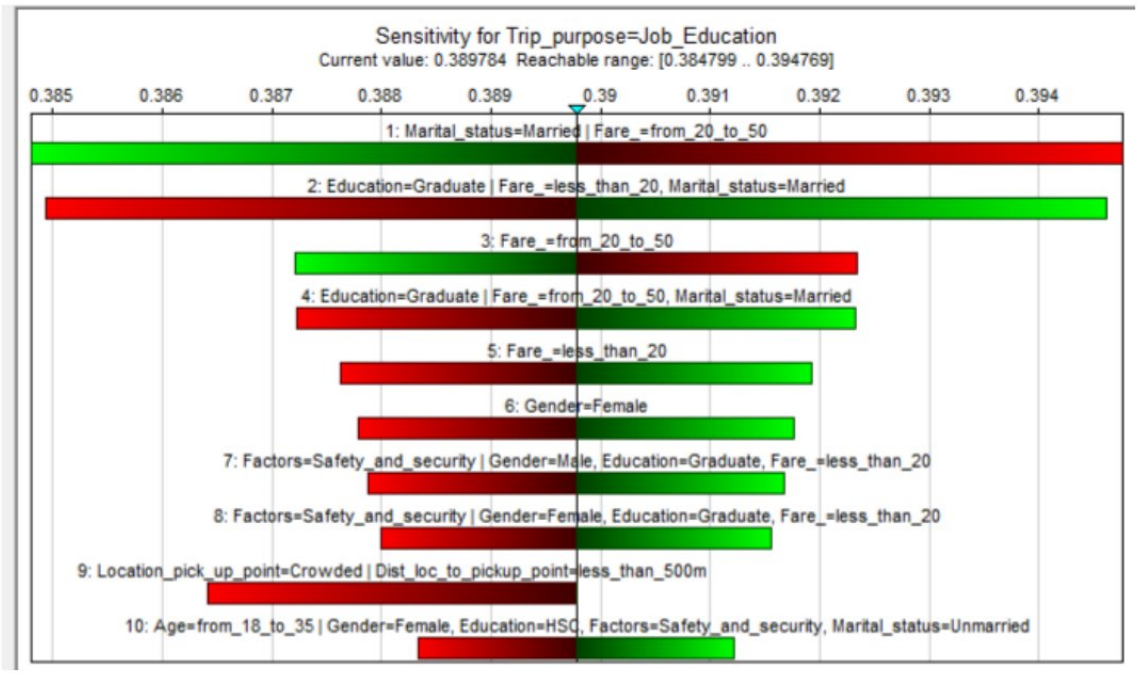


Figure 3: Tornado diagram



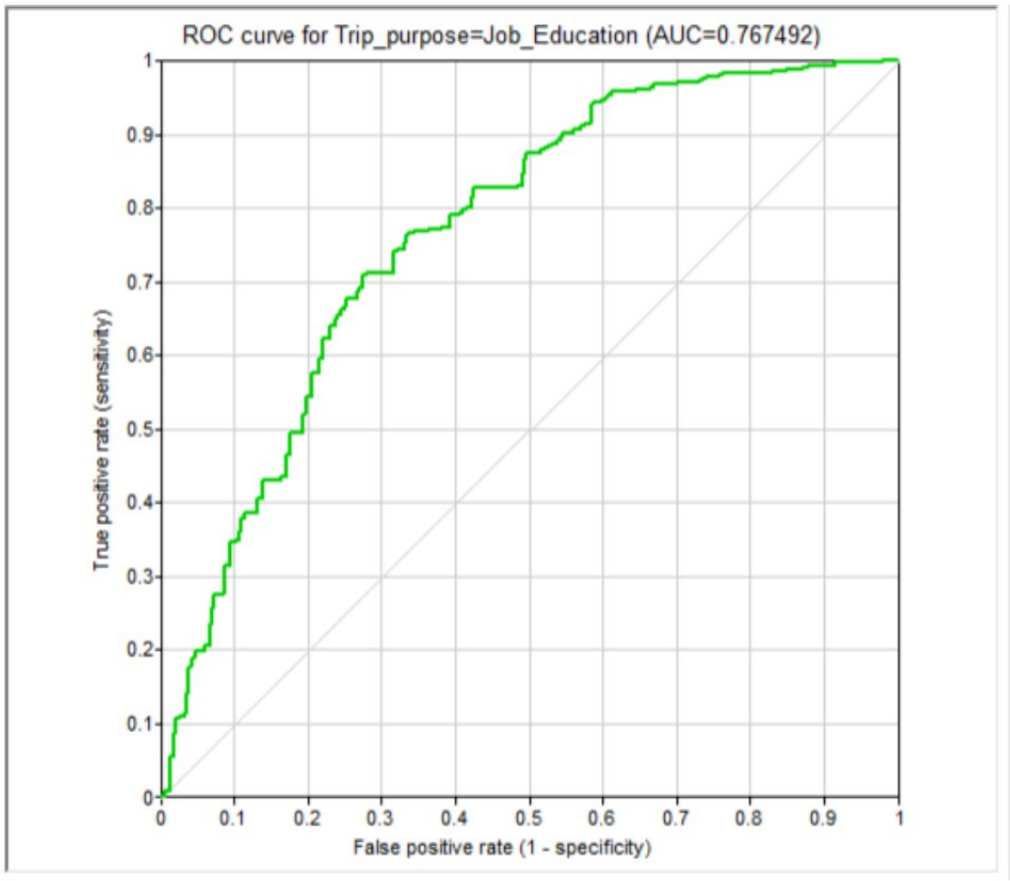
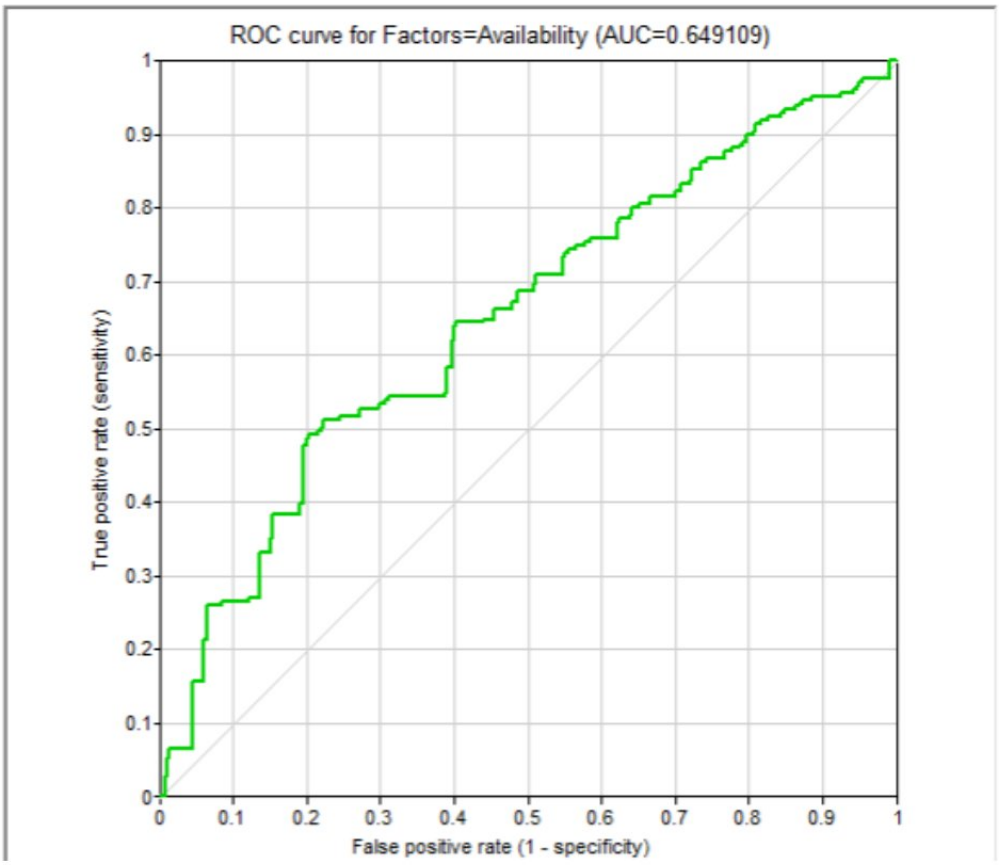


Figure 4: ROC curve (Trip purpose)



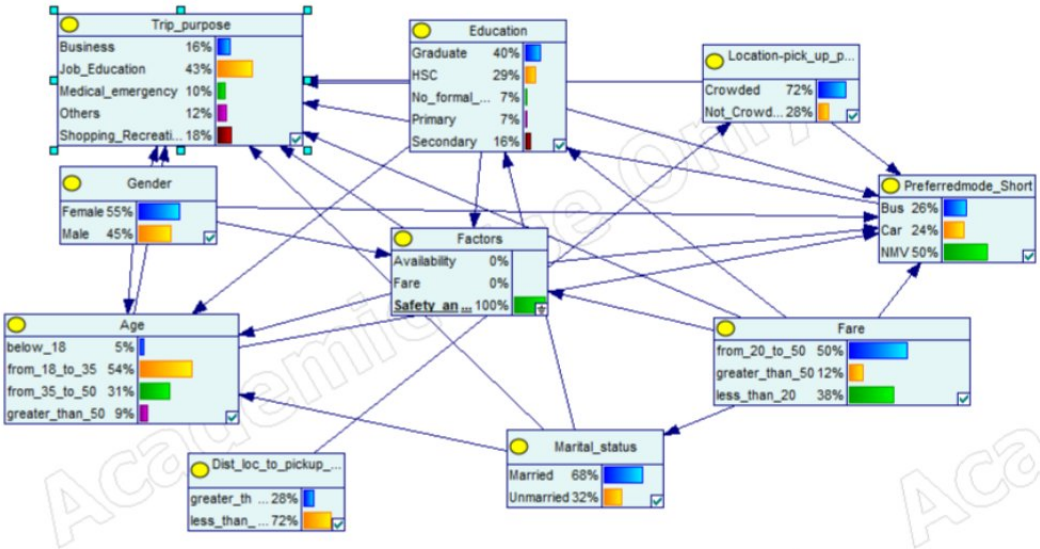


Figure 5: Setting safety and security as evidence

CHAPTER 5

5 Conclusion and Recommendations

5.1 Introduction

From the analysis, based on the factors affecting the mode choice from the study policy is recommended to address the issued relating to gender based mode choice. Through sensitivity analysis, significant variables were selected and correlation was established.

5.2 Major findings

Sensitivity factors such as age, income, level of education determines the mobility pattern of women as well as mode choice.

From the result analysis, we found that safety and security is the major concern while choosing any mode. Women tend to use non motorized vehicles for travelling shorter distances and the trip purpose dominating is education and job which denotes women empowerment and their tendency of becoming independent.

5.3 Policy Implications

Transport inequality is the result of "gender blind planning" which should be addressed through gender audits just like EIA report during the planning of transport infrastructure(Issue et al., 2021)

Creating time efficient mode doesn't necessarily improve accessibility of women mobility rather more flexible, less crowded and secured mode are to be considered for planning transportation facilities for women (Pablo et al., 2017)

Women who frequently needs travelling can drive motorbike themselves instead of using crowded public transport (Kawgan-kagan & Popp, 2018)

Public transportation waiting zone should be designed in such a way that female passengers can feel more secured with the presence of police enforcement (Chowdhury & van Wee, 2020)

Public transport can be build on road network of shorter distance where non-motorized vehicles can play role in ensure safe mobility. This can ensure sustainable development by creating separate walking lane, cycling lane with proper lighting system and monitoring body for ensuring their safety and security.

5.4 Limitations and future scope

Lack of inadequate datasets regarding bicycle riders and relevant datasets is one of the major drawback of this study. Future studies can be made to find out the active mode of transportation and their available scopes to implement them.

Discrete choice modelling can be implemented to find their mode choice based on trip distances.

References

America, N. (2021). *Transport in Europe : The impact of gender on the perceived value of travel time*. 1–9.

Badawi, S., & Aboelmakarem, A. (2021). Young Saudi Women ' s travel behavior change over 2015 / 2020. *Journal of Transport & Health*, *21*(May), 101080.

Baig, M. H., Rana, I. A., & Waheed, A. (2021). Case Studies on Transport Policy An index-based approach for understanding gender preferences in active commuting : A case study of Islamabad , Pakistan. *Case Studies on Transport Policy*, *9*(2), 600–607.

Chowdhury, S., & van Wee, B. (2020). Examining women's perception of safety during waiting times at public transport terminals. *Transport Policy*, *94*(May), 102–108.

Dilmaghani, M. (2021). The fast and the female : Gender differences in wellbeing and wage consequences of commute impedance. *Transportation Research Part F: Psychology and Behaviour*, *80*, 295–312.

Fu, X., & Juan, Z. (2017). Exploring the psychosocial factors associated with public transportation usage and examining the "gendered" difference. *Transportation Research Part A: Policy and Practice*, *103*, 70–82.

Garrard, J., Rose, G., & Lo, S. K. (2008). Promoting transportation cycling for women: The role of bicycle infrastructure. *Preventive Medicine*, *46*(1), 55–59.

Havet, N., Bayart, C., & Bonnel, P. (2021). Why do Gender Differences in Daily Mobility Behaviours persist among workers ? ☆. *Transportation Research Part A*, *145*(December 2020), 34–48.

Issue, T. S., Issue, S., America, L., America, L., & Bogot, E. (2021). *Editorial of special issue on ' transport , gender , culture . ' 144*(December 2020), 34–36.

Kawgan-kagan, I., & Popp, M. (2018). ScienceDirect ScienceDirect ScienceDirect Sustainability and Gender : a mixed-method of urban Estimating and visualizing perceived analysis accessibility women ' s mode choice with particular of e -carsharing to transportation and consideration urban facilities. *Transportation Research Procedia*, *31*, 146–159.

Khan, N. A., & Habib, M. A. (2021). Development of households' vehicle choice models for travel accompanying arrangements. *Transportation Engineering*, *4*(April), 100071.

Malik, B. Z., Rehman, Z. ur, Khan, A. H., & Akram, W. (2020). Women's mobility via bus rapid transit: Experiential patterns and challenges in Lahore. *Journal of Transport and Health*, *17*(610), 100834.

Mark, L., & Heinrichs, D. (2019). More than time and money - Influences on mobility of low-income women in the Villa 20 in Buenos Aires, Argentina. *Journal of Transport and Health*, *15*(December 2018).

Montoya-robledo, V., Montes, L., Bernal, V., Carolina, D., Molina, G., Pipicano, W., Javier, A., Pipicano, C., Segundo, J., Valderrama, L., Andrea, M., Porras, I., Arias, N., & Miranda, L. (2020). Gender stereotypes a ff ecting active mobility of care in Bogotá. *Transportation Research Part D*, *86*(88), 102470.

Natarajan, M., Schmuhl, M., Sudula, S., & Mandala, M. (2017). Sexual victimization of college students in public transport environments: A whole journey approach. *Crime Prevention and Community Safety*, *19*(3–4), 168–182.

Pablo, J., Bocarejo, S., Lecompte, M. C., & S, J. P. B. (2017). ScienceDirect ScienceDirect ScienceDirect Transport systems and their impact con gender equity Transport systems and their impact con gender equity b. *Transportation Research Procedia*, *25*, 4245–4257.

Policy, C. (2021). *Ridding transport of gender bias is no simple task Most decision-makers are white males , so what chance is there for others to have their hopes and fears properly represented ? asks Laura Laker*. 1–10.

Polk, M. (2003). Are women potentially more accommodating than men to a sustainable transportation system in Sweden? *Transportation Research Part D: Transport and Environment*, *8*(2), 75–95. Porter, G., Murphy, E., Adamu, F., Dayil, P. B., Lannoy, A. De, Han, S., Mansour, H., Dungey, C., Ahmad, H., Maskiti, B., Clark, S., & Weidje, K. Van Der. (2021). Women ' s mobility and transport in the peripheries of three African cities : Reflecting on early impacts of COVID-19. *Transport Policy*, *110*(February), 181–190.

Safe transport modes for women can only mean better connectivity / 14. (2021). 2020–2022.

Siren, A., & Hakamies-Blomqvist, L. (2006). Does gendered driving create gendered mobility? Community-related mobility in Finnish women and men aged 65+. *Transportation Research Part F: Traffic Psychology and Behaviour*, *9*(5), 374–382.

Wang, Y., & Yan, X. (2020). *Influencing Mechanism of Potential Factors on*

Passengers ' Long-Distance Travel Mode Choices Based on Structural Equation Modeling. 1–22.

Xu, J. L. (2020). Generational trends of gendered mobility: How do they interact with geographical contexts? *Journal of Transport Geography*, *82*(December 2019).