



An-Najah National University
Faculty of Graduate Studies

**MODELING MODE CHOICE BEHAVIOR OF
EMPLOYEES FOR COMMUTING TO WORK
IN RAMALLAH AI-BIREH GOVERNORATE**

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Dedication

I dedicate this work to the souls of Palestinians' martyrs who ascended during this war to their Creator, reaching the highest ranks of martyrdom in gardens of paradise; whose determination inspires generations; and to all the sons and daughters of my people in Palestine and the diaspora, who carry the light of hope and strength. And to my two, adorable parents that gave up everything precious and raised me from a child with love for knowledge, learning and shaping my character and guiding me on the path to success. To my dear wife Eng. Shorouq Salahat, my best friend and partner in life, for her continuous support and encouragement, the one who has been by my side through challenges, always pushing me forward in difficult times and laughing with me in good times. For my children, Yasmin and Elias, my life's joy and mission, I hope this sets will be an example for you to always follow your dreams and contribute to building a better future for our beloved Palestine. To my dear brothers who have been the back bone of my strengths; all my relatives whose prayers and joint efforts supported me laying a strong foundation of this platform, all respected teachers for guiding me toward academic excellence and all friends for supporting my academic journey with friendship, teamwork, and shared experiences, shaping me both as an individual and as a scholar.

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It is through such collaborative elements that nations are built.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

MODELING MODE CHOICE BEHAVIOR OF EMPLOYEES FOR COMMUTING TO WORK IN RAMALLAH AI-BIREH GOVERNORATE

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Date: 15-3-2026

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Abstract

Background: Mode choice is an important consideration in urban transportation planning, especially in developing countries. Transportations in the West Bank is affected by many challenges, including mobility restrictions, economic constraints, and limited public transportation. This motivated the study to understand how the employees, forming a large share of population, commute on the intercity level.

Aims: The goal is to analyze the patterns of employees' mode choice, examine the factors affecting mode choice behavior, understand mode choice for three periods: normal conditions (pre-7 October war), crisis conditions (post October 7 war), and COVID 19 pandemic, and propose policies for enhancing public transportation.

Methodology: A mixed-methods approach (quantitative and qualitative) was used. A survey was conducted utilizing a questionnaire distributed to a sample of 266 out-of-governorate employees commuting to Ramallah-Al Bireh urban area. Discrete choice models considering the multinomial logit modeling approach were estimated to understand mode choice behavior. Four transportation modes were analyzed: private car, shared car, shared taxi, and bus. The influence of extraordinary events on mode choice was analyzed through comparison over the indicated periods.

Main Results: Private and shared cars are the main modes for the targeted employees, accounting for 83% of trips, while public transportation attracted only a marginal share. The models for the crisis conditions and the normal conditions demonstrated good statistical fit levels. Mode choice is affected by travel time, cost, gender, marital status, and private car ownership. Participants' sensitivity to time and cost was reduced under

crisis situations, with a shift of focus from efficiency-seeking to reliability-seeking. They indicated a significant lack of public transportation service quality.

Conclusion: There is predominance of private car choice among available modes for intercity commuters, influenced by the ease of obtaining banking facilities and the inadequacy of public transportation services. Unusual events have a considerable impact on travel behavior, as travelers are willing to pay higher costs and longer times for more trip reliability. The results emphasize the necessity for adopting governmental policies support ridesharing and mass transportation, and the creation of reliable public transportation system.

Keywords: Mode Choice, Discrete Choice Modeling, Commuter Travel, Travel Behavior Characteristics, Public Transportation, Palestine, Ramallah-Al Bireh.

Chapter One

Introduction

1.1 Background

At the level of individuals moving from one place to another, transportation is a trip that begins at a starting point (the origin) and ends at a destination to achieve a specific goal. If transportation at the city or state level is considered, it is a collection of trips, where the related decisions are made by individuals, resulting in the transportation of individuals, mostly by vehicles, during specific times of the day. Therefore, the transportation system consists of the services and facilities that enable these travel movements to occur (Morlok, 2001).

The transportation planning process goes through several stages. These stages begin with setting vision and goals, developing and evaluating strategies, and end with implementing the system and monitoring and developing its performance (Alkafoury, et al., 2012).

The four steps of the transportation planning process consist of trip generation, trip distribution, mode split, and route assignment. The process of analyzing mode choice occurs in the third step after trip distribution and precedes the process of route assignment. The process of analyzing mode choice allows planners and engineers to determine the possibilities of travelers using a specific mode of transportation, which is called mode choice.

Mathematical models have been used to determine the demand for intercity or intra-city transportation since the 1960s. The quality and efficiency of these models have greatly developed since then until the present time. These have been used in a large number of countries. However, in the past, the lack of advanced mathematical models to determine the demand for transportation between cities, forced the concerned authorities to use primitive and simple methods to determine the demand for transportation. The disadvantages of these simple methods are not limited to the inaccuracy of their results, but they also do not enable to evaluate policy scenarios expected, or that decision-makers wish to study. Perhaps this last point represents one of the main advantages of using mathematical models, which makes providing quick answers to some scenarios relatively simple.

There are many studies that deal with building and developing models for intercity transportation. Since the mid-1960s, many research efforts have been conducted that aimed at developing models for travel demand between cities. These models can be divided into two types; aggregate models and disaggregate models.

In the aggregate models, the construction of models relied on average values of independent variable (s) when calibrating the models. These models depend on the assumption that choosing travel modes do not depend on the mode only, but rather on the characteristics of the potential modes of travel, such as the level of service, the cost and travel time of each of these modes. The models showed the important factors for the traveler in choosing the modes of travel (Al-Ahmadi, 2006)

Aggregate models were often classified according to trip purpose was necessary when building the model for choosing the modes for transportation between cities. It was found that there had been shortcomings in the performance of the aggregate models, because they use average values before calibrating the models. This leads to loss of information about the variation in the data, and therefore to decrease in their explanatory power. Another shortcoming in the performance of these models is that the relationships are based on the average social and economic data in a given area does not necessarily represent the individual behavior of the commuters in that area (Al-Ahmadi, 2006).

The shortcomings in the performance of aggregate models were avoided by using disaggregate models, which rely on data of the individual commuters when calibrating these models. Disaggregate models have been widely used to predict the desires of inter-city and intra-city commuters. Watson (1974) compared the explanatory power of aggregate and disaggregate models. It was found that the accuracy in predicting the choice of modes of transportation with the disaggregate model exceeds that with the aggregate model by 12 to 15 percent.

Disaggregate models represent individuals' decisions and are characterized by efficient use of data. These models are based on the theory of maximum utility, where it is assumed that the commuter makes the decision to choose the mode of transportation among those available to him/her is based on the maximum benefit he/she finds in the chosen modes of transportation.

In Palestine, research on mode choice remains relatively limited, particularly considering the distinctive challenges which the travelers encounter, including mobility restrictions and economic difficulties. Most research conducted on transportation planning aspects in Palestine pays little attention to analysis of travel behavior, including mode choice, despite the importance of studies in this field on enhancing mobility and the provision of more reliable and sustainable transportation.

1.2 Significance of the Research

It has been observed in Palestine that the number of private vehicles and their ownership have increased, which could have been influenced by the ease of obtaining bank facilities to purchase cars, especially for government and private sector employees. One of the reasons for owning cars is to use them to travel to their workplaces, mainly due to the lack of regular and comfortable public transportation that connects their places of residence and those of work, in addition to the relatively high fare for public transportation. Recently, it has been observed that groups have spread on social media sites promoting the use of car sharing. These are groups in which individuals announce their desire to travel from one place to another at a specific time, and any employee or person who owns a private car can take them and share the fuel costs.

This study will focus on the choice of the mode of transportation by government and private sector employees heading to their workplaces in Ramallah-Al Bireh urban area from outside the governorate.

There is a gap in scientific research in Palestine with respect to use of advanced mathematical models to understand how people decide which mode of transportation to use. There are not enough studies in Palestine that explain how people travel and the real reasons behind their choices. This highlights the significance of conducting transportation planning studies based on models that reflect the unique conditions in Palestine. Without the use of proper models, planning efforts are less effective. This study is designed to address this gap by creating proper models that will provide evidence-based recommendations and future transportation policies.

The governorate of Ramallah-Al Bireh is chosen because it includes a large number of Palestinian ministries and governmental institutions, as well as private sector enterprises, and is considered as the temporary administrative capital of Palestine. Many of the

employees in these institutions and enterprises come from all areas of the West Bank, while they have their destination in the governorate of Ramallah-Al Bireh. Therefore, this study will analyze the current situation of mode choice behavior, focusing on the employee's choice of their modes of transportation. This is considered one of the important aspects that needs to be deeply understood in order to know the factors that affect the process of choosing a mode of transportation, and, as a result, to effectively contribute to sound future planning of transportation systems.

This study provides a basis to understand and analyze the factors affecting on the employees to choose certain mode of transportation. By modeling this behavior, the study highlights the observed dependence on private and shared cars, which has contributed to the increase in car ownership and traffic congestion in Ramallah-Al Bireh Governorate.

1.3 Research Objectives

The main objectives of this research in the context of mode choice for out of governorate employees traveling to their destinations in Ramallah-Al Bireh Governorate are:

1. To review and analyze the current situation of employees' transportation mode choice used.
2. To identify the key factors influencing employees' transportation decisions to choose the mode of transportation used.
3. To develop a database and construct a predictive model that represents the current passenger mode choice.
4. Identify recommendations that can be made regarding the extent of use of public transportation and the traffic congestion observed in the cities of Ramallah-Al Bireh.

1.4 Development of Transportation Mode Choice Models

– Aggregate and Disaggregate Models

In the early stages of transportation mode choice studies and until the late 1970s, planners and engineers heavily relied on aggregate models to forecast travel demand and assess the significance of influencing factors in mode selection (Barff et al., 1982). These models primarily focused on the mode choices of average individuals traveling between different geographical zones. However, Domencich and McFadden (1975) identified several shortcomings in this approach:

- Aggregate models lack behavioral insight, merely replicating survey results without offering guidance on how travel decisions might change under different circumstances or in the presence of competing alternatives.
- Apart from mode choice, these models are not policy-oriented, often excluding variables within the control of policymakers and applying them mechanically, if at all, in trip distribution functions.
- They rely on data aggregated at the zone level, which obscures valuable information and, combined with the absence of a behavioral framework, makes generalization across cities challenging.

Due to the limitations of aggregate models, researchers began to shift towards developing "disaggregate models" as a solution. These models have gained popularity since the 1980s and offer significant advantages over aggregate models while remaining practical for many applications (Ortúzar and Willumsen, 2011). In disaggregate models, data are gathered at the individual or household level, with parameters estimated across individuals or households in a sample or subset of the population (Barff et al., 1982). Adopting the disaggregate modeling approach could enhance the precision of parameter estimates and allow for a broader range of explanatory variables (Ben-Akiva and Lerman, 1985). Among disaggregate models, discrete choice models are frequently utilized for modeling travelers' mode choice. Next, the theoretical framework of discrete choice models is presented, followed by an introduction to two of the most representative models in this category.

– **Discrete Choice Models**

In discrete choice models, the likelihood of individuals selecting a particular option is typically modeled as a function of their socioeconomic characteristics and the perceived attractiveness of each option (Ortúzar and Willumsen, 2011). The predominant theoretical framework for discrete choice models is random utility theory (Domencich and McFadden, 1975), which posits that travelers aim to maximize their utility when making decisions.

In discrete choice modeling, utility equations are constructed to estimate the overall utility associated with traveling by a specific mode, taking into account relevant influencing factors as discussed earlier. To predict the probability of an individual opting for a specific travel mode, the utility of that mode for the individual is translated into a probability

distribution using mathematical functions such as logit models (Ortúzar and Willumsen, 2011). Logit models, particularly binary logit and multinomial logit models, are widely employed in transportation mode choice analysis (Ben-Akiva and Lerman, 1985). These models, briefly introduced hereafter, vary based on the number of potential outcomes for the dependent variable.

The binary logit model is a logistic regression model used when the dependent variable has only two possible values. In practical applications, researchers utilize the binary logit model to examine the factors influencing travelers' choice between two modes. For example, a study conducted in Metro Manila, Philippines utilized the binary logit model to assess the probability of residents selecting public transport over private transport, considering four distinct factors (Doroy et al., 2016). Similarly, Winn (2005) employed this model to identify the most influential factors leading travelers to select for casual carpooling over public transit in Houston, Texas. The analysis revealed that commuters were more inclined towards casual carpooling.

The multinomial logit model is often viewed as an expansion of the binary logit model, as it accommodates more than two potential outcomes. Additionally, other logit models exist, including the nested logit model and the conditional logit model.

1.5 Literature Review

First, a thorough review and discussion of the current literature and related past studies in terms of factors that affect transportation mode choice was conducted. In order to substantiate the theoretical construct and contextualize the current study, a literature review was carried out that included scholarly articles, scientific journals, conference papers/articles and other significant publications available online.

The review is organized to include different socio-economic contexts and geographical distributions of the examined studies in three main subsections studies in developed countries, developing countries, and Palestine. This multi-level approach accommodates a comparative analysis which brings out general trends as well as variables pertaining to the context that analyzes how the choice of transportation mode is done, and how decisions of travelers regarding transportation mode choice are made.

– **Developed Countries**

Ali et al. (2025) examined the factors influencing users' transportation mode choice in the UK when using the "Breeze", which is a Mobility-as-a-Service (MaaS) application that integrates different transportation options into a single platform. By analyzing actual user data using polynomial logistic regression models, the study intended to identify characteristics that distinguish users who prefer a particular mode of transportation. The analysis showed that students were the segment most likely to use public transportation and shared transportation via the app, while employees and retirees were less likely to do so, which may reflect their habituation to the private car. Car ownership was also found to be the strongest factor reducing the likelihood of using public transportation. The study's significance lies in the fact that it provides direct insights from users of actual MaaS platforms and concludes that these applications do not appeal to all segments of society equally, requiring designers and policymakers to develop customized incentives and services targeting segments that still rely on cars.

Akter and Alam (2024) conducted a comprehensive study of mobility choice behavior within the University of Toledo, Ohio in the USA, involving students, staff, and faculty. The study utilized comprehensive questionnaire data and multinomial logit models in order to portray variables that influence the choice of means for accessing and moving within the campus. The results showed that owning a private vehicle is the strongest determinant of behavior, in addition to the trip distance, which clearly increases car preference. Moreover, age and gender have also been shown to influence, where females are less likely to use bicycles but tend to walk more than males. Students use more active modes than employees, who rely more on cars. The study showed a drop in the use of public transportation within the campus due to its weak infrastructure. It recommended that to enhance sustainable mobility behavior and reduce the use of private vehicles, there is need for improvement of walking and cycling infrastructure along with efficient indoor transport stations, and implementation of paid or limited parking.

Makkonen et al. (2024) analyzed massive data from 10,983 Finnish public sector employees to develop a multifactorial predictive model of mobility choice behavior. The study used a combination of statistical models and advanced predictive models to identify the most influential variables in the advanced European context. Researchers found that distance to work was the most prominent factor, followed by having a vehicle, age, health

condition, and the nature of the job. The results also showed that older, more functionally stable employees prefer the car. Good health is associated with an increased likelihood of walking or cycling. The resulting model demonstrated excellent predictive ability in advanced infrastructure environments. The study shows that behavioral factors and personal habits are no less important than spatial variables. It also recommended using the model to support policies to encourage public transportation and financial support for active means.

Lodi et al. (2024) analyzed mode choice behavior of Urbino University students in Italy using mixed multinomial logit models (MMLM). Results indicated that distance from residence and the cost of the trip were among the most influential factors on transportation mode choice, though the Covid-19 pandemic did not fundamentally influence transportation patterns. The study confirmed the importance of individual characteristics and trip characteristics in modeling university mobility trips in developed countries.

Yanar (2023) investigated the factors that affect individuals' choice of sustainable transportation for daily trips to work in five main US cities (San Francisco, San Diego, Los Angeles, San Jose, Sacramento) using National Household Transportation Survey data and Binary Logistic Regression models. The results showed that personal factors, traffic environment, and distance to needed to commute work centers are significant players in the preference between using private cars and sustainable options such as walking and public transportation, with the importance of these factors varies from one city to another. The study suggests that local policies should be designed to suit the contextual characteristics of each city to in order to encourage the transition to more sustainable transportation.

Ferreira et al. (2022) conducted a study about the analysis of the mobility preferences of travelers in Germany during the initial stages of the COVID-19 pandemic using a three-wave questionnaire and a Conditional Logit model to assess the responses of approximately 4,800 respondents. The study revealed that the confidence of passengers in public transportation has slowly recovered after the pandemic's declines, but at very low rate. They also discovered that reducing the passenger ticket fares of public transportation to the least cost possible would be the most effective strategies for recovering users who shifted to private cars or other alternatives. The study highlights the

importance of policies supporting public transportation in promoting its use for work mobility in developed countries.

Deka and Carnegie (2021) conducted a study on predicting transit mode choice of New Jersey workers commuting to New York City. This study examines the preferences for choosing a transportation mode system for passengers traveling from New Jersey to New York City in order to evaluate the maritime transportation service across the Hudson River based on the variables that affect the choice of transportation system. The researchers used MMLM with random coefficients to analyze the data. The study took into account four transportation systems: ferry, train, bus, and rail which can be used to cross the Hudson River to get from New Jersey to New York City. The research results indicated that commuters' choices are not affected by travel time and trip cost, but rather are greatly influenced by comfort, reliability, and access cost from home to stations before crossing the river.

Ruiz-Pérez and Seguí-Pons (2020) conducted a study of transportation patterns in relation to various social and regional variables on the island of Mallorca, Spain. The study showed that choosing a mode of transportation is affected by a wide range of factors such as age, gender, profession, reason for the trip, duration of the trip, and place of residence. The results of the study indicate that private vehicles are the most chosen means of transportation, as private vehicles are used by working men between the ages of 30 and 44 years for trips between home and work that do not exceed 30 minutes. Sustainable public transportation is little used, mainly by young people, women, and retirees for work purposes and access to health and educational centers.

Yu (2018) conducted research on understanding the choice of intercity transportation mode for university students with a case study of the travel behavior of University of Waterloo students between the Waterloo region, Greater Toronto, and Hamilton in Canada. The researcher selected 12 factors to analyze the travel behavior of university students. The factors were divided into three groups: social and demographic characteristics of the travelers, trip characteristics, and characteristics of the transportation facility. The researcher chose the binary logit model to use in this research. The binary logit model determined the importance for the selected factors, which show that whether or not the presence of a transportation fare payment card and the availability of a car are the two most influential socio-demographic factors. University students'

residence locations and their level of study also have a significant impact on their choice of mode. In addition, travel time is the only factor that belongs to the group of trip characteristics that have a strong association with university students' choice of transportation mode. The results show also that nearly half of the students have positive attitudes towards using high-speed rail.

– **Developing Countries**

Gunn and Deinne (2025) carried out the study of mobility choice in coastal communities in Yinyagua, Nigeria, focusing their attention on gender disparities. They used questionnaires and a binary logistics model in checking the influence of factors such as vehicle ownership, safety, distance, and sex. From the findings, it was observed that men are likely to use cars and motorcycles, while females prefer public transport due to safety and distance. Vehicle ownership has been a strong factor in increasing private car reliance. For women, safety was of essence, given that risks affect the type of means chosen. It was also realized that with an increased distance to work, the probability of using faster or special means is increased. The recommendations were to consider gender difference in designing transportation, provision of safe means for women, improvement in public transport infrastructure, and awareness creation on sustainable transport and road safety. This indicates that it is important to design transportation policies which consider social and environmental disparities of developing cities.

Noman et al. (2024) studied Karachi in Pakistan to analyze how people commute in case of poor infrastructure and low-quality roads. They used field surveys and traffic data from key corridors. They found that public transport had a low share, 16%, because of the limited efficiency, long journey time, and safety. The major factors of influence identified include income, comfort, availability of means, and safety. They established that residents are willing to shift to public transport provided the level of service improves, especially waiting time and reliability. Infrastructure gaps were also established as lack of sufficient frequency and bus route regularization. Expansion of high-quality bus networks, interchange stations, and active transportation programs like walking and cycling were recommended in this study. The researcher further reiterated that there is a need for institutional reforms to improve confidence in public transport. The paper is thus an excellent example in developing cities which are experiencing a rapid urban transformation.

Deneke et al. (2024) used the multinomial logit model to analyze daily trips to work and school in a medium-sized Ethiopian city. Family income, in-vehicle time, wait time to get to the vehicle, cost, and comfort level all were examined for their impact on the formation of behavior. The study's results indicated that low-income individuals tend to use walking or low-cost travel modes, while middle-income classes prefer to use shared public transport. It also showed that improving waiting time and reducing costs can significantly change market shares. In addition, the study showed that lack of frequency, noise, and insecurity reduce the attractiveness of buses. The study recommended developing an updated public transport fleet, providing regular-frequency bus routes, and improving waiting stations as short-term solutions. It also proposed introducing electronic payment systems and regulating routes. The study is suitable as a reference for developing cities with limited resources.

Fan et al. (2024) researched the choice of public transportation in the mountainous city of Lanzhou in China, which complicates transportation access. They had data from questionnaires and merged the individual characteristics with determinants of the built environment and psychological factors, taking into account models inspired by the theory of planned behavior. The most important variables of influence that appeared were time inside the vehicle, walking time to arrive, personal perception of comfort and safety, and impression of the quality of service. It has also been demonstrated that poor comfort or congestion inside the buses discourages the shifting away from the vehicle. However, this suggests that basic enhancements like reducing waiting time and providing comfortable seating could even significantly boost public transportation in cities burdened with difficult geography. Recommendations included reinforcing the walking structure, expanding bus routes, and offering users instant information through applications. Additionally, encouraging awareness campaigns would build confidence in public transportation. The study acts as a powerful model for developing urban centers burdened with geographical challenges.

GAO & Zhao (2024) study aimed at depicting the changes in mobility habits of workers in Beijing during and after the COVID-19 pandemic and its influence on the environment. In this modern study design, the researchers drew upon mobile phone monitoring data over a long period, from April 2018 to November 2023. It was found that public transportation usage decreased sharply during the pandemic, while those who depended

on public transportation opted for using a private car or active modes of transportation such as walking and biking. In the post-pandemic phase, public transportation regained its speed but, at the same time, dependence on private cars continued, and the possibility of public transportation passengers shifting to private cars increased. In the pandemic-free phase, signs of private car dominance have emerged, whereby some driving habits started to take hold, and some people who were using active means of transportation have switched to cars, which indicates a decline in the opportunity to encourage low-carbon transportation. The researchers discussed through it the challenges and opportunities for the transportation system in Beijing, presenting policy recommendations and possibilities for further research.

Ashraf et al. (2023) aimed to identify the major factors affecting transportation choice behavior among Nizwa University students in the Sultanate of Oman through a questionnaire that included 157 students and the use of a binary logistic regression model. The results indicated that gender, personal car ownership, and travel distance are all factors that have an important impact on the choice of modes, as increasing travel distance and presence of females reduce the probability of choosing a private car. The analysis also showed that car ownership reduces the probability of choosing bus, reflecting students' preference for private cars when available.

De Oliveira and Lima (2023) conducted a study in Itajubá, Brazil, which aimed to analyze transportation choice behavior among residents using field questionnaires that collected demographic, economic, and temporal data on trips and preferences. The multinomial logistic regression model was employed to examine the significance of various factors in influencing the use of different modes of transportation (public transportation, private cars, walking, and bicycles). The findings indicated that the use of public transportation for work and study is positively correlated with transportation vouchers, distance to the center of the city, and ease of access to transportation systems, while its use is less with owning a car, and displeasure with fares and bus schedules. The study is theoretically consistent with previous literature, suggesting that public transportation is not the main option due to car ownership, poor user satisfaction, low income, and access difficulties. In practice, the study recommends that public transportation providers and government agencies improve service quality, support tariffs, and facilitate access to promote sustainable mobility and achieve community benefit.

The Kingdom of Saudi Arabia has completed a sustainable public transportation system project called the Riyadh Metro. Youssef et al. (2021) conducted a study that explores users' potential perceptions of metro services and the factors that may limit their inclinations to use the metro, and to understand the trade-offs and advantages that individuals make when faced with a combination of mode characteristics, such as travel time, cost, and walking time. The researchers developed a discrete choice model based on binary logistic regression. It was found that the coefficient of travel attributes that include travel time, fuel cost, metro fare, and walking time are important with varying influence on the mode choice. The coefficient elasticity showed that increasing the price of fuel by 10% would increase metro ridership by 5.3% and reduce dependence on the car. Reducing the walking time by 5 minutes to the metro station will increase the metro ridership by 22%. In addition, the study found that implementing 1 SAR per hour as a parking fee will reduce dependence on the car by 14%. Increasing the metro fare by 10% will reduce metro ridership by 6.9%. The socio-economic factors coefficient appears to have marginal influence on the choice decision of passengers.

In another study, Al-Ahmadi (2006) developed models for choosing the mode of transportation at intercity in Saudi Arabia. These models described that the travel time in the vehicle, the out-of-pocket cost, the number of family members traveling together, the monthly income of the household, the travel distance, the nationality of the traveler, and the number of cars owned by the family, all played an important role in the decisions related to choosing the intercity mode of transportation. These models were considered to be useful in demand forecasting analysis for Saudi Airlines and the Ministry of Transportation. Therefore, the study conclusion helped public transportation agencies and transportation sector operators to make proper decisions and to prevent under or over-design of their facilities.

Al-Ahmadi et al. (2005) conducted another study on developing a model for intercity bus transportation in Saudi Arabia. The study aimed to determine the requirements and responsibilities for creating an information base for intercity transportation and developing a model for intercity transportation by buses. This model was intended to be used to determine the future demand for this service and the elasticity coefficients of the variables. The results include the various dimensions for determining the requirements for developing transportation models, which include the variables required to calibrate

the models and methods for obtaining them. The research identified the appropriate calibrated mathematical models, and the entities responsible for creating and developing the information base and model standards and the role of each of them.

Obaid and Hamad (2020) developed and used a multinomial discrete logit choice model to evaluate the proportion and probability of commuters at the University of Sharjah, UAE, considering available modes of transportation; car, private bus, and public bus, taxi, walking, and biking. They found that travel time, travel distance, characteristics of trip makers (gender, citizenship, car ownership, car sharing, the number of cars owned by the household), and other contributing factors, such as weather conditions, suitability of infrastructure, level of quality of bus services, are all major factors that fundamentally and importantly affect the choice of transportation mode at the University of Sharjah. The model which the researchers developed can be used for future studies to predict the demand for travel for the university students in order to find appropriate solutions and policies that the university and transportation agencies should implement.

Alkaabi (2019) developed a binary logistic regression model to assess the choice of ground transportation mode by users of Dubai International Airport, focusing on the mixture between private vehicles and public transportation (taxis, limousines, bus network, Dubai Metro) using information and data collected specifically for this study. The result of the model show that the mode of transportation choice is mainly influenced by the socio-economic characteristics of travelers, including income, nationality, family size, vehicle ownership, and trip characteristics, including the number of passengers and how air travelers typically use public transportation in their countries.

– **Palestine**

Al-Sahili & Sadeq (2003) studied the intercity bus ridership demand in the West Bank, which was aimed at evaluating the service provided and forecasting future demand. The research established a linear regression model relating the demand for ridership with various variables, including socio-economic and service variables. The variables were origin and destination population, fare, as well as percentages of employees and students. The research revealed that service variables and socio-economic variables both play an important role in influencing public transportation demand. The research also indicated that it is possible to forecast ridership demand using this model.

Al-Sahili & Sadeq (2004) studied the elasticity of demand for intercity public transportation in the West Bank using questionnaire-based data from users of buses and shared taxis. The research revealed that public transportation demand, especially for buses, is highly responsive to fare changes, having an elasticity of about -1.83, while for shared taxis, it was positive. Travel time, waiting time, and service characteristics were established as important determinants of mode choice behavior. The research revealed that many users would switch modes depending on fare and service improvements, especially for frequent users like employees and students. The research established several recommendations, including improving bus services, reducing waiting time, and improving service quality in order to increase public transportation usage.

Almasri & Alraee (2013) studied the work trip mode choice behavior of employed people in Gaza using a discrete choice modeling technique. The results revealed that travel time, cost of travel divided by income, vehicle ownership, age, distance, and income are significant factors in mode choice. In contrast, gender and out-of-vehicle time were statistically insignificant and were dropped from the model. The model was proved to have good prediction power at a confidence level of 95%. The research suggested using the model for planning, encouraging non-motor modes, and conducting future research on other trip purposes and using different modeling approaches.

Abdulhaq (2016) developed a model for choosing transportation modes to predict the utility function of transportation modes used in Palestinian universities, taking the largest university in Palestine, An-Najah National University-New Campus, as a case study. The researcher analyzed the current situation to choose the mode of transportation used by university students. The result of the analysis of the current situation was that there are three basic modes of transportation. The first mode is the private car, which is preferred by students who owned private cars. The second mode is the shared taxi, which is the most widely used mode compared to the other modes. The third mode is bus, which is a rarely used mode. The variables that most influence the choice of transportation mode in this study are gender, car ownership, per capita household income, the cost of traveling by shared taxi, and travel time by bus. The researcher indicated that people who own private cars prefer to go to university using them instead of using public transportation. The results of the study indicated that the higher the monthly income of the household,

the greater the use of the private car, and that students prefer using private cars over buses and shared taxis because they believe that private cars are safer and more comfortable.

The National Transportation Master Plan of Palestine (MOT, 2016) considered the choice of mode of transportation in the study, which was influenced by an associated set of structural and behavioral factors, mainly travel time, cost, and ease of access, in addition to the restrictions imposed on the transportation network. The plan considered national multimodal transport model based on travel demand analysis, taking into account demographic and economic characteristics and growth scenarios, which was used to estimate current and future mobility patterns. It also illustrated that spatial and political constraints imposed on the network which cause distortions in transportation choice patterns and limit individuals' ability to choose more efficient alternatives. The plan emphasized the role of enhancing public transportation and integrating different modes in shifting individual behavior to more sustainable transportation options, by minimizing travel time and increasing service reliability. The analytical framework was used to examine potential changes in transportation choice if the network is enhanced or restrictions are eliminated.

The plan is a major strategic reference concentrating on the analysis of the mode choice model, which is one of the main pillars in the four-step modeling framework for estimating transport demand in Palestine up to 2045. The report simulated passenger behavior in a trade-off between four main modes, including private cars, shared taxis, and public transit (buses and future trains). The methodology depended on deriving travel time and operating cost values based on international standards and matching them with local demand characteristics to guarantee accurate prediction of the distribution of trips between different modes, while analyzing the impact of enhancing the services of public transportation services and eliminating traffic restrictions on changing user behavior.

The results of modeling for the base year (2015) indicated a clear dominance of private cars at 60.0% of total trips, followed by taxis at 19.7% and group taxis at 16.3%, while public transportation recorded the lowest share at 4.0%. Through future scenarios, the report expected a gradual shift in mobility patterns (modal shift) as a result of investments in infrastructure, as the share of public transportation is estimated to rise to reach 7.7% by 2045, compared to a slight decline in reliance on private cars to reach 57.8%. The scientific value of this reference lies in its provision of accurate quantitative data on the

share of each mode, its link between economic and social variables, and its prediction of shifts in mobility patterns to support the sustainability of the transportation sector and reduce reliance on private vehicles in the national network.

In summary, the presented literature and the reviewed previous studies assisted in determining the key factors impacting mode choice, such as cost, travel time, and socio-economic characteristics. It also offered a better understanding of the followed methodologies, particularly through the utilization of proper models like multinomial logit. Additionally, it assisted in identifying the gap in applying such models in the Palestinian context under constrained situations, which this study seeks to address.

1.6 Thesis Structure

This thesis is organized into four main chapters. Chapter one introduces research background, research significance, research objectives, and relevant literature. Chapter two describes the research methodology, including data collection, design designing the questionnaire, pilot study, study community, sample size calculation, pilot study, and quality assurance measures. Chapter three presents data analysis, model estimation results, and discussion. Finally, chapter four draws the conclusion and provides recommendations.

Chapter Two

Methodology

2.1 Introduction

This chapter presents the study population and sample, the study questionnaire, and the analysis plan. After the theoretical background and literature review presented in the previous chapter, this chapter is a logical continuation through presenting the methodology and data collection process, which serves as the foundation for results analysis and discussion in next chapter.

First, the chapter describes the research context by explaining the methodological approach, identifying the case study area, and introducing the study community and sample, as well as the study tools. After illustrating the methodological approach, it proceeds to clarify data collection, including the design and execution of the survey, the pilot study, and the final structure of the questionnaire considering the pilot study outcome, sample size calculation justified to guarantee statistical efficacy, statistical sampling strategy, and field data collection tactic. After that, the chapter describes the research modeling approach as well as validation of the resulting models.

2.2 Methodological Approach

The study used a mixed methods approach, quantitative and qualitative, in order to obtain an overall understanding of the phenomenon under inspection. In this context, the geographical focus of the research was determined, and the needed data and information were identified and collected, whether from primary or secondary sources. Data analysis was conducted and the resulting models were identified, calibrated, and validated. This was the basis to derive the findings and identify the conclusions and recommendations.

The approach considered potential variables that might affect mode choice. The first type of variables were related to the traveler personally, where the economic and social conditions might affect the choice of means of travel, including income, car ownership, driver's license, age, nationality, group size, number of family members, and population density. The second type of variables were related to the level of service of the modes of transportation that might affect the traveler's decision, including travel time inside the vehicle, departure time, arrival time, waiting time, total travel time, travel cost, and other variables specific to the modes of transportation such as (comfort, privacy, reliability,

safety). The last type of variables were trip-specific variables, including purpose of the trip, length of stay, distance of the trip, and time of day to take the trip.

Finally, the approach included illustration on how the model choice models were constructed and validated using appropriate modeling tools. It also included setting the validation procedure to ensure that that estimated models reasonably replicate the actual travelers' choices.

2.3 Identifying the Case Study

The study considered work trips from the various governorates of the West Bank to their work place destination within Ramallah-Al Bireh Governorate, situated in the central part of the West Bank, located at 18 km to the north of the capital of Palestine "Jerusalem". The study area was chosen as it serves as an important political, administrative, and economic core of the State of Palestine. It is the home to many government agencies, international organizations, non-governmental organizations, and major companies, all having a large number of employees commuting from outside the governorate. Therefore, the consideration of the case study captures inter-government work commuting travel pattern, which presents a good sample to analyze mode choice at this level and for such purpose.

2.4 Defining the Study Area

Administration in the West Bank and Gaza Strip was established under the framework of Oslo Accords, which resulted in the establishment of Palestinian National Authority (PNA) in 1994. As a result of this agreement, the area was administratively divided and structured into governorates as presented in Figure 1. Since it was created, the PNA's administrative body expanded rapidly. It started with 19 ministries and government bodies in 1994 and has extended to around 50 ministries and government institutions today.

Ramallah-Al Bireh urban area serves as the de facto administrative capital of Palestine, receiving a large percentage of the government employees who are coming from various parts of the West Bank. Due to such status, many Palestinians working for the Palestinian government commute to it. It has become attractive to thousands of people who work in its official institutions or private enterprises. Besides, Ramallah-Al Bireh urban area accommodates most government offices, they also attract many of large companies in the

private sector. The offices of key government and corporate are situated throughout city of Ramallah-Al Bireh urban area such as Al Masyoun district, which has a special importance as it includes the central government complex and the Palestinian Council of Ministers. This mix of government and business activity makes the area an important center not only employment, but also for public demand for services, where many people visit the city every day.

2.5 Identifying Study Community

The study community for this research, or the "target population", is employed individuals in both public institutions and private enterprises with a daily commute to Ramallah-Al Bireh urban area. It is decided to focus on this group because of its massive daily commute pattern.

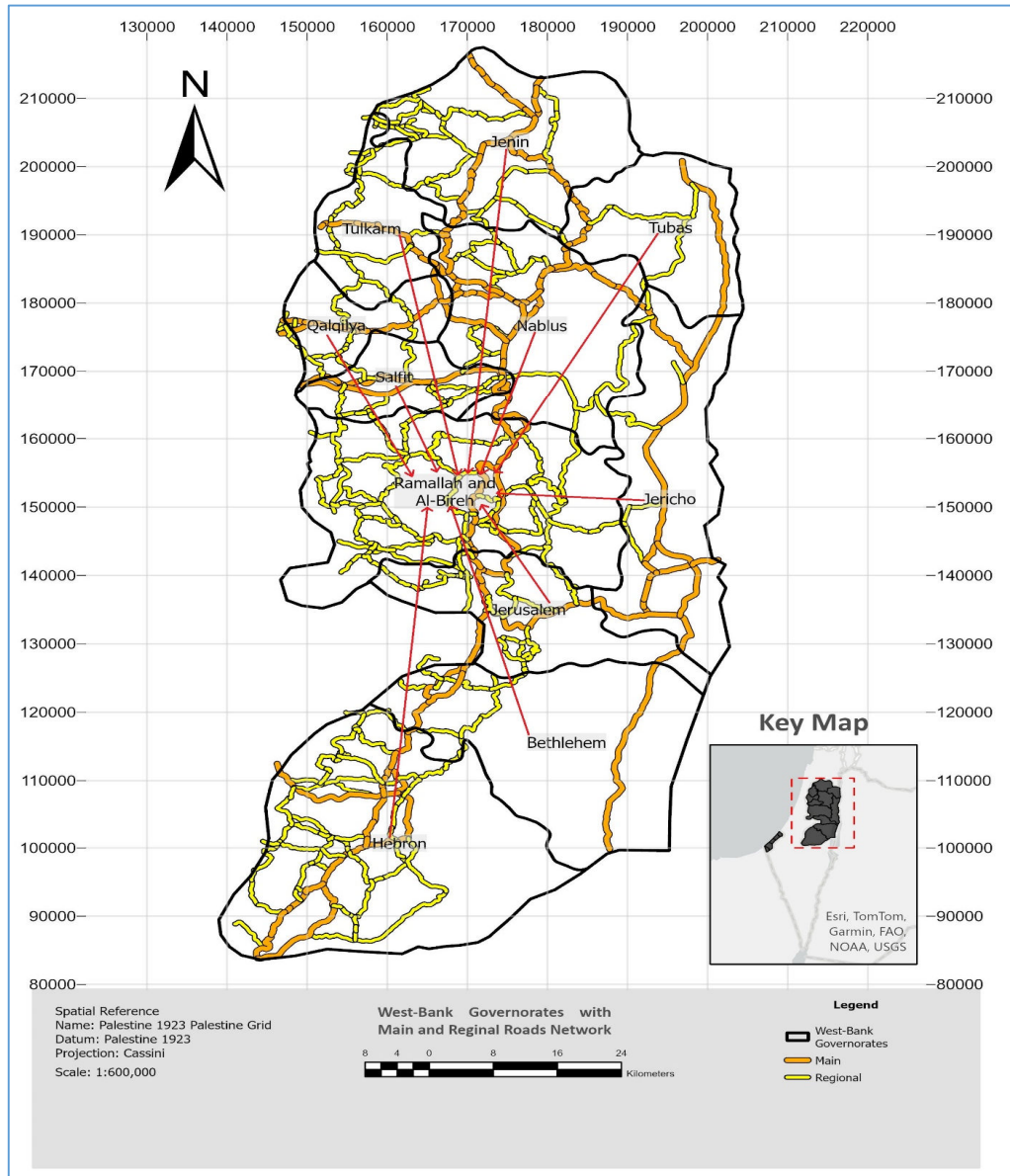
The focus on the employees who travel to their work daily can be explained by several reasons. First, their travel habits occur daily and regularly, making it easy to capture and understand their travel choices. Second, their trips are mainly for work, which allow to analyze them by concentrating on a clear purposes and reasons of the trip. Third, their different socio-economic characteristics, place of residence, and jobs provide a clear picture of the general travel behavior of these employees. Therefore, tracking these regular work trips is very important for modeling the employee mode preferences and understanding their actual mode choice behavior.

2.5.1 Government Sector Institutions

From the government sector component of the sample, five major ministries were chosen to represent various public sector institutions, in order to have diversity in the professional position and employment characteristics of the surveyed employees. The selected ministries, the total number of employees, and the number of employees commuting to Ramallah-Al Bireh urban area from other West Bank Governorates, are as follows:

Figure 1

Map of West Bank Governorates showing road links connecting to Ramallah-Al Bireh



1. Ministry of Education and Higher Education: it is the largest Palestinian ministry in terms of manpower, with 42,092 workers across the West Bank. Out of this total, 3,652 employees work at Ramallah-Al Bireh headquarters. Out of those, 1,198 workers travel to work in Ramallah-Al Bireh headquarters from other governorates.
2. Ministry of Public Works and Housing: There are total 355 employees in the West Bank. Out of this total, 220 employees work at Ramallah-Al Bireh headquarters, among them 83 who commute to the study area from other governorates
3. Ministry of Local Government: There are 341 staff working in the West Bank. Out of this total, 157 employees work at Ramallah-Al Bireh urban area. Out of those, 57 travel

daily from other governorates to commute and work in Ramallah-Al Bireh headquarters.

4. Ministry of Agriculture: It has a staff of 1,260 employees in the West Bank. Out of this total, 243 employees work at Ramallah-Al Bireh urban area and 90 of those commute to Ramallah-Al Bireh headquarters from other governorates
5. Ministry of Health: This ministry has 9,219 staff members in the west Bank; 1,662 of those work at Ramallah-Al Bireh urban area headquarters, and 30 of those commute from other governorates to work in Ramallah-Al Bireh headquarters.

2.5.2 Private Sector Institutions

From the private sector, enterprises have been chosen from the two major economic sectors in Palestine, which are the banking sector and the insurance sector. The selection of these sectors was based on their importance to the Palestinian economy and because they demonstrate a corporate working conditions that differ from public sector, thus offering an opportunity to compare with. The headquarters for such enterprises are located in Ramallah-Al Bireh urban area, with a share of employees' community from other governorate.

– The Banking Sector

The sample selected from five major banks. Below is the breakdown of the selected banks, and total number of workers and workers who commute daily to Ramallah-Al Bireh urban area from outside the governorate:

1. Arab Bank: Has 910 employees, 491 of these employees work at Ramallah-Al Bireh branches, and 10 of these come from other governorates to work in Ramallah-Al Bireh branches.
2. Palestine Islamic Bank (PIB): It employs 582 persons, 298 of these employees work at Ramallah-Al Bireh branches, and 64 commute from other governorates to work in Ramallah-Al Bireh branches.
3. Safa Bank: The bank employs a total of 183 individuals, 177 of these employees work at Ramallah-Al Bireh branches, and 10 of those commute to Ramallah-Al Bireh branches from other governorates.

4. Arab Islamic Bank: Has a total of 670 employees, 364 of these employees work at Ramallah-Al Bireh branches, and 26 commute from other governorates to work in Ramallah-Al Bireh branches.
5. Palestine Investment Bank: Has a total of 308 employees, 185 employees work at Ramallah-Al Bireh branches, and 19 of those commute to Ramallah-Al Bireh branches from other governorates.

– **The Insurance Sector**

Ten leading companies in the Palestinian market were chosen to represent the insurance sector. These companies have several professionals in different insurance domains. The selected companies are:

1. Takaful Insurance: There are 204 employees in the company, 96 of them work at Ramallah-Al Bireh branches, and 18 of them travel daily to Ramallah-Al Bireh from other governorates.
2. Al-Mashreq Insurance: There are 228 employees in the company, 103 of them work at Ramallah-Al Bireh branches, and 18 of them travel daily to Ramallah-Al Bireh from other governorates.
3. Tamkeen Insurance: Has a total of 151 employees, 85 of them work at Ramallah-Al Bireh branches, and seven of them travel daily to Ramallah-Al Bireh from other governorates.
4. Al-Baraka Insurance: The Company has 84 employees, 36 of them work at Ramallah-Al Bireh branches, and four of them travel from other governorates to Ramallah-Al Bireh from other governorates.
5. Ahliea Insurance Group: Has a total of 127 employees, 52 of them work at Ramallah-Al Bireh branches, and 12 of them travel daily to Ramallah-Al Bireh from other governorates.
6. Trust International Insurance Company: Employs 234 individuals, 106 of them work at Ramallah-Al Bireh branches, and 18 of them travel from other governorates to Ramallah-Al Bireh from other governorates.
7. Palestine Insurance Company: Operates with 164 employees, 88 of them work at Ramallah-Al Bireh branches, and 17 of them commute daily to Ramallah-Al Bireh from other governorates.

8. Global United Insurance Company: Has a total of 188 employees, 69 of them work at Ramallah-Al Bireh branches, and 9 of them travel daily to Ramallah-Al Bireh from other governorates.
9. National Insurance Company (NIC): Has a total of 223 employees, 99 of them work at Ramallah-Al Bireh branches, and 14 of them are commuters to Ramallah-Al Bireh from other governorates.

Considering the above, it was found that there are 57,595 employees at all of the public and private sector institutions that have been targeted. Out of this total, 8,167 employees work at Ramallah-Al Bireh urban area. Out of those, 1,705 employees who are regular commuters to Ramallah-Al Bireh urban area from other governorates. This particular population comprises the sampling frame of which a sample from the study was taken. A detailed decomposition of this population by sector and organization is provided in Appendix A.

The study population is distributed as summarized below:

- A. Government Sector: 1,458 employees (85.5% of the study population).
- B. Private Sector:
 - Banking Sector: 129 employees (7.6% of the study population).
 - Insurance Sector: 118 employees (6.9% of the study population).

This breakdown gives an indication of the employment pattern, where the government sector has the highest proportion among those who commute to Ramallah-Al Bireh urban area. That underlines the area's position as an administrative center and the home for governorate headquarters.

2.6 Data Collection

Collecting accurate information contributes to maintaining the integrity of scientific research and thus controlling the quality of research and its results and reducing the potential of errors. Relevant information was collected from the Palestinian Central Bureau of Statistics (PCBS), in addition to information and data obtained from the administrative affairs departments in the relevant official and governmental ministries, as well as the private sector enterprises that were included in this research.

The data-gathering phase was planned and carried out carefully in order to collect detailed information about mode choice behavior of commuters. All data were collected using a

structured questionnaire as the main tool of data collection. This approach was selected to collect information under three main categories, trip specific characteristics, socio-economic characteristics, and perception factors, as illustrated in the next sub-section.

2.6.1 Survey Design and Structure

An extensive questionnaire was organized and designed as the basic method for data collection. The questionnaire consisted of 27 questions and was divided into four parts to capture commuter characteristics and behavior, in addition to trip characteristics, in a systematic manner to ensure simplicity. The questionnaire can be found in Appendix 2. Each part is presented briefly hereafter.

- Part 1: Socio-economic information (Questions 1-12). This first part was sought to obtain the most basic demographic and economic information about the respondent. These included demographic questions on gender, marital status, number of persons in the household, number of non-school commuting workers in the household, and number of employed sons/daughters along with level of education. It also included information on nature of work, monthly income, and vehicle ownership at the household level.
- Part 2: Trip attributes and travel characteristics (Questions 13-20). This part dealt with specifics of the daily work trip. To illustrate the effect of extraordinary events on travel behavior beyond the normal conditions, three different time periods were investigated for each respondent:
 - The "present" following the day of October 7th
 - Before October 7th “normal” period.
 - The COVID-19 pandemic period.

Discrete choice questions for each period involved the mode of transportation used, the number of occupants per vehicle, travel time, cost of the travel, departure location, and trip expenses if the trip was shared with passengers (cost sharing).

- Part 3: Assessing modes of transport (Questions 21-23). This part required the respondent to make an evaluation of different transport options, considering a variety of attributes, safety, comfort, speed, and cost. A five-point Likert scale was utilized for this assessment. This part also comprised question to understand the reasons for mode

selection in general and not using public transportation at specific. It also included assessment of inter-governorate public transportation services.

- Part 4: Stated preference and event impact scenarios (Questions 24-27). The last part examined behavioral intention using hypothetical situations. It was complemented by stated preference questions aimed to see how people might change their travel choice and how people would shift mode choices in extraordinary circumstances (i.e., the post-October 7th and COVID-19 periods). It also measured any changes in behavior as a result of having access to a new, better public transportation system.

2.6.2 Data Collection Method

After the questionnaire was prepared, and in order to reach reasonable share and representation of the study population, a dual mode method was used in gathering data. This approach combined both standard and digital distribution processes:

1. Paper and Pencil Survey Distribution: Printed copies of questionnaires were handed directly to employees of the selected governmental and private institutions. This was done after coordination and consultation with management of these institutions in order to obtain the required permissions and approvals, in order to ensure that the distribution process is facilitated in a good manner on site.
2. Online Electronic Distribution: A web-based format of the survey was prepared and then distributed electronically. This was shared via personalized email and professional social media channels and applications to reach more employees from both the public and private sectors that were not accessible in-person for questionnaire distribution.

2.7 Sampling Strategy and Sample Size Calculation

In order to have a representative and statistically powerful sample, a stratified random sampling was used. This approach was selected over simple random sampling, because of the established heterogeneity of the study sample. This would ensure that all critical subgroups were sufficiently sampled in the final sample.

The study group of 1,705 commuters was divided considering the following:

- Sectors: The population was stratified in three domains of interest, Government, and Private Sector, comprising Banking and Insurance.

- Institution: these were classified as sub-strata in each sector to control for variation between working environments.
- Size proportionality: The sample sizes in each institutional sub-stratum were proportionate to the number of commuting employees therein.

This multi-stage stratification guarantees that the sample reflects the actual structure of commuters. Thus, external validity of the results is improved and can be generalized with more confidence to the study population.

The calculation of a proper sample size is an important step in guaranteeing statistical validity for any study. The sample size needs to be large enough for the findings to be valid and generalizable without being so large that it becomes cost prohibitive. The sample size in this study was calculated based on the statistical method of finite population which is an appropriate measure for the sampling procedure considering that the size of community under investigation was already known.

2.7.1 Statistical Formula and Parameters

The initial sample size was calculated using Cochran’s formula (Cochran, 1977)

$$n = \frac{(Z_{\alpha/2})^2 (\pi)(1 - \pi)}{e^2 + (Z_{\alpha/2})^2 (\pi)(1 - \pi)/N} \dots\dots\dots (1)$$

where:

n: The initial required sample size

Z: The Z-score corresponding to the desired confidence level

π: The estimated population proportion (response distribution)

e: The desired margin of error

N: Population Size

The parameters used for this calculation are explained in Table 1, along with their justifications.

2.7.2 Sample Size Calculation and Adjustment

Step 1: Calculation of the Initial Sample Size (n): Based on the above parameters, the initial sample size calculation as follow:

$$n = \frac{(1.96)^2 (0.5) (1- 0.5)}{(0.05)^2 + (1.96)^2 (0.5) (1- 0.5)/1705}$$

$$n = 314$$

Table 1

Sample size calculation parameters

Parameter	Value	Justification
Confidence Level	95%	Considered an average level in social science, with a high confidence on results.
Margin of Error (E)	5% (0.05)	A standard and acceptable level of survey accuracy.
Population Proportion (π)	50% (0.5)	When the real proportion is unclear, the most conservative estimate. This approximate value maximizes the resulting sample size, guaranteeing a necessary big sample Cochran, 1977).
Population Size (N)	1,705	The total number of employees who commute in the chosen institutions.
Z-score	1.96	The 95% confidence level Z score.

Step 2: Testing the sample to Population Ratio

$$n / N = 314 / 1,705 = 0.18 > 0.1$$

Since $n / N > 0.1$, a corrected sample size is calculated to reduce sample in comparison with the total population, without influencing the statistical power of the sample size (Cochran, 1977; Krejcie and Morgan, 1970). Thus, the sample size was adjusted as illustrated in next step.

Step 3: Sample Size Adjustment

$$N_1 = n_0 / (1 + (n_0 / N))$$

where:

n_0 : number of sample observations originally estimated.

N_1 : adjusted number of observations.

N : total population.

$$N_1 = 314 / (1 + (314 / 1705)) = 266$$

The final sample minimum size: 266 employees.

This sample size achieved response rate of 100%. This high incidence likely reflects the rigorous effort in data collection, including direct contact with participants followed by most questionnaires being filled face-to-face to ensure good quality of the collected data and minimum errors or missing values.

2.7.3 Final Sample Size Distribution

Table 2 shows the distribution of the sample across sectors in accordance with that of actual proportions in the frame population.

Table 2

Sample size distribution by sector

Sector	Number of Commuting Employees	Percentage %	Required Sample Size
Government Sector	1,458	85.5%	227
Banking Sector	129	7.6%	20
Insurance Sector	118	6.9%	19
Total	1,705	100%	266

This sample size ensures:

1. Getting enough number of responses.
2. The capability to do advanced and complex statistical analyses with high confidence.
3. Reasonable cross-section of all the categories of study population.

2.8 Pilot Study

A pilot study was conducted on a few respondents before the actual survey was conducted to determine the comprehensibility, organization, and time taken to fill in the survey form. The respondents provided feedback concerning questions that they could not comprehend, and accordingly changes were made to improve the questionnaire.

2.8.1 Pilot Study Design and Implementation

A group of 50 employees was chosen in order to cover target group of various institutions and representing to about 19% of the sample size (n=266), which was intended for the final assessment for the questionnaire. This number was sufficient to detect major issues in the questionnaire without being resource-demanding. The division of the pilot study sample is presented in Table 3.

Table 3

Pilot study sample distribution

Sector	No. of Participants	Proportion (%)	Distribution Method
Government Sector	35	70%	Paper (30) + Electronic (5)
Banking Sector	10	20%	Paper (8) + Electronic (2)
Insurance Sector	5	10%	Paper (4) + Electronic (1)
Total	50	100%	Paper (42) + Electronic (8)

The criteria that were considered for the pilot study sample include:

- Ensures including employees from each sector (Government, Banking and Insurance).
- Ensures heterogeneous demographic features (age, gender and educational status).
- Ensures variability in participant's home locations and modes of transportation used.

2.8.2 Pilot Study Results and Modification

The outcome of the pilot trial is outlined in Table 4. Several major modifications were conducted based on the observations and feedback of the pilot study:

- Revision and clarification of questions: Three questions, which were found vague and unclear in the present form, were amended. These mostly referred to the cost of a trip and the transportation mode used at different times. The latter was organized to a single table for three periods (pre-October 7th, post-October 7th, and COVID-19).

- Flow enhancements: The sequence of certain questions were re-ordered to improve the narratives and increase ease of understanding by respondents.

2.8.3 Final Questionnaire Structure

Based on the above indicated amendments, refinements were done, and the final version of questionnaire was developed. The final content questionnaire is described in Table 5, and the entire questionnaire is included in Appendix B.

Table 4

Pilot study results and response rate

Indicator	Value	Observations
Questionnaires Distributed	50	Balanced distribution across sectors.
Questionnaires Received	48	High initial response rate.
Response Rate	96%	Illustrates strong degree of interest.
Valid for Analysis	46	After excluding incomplete responses.
Average Completion Time	10 minutes	Time commitment is reasonable.
Number of Modified Questions	3	To improve clarity and precision.

2.8.4 Quality Assurance Measures

In order to ensure the reliability and high quality of gathered data, a series of strict quality assurance and control measures (QA/QCs) were implemented in the process of data collection:

Table 5*Final questionnaire structure*

Part	No. of Questions	Content	Objective
One	12	Personal, socio-economic, and geographic characteristics	To provide demographic and economic context.
Two	8	Trip characteristics and travel patterns	To collect information on current travel behaviors and costs.
Three	3	Evaluation of transportation modes	To illustrating perceptions and preferences for each mode.
Four	4	Stated preference and event impact scenarios	To investigate the impact of scenarios and events on travel.
Total	27	Comprehensive and refined questionnaire	For the purpose of obtaining integrated data.

- Random sampling strategy and targeted institutions: A random sampling strategy was applied to ensure that the sample properly reflects the population and to achieve the statistical reliability.
- Face-to-face questionnaire administration: A large part of surveys (about 85%) were collected in a face-to-face environment. This was very successful and efficient because it gave direct answers and clarification to employee's questions, thus reducing the likelihood of misinterpretation and item non-response.
- Logical consistency: After the data were collected, they were checked for logical consistency. For example, responses were screened against each other so that the reported travel cost made sense in relation to distance travelled, originating location, and mode of transportation used. This was instrumental in detecting and flagging questionable or possibly incorrect data that need further investigation.

These complete quality assurance procedures and the understandings obtained from the pilot study, helped in elaborating a reliable and effective questionnaire for data collection. This, in turn, contributed to the successful performance of the obtained main study results.

At the end, 266 valid filled questionnaires were received and considered eligible for analysis through continuous follow up with the sample respondents to ensure achieving

the targeted sample size. This high response rate may be attributed to the clear survey design, effective collection of data (mainly face-to-face method) and high degree of interest expressed by the respondents concerning the study topic.

2.9 Approach to Estimate Mode Choice Model

The estimation approach to specify the mode choice model utilized the multinomial logit modeling procedure. This was conducted through building mathematical models with the aim to replicate the travelers' decision making to choose among available transportation modes for their commuting to work trips.

This approach, common for discrete choice, treats the estimated model coefficients (i.e., estimates of the effects of the attributes or variables on the probability of choosing that particular alternative) as parameters to be estimated using Maximum Likelihood Estimation (MLE) approach.

The multinomial logit model is utilized to estimate the probability of a mode using logistic regression modeling. The modeling approach considers specific dependent variables with factors believed to be influencing travelers' choice of a mode among specific potential modes. In this model, the probability of choosing option i (P_{iq}) among all the alternatives (q) is defined as:

$$P_{iq} = \frac{\exp(\beta V_{iq})}{\sum_{A_j \in A(q)} \exp(\beta V_{jq})}$$

where

P_{iq} : Probability that individual q chooses alternative i .

V_{iq} : Systematic (observable) utility of alternative i for individual q .

$A(q)$: Set of all available alternatives for individual q .

j : Index representing each alternative within the choice set.

β : Vector of estimated parameters (coefficients)

q is the alternative mode choice set, and iq is one of the modes in the alternative mode choice set.

In the model estimation process, calibration was conducted to find the most appropriate variables to be used in building the model. This process is carried out considering relevant statistical tools, including the degree of statistical confidence in testing the factors of the variables, such as factor statistics [t] to evaluate the overall model. When calibrating the models, the signs of the variable factors must be noted in terms of their logicity. For example, the effect of the cost of transportation is negative on the demand for transportation. Therefore, the sign of this variable must be negative, otherwise this model will be invalid.

2.10 Approach to Model Validation

After completing the process of calibrating the transportation models, validation of those models was conducted, where data were used to predict the choice of transportation modes other than those used in calibrating the models. The validity of these models was tested by comparing travelers' predicted choice of mode of transportation with their actual choice.

The validation process followed examined first the reasonableness of the sign of coefficients and model predictability to test how it actually predicts travelers' choices. Random testing for a sub-sample was selected to determine the expected choices by calculating the probabilities to choose each of the competing alternatives using the multinomial logit model equation stated above. The results were then compared with the actual choices to ensure proper validation.

Chapter Three

Data Analysis, Model Estimation Results, and Discussion

3.1 Introduction

The purpose of this chapter to present the statistical and econometric analysis of the data obtained from the filled questionnaires obtained from a sample of public and private sector staff commuting on daily basis from outside the Governorate of Ramallah-Al Bireh to their work places in Ramallah-Al Bireh urban area. Descriptive analysis is conducted first, which contributes proper knowledge of the sample characteristics and behavior patterns that allow for better understanding of the results that will be obtained. Furthermore, this chapter presents the choice models estimation using the logit model, as well as the main results of the study. A comprehensive discussion of the extracted research findings is then presented.

3.2 Analysis Plan

The 266 valid questionnaires will be processed in a two-step quantitative manner in order to achieve the objectives of the study. The first step is the descriptive statistical analysis, which takes advantage of both Excel feature for data organization and visualization and SPSS tools in creating summary statistics. The goal is to abstract the basic details and characteristics regarding the sample and traveling habits. Basic demographic, socio-economic and trip characteristics variables will be analyzed and summarized as frequencies, percentages, means and standard deviations, with the supplement of tables and figures for the dataset.

The second step is the econometric modeling phase which is conducted with the aim of identifying the factors behind the transportation mode selection. This requires the application of a specialized software, where the TransCAD software is utilized for formulating and calibrating mode choice models considering the multinomial logit model. This model is highly suitable for the analysis of the individual's choice among multiple discrete alternatives of transportation modes. The model could also estimate the effect of different attributes, whether mode related or those related to the individual's socio-economic factors or preferences in his/her choice of a specific mode. The weights of each variable are tested to find the most relevant factors that affect travel behavior within the study domain.

3.3 Descriptive Analysis

This section introduces description of the collected data by summarizing the major characteristics of the study sample.

3.3.1 Sample Characteristics

The key attributes of the respondents which were covered in the analysis are illustrated hereafter.

3.3.1.1 Gender Distribution

The analysis showed that males represent a share of 57%, while the females represent 43% of the sample, as shown in Figure 2a. This fairly balanced distribution reflects the existence of women working in the public sector institutions and private sector enterprises. Additionally, this distribution correlates with social changes that are occurring in the Palestinian society, especially the significant increase in women's labor force participation.

3.3.1.2 Age Distribution

The statistical analysis regarding age distribution showed that there is a high concentration in the economically active group, with the 30-39 year age group dominating with 35% of the respondents, followed by the 20-29 year age group with 29% of the respondents, as shown in Figure 2b.

3.3.1.3 Marital Status

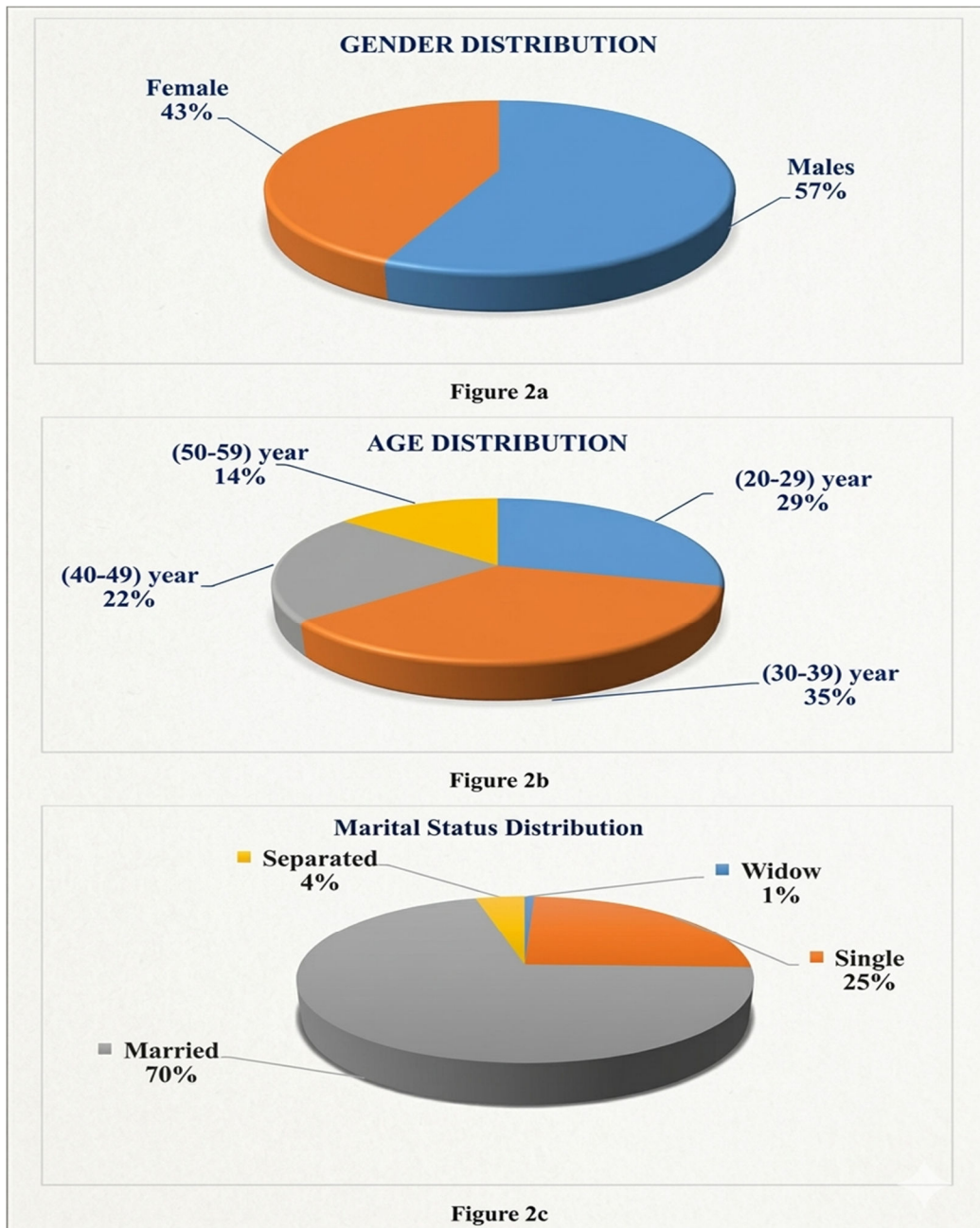
Most of respondents are married (70%) as shown in Figure 2c, indicating the social status of the sample, which is followed by the single status of 25%, and the remaining are widows and separated.

3.3.1.4 Educational Level

The sample has a very high educational level, where about 88% of the respondents have a bachelor's degree or higher as illustrated in Figure 3a, which is consistent with the type of the jobs requirements in the public and private sectors in Ramallah-Al Bireh, where they have a demand for highly qualified employees.

Figure 2

Sample distribution by gender, age group, and marital status



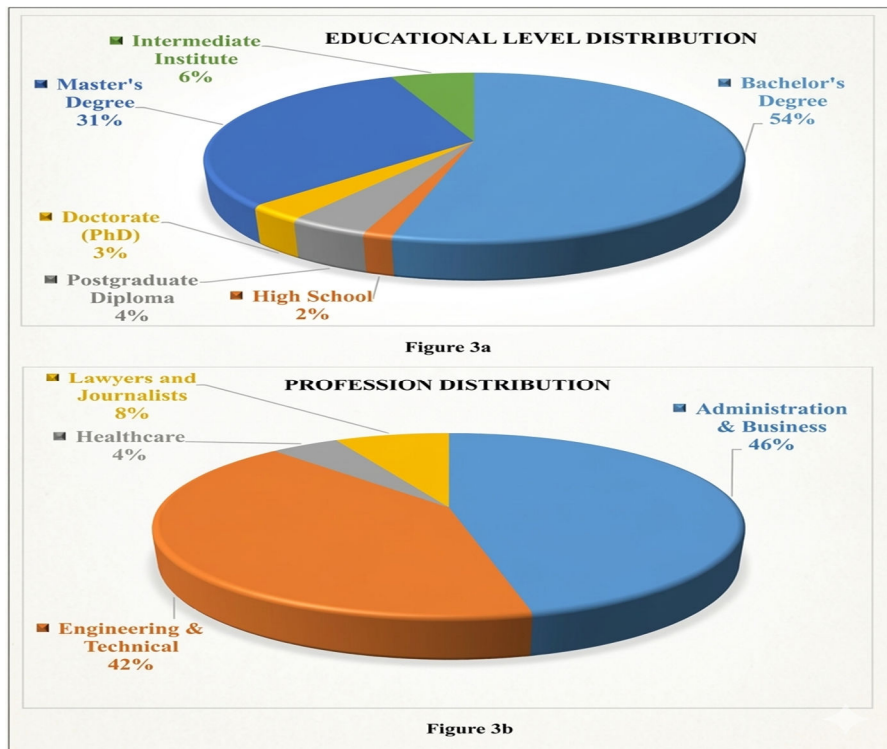
3.3.1.5 Professional Distribution

The technical professionals and engineers are the most represented sector in the sample (36%), which can be described by providing the highly technical nature jobs that exist in the sample. Accountants are next respondent in the sample at 21%, then other professionals ranging from administrators to lawyers and doctors at varying proportions as shown in Figure 3b. This professional distribution indicates the nature of the target sample where educated and specialized employees commute daily to work. On the other

hand, this spread reflects the pattern of economic activity in Ramallah-Al Bireh area which is characterized as the main administration and economic center, where various government institutions along many private companies need these specializations.

Figure 3

Sample distribution by educational level and profession



3.3.1.6 Family Size

The majority of families are medium (4-6 members) in size at 65%, followed by (1-3 members) at 21%, and 14% of the sample have more than 6 members as illustrated in Figure 4a, reflecting the Palestinian social family structure nowadays.

3.3.1.7 Number of Workers in Family

It can be observed that over 50% of the families have two income providers as shown in Figure 4b. This phenomenon represents an increasingly active role played by women in the labor market and an enhancement in economic situations.

3.3.1.8 Number of Employed Children in the Household

The information provided in Figure 4c indicates that the substantial majority of households (91%) have no children who are employed. This reflects that work is a second-

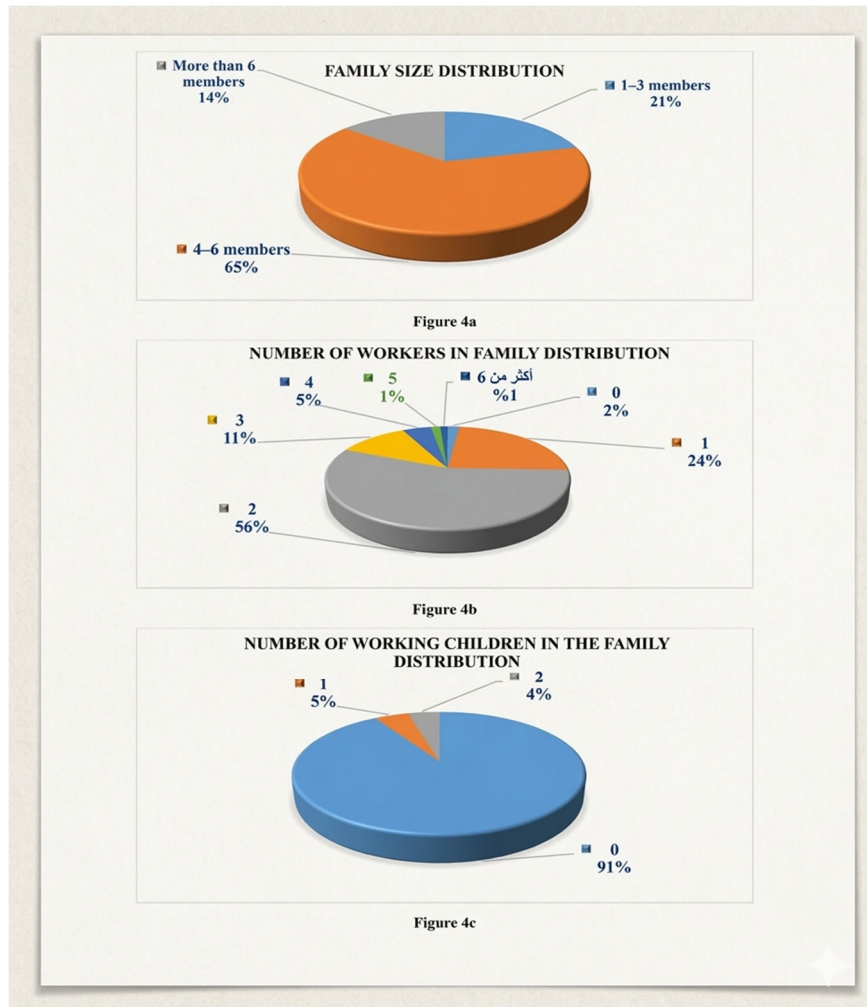
tier priority compared with education, and it also reflects some economic stability at the households' level. This result is reasonable because most respondents' children in the sample are currently studying and have not transitioned to work.

3.3.1.9 Geographical Distribution

The results showed that the percentage of the respondents who are commuting to their work from the northern governorates, which comprise the governorates of Nablus, Jenin, Tubas, Tulkarem, Qalqilya, and Salfit is 57%. Next, the percentage of respondents who are commuting to their work from the middle governorates, which comprise the governorates of Jericho and Jerusalem is 13%. Meanwhile, the percentage of respondents who are commuting to their work from the southern governorates, which comprise the governorates of Bethlehem and Hebron is 20% as illustrated in Figure 5a. These results reflect that the respondents are distributed geographically throughout most of the Palestinian governorates that would add comprehensiveness to the study findings and interpretations. It covers a relatively wide area extending through several governorates.

Figure 4

Sample distribution by family size, number of household workers, and number of employed children in the household



3.3.1.10 Monthly Family Income

Monthly income details presented in Figure 5b indicates that the majority of the participants in the sample (43%) have a monthly income level of between 6,000-9,000 NIS, followed by those earning between 3,000-6,000 NIS at 32%, and therefore, 75% of the sample has a household income falling in 3,000-9,000 NIS bracket. On the other hand, those with a high income (over 12,000 NIS) represent only 11% of the sample, compared to 9,000–12,000 NIS category that makes up 14%. This distribution mirrors the economic reality status of worker in Palestine and gives good picture of the income categories, which could have an effect if the current study with respect to income impact on mode choice.

3.3.1.11 Private Car Ownership

Nearly three quarters (72%) of the respondents possess a personal vehicle, while only over one quarter (28%) are not owning a car as shown in Figure 6a. There has been a high level of private car ownerships among the targeted sample, indicating a potential of over reliance on private cars among the transportation modes. One of the contributing factors for this relatively high rate is that banking services and soft loans that made car ownership affordable to a large number of employees. The high level of car ownership offers the potential for modal privacy, comfort and prefer the flexibility offered by private cars.

3.3.1.12 Method of Private Car Ownership

The results indicate that financing facilities either by loan from a bank (40%) or issuing private checkbooks (31%) are tools most frequently used to own private cars as illustrated in Figure 6b. These results demonstrate the main role played by the banks in raising the number of private cars in Palestine.

Figure 5

Sample distribution by place of residence / governorate (geographical distribution)

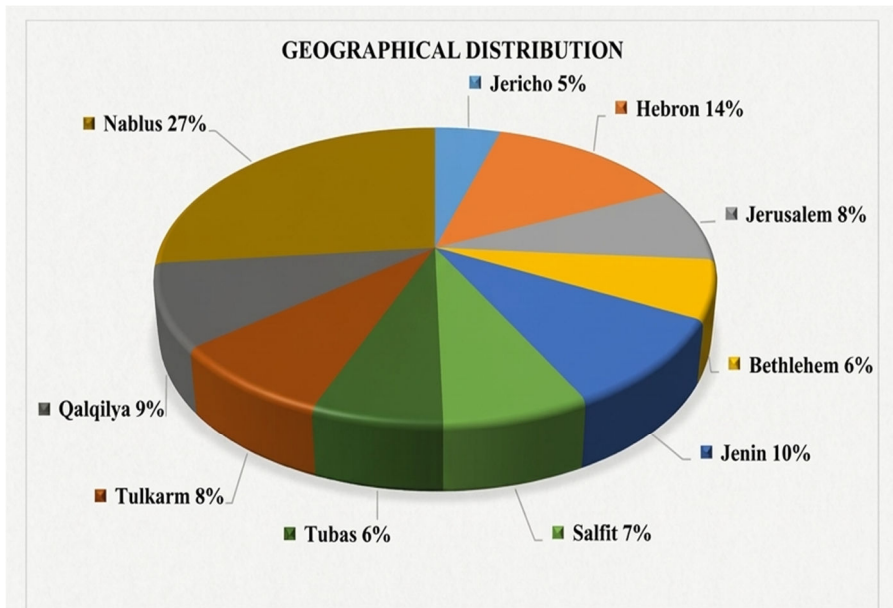


Figure 5a

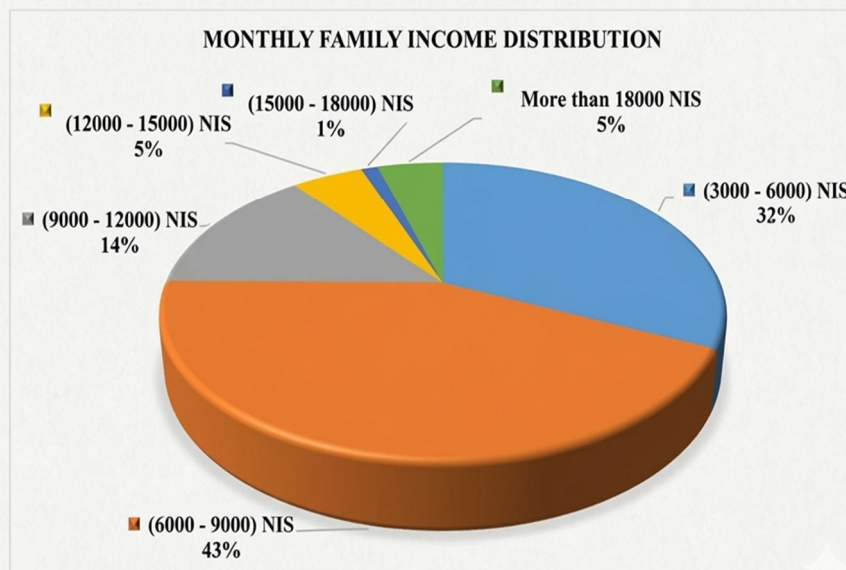


Figure 5b

Figure 6

Sample distribution by private car ownership and method of private car ownership

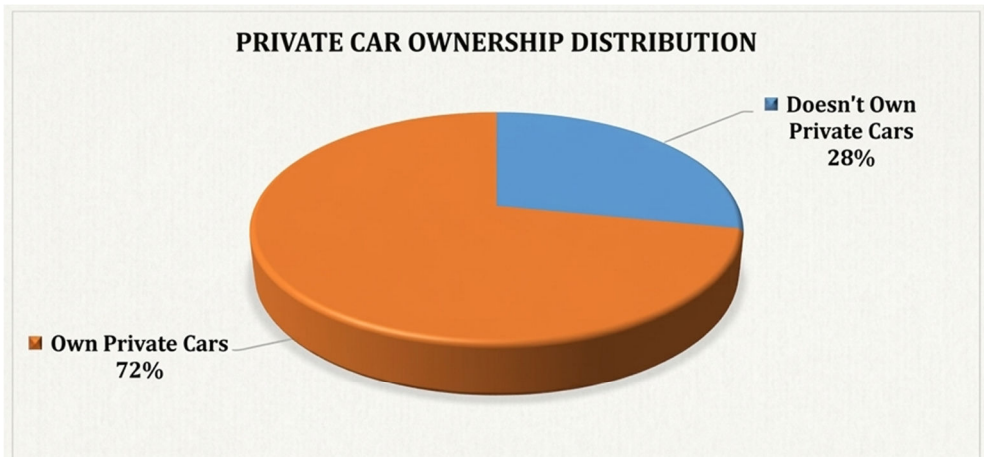


Figure 6a

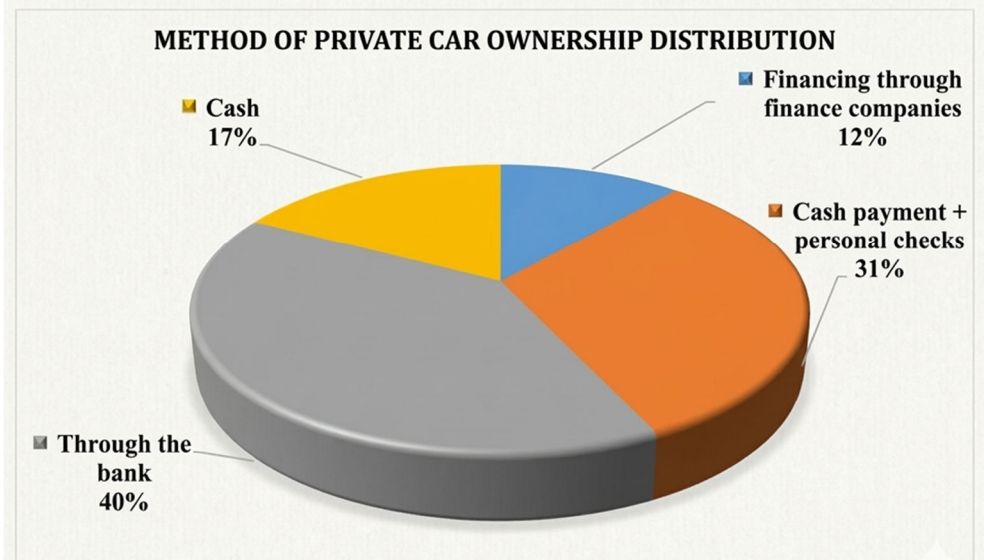


Figure 6b

3.3.2 Trip Characteristics Analysis

3.3.2.1 Distribution of Transportation Modes Used

In order to identify the specific modes to be investigated in mode choice modeling, the questionnaire was set up and structured to include detailed information concerning the modes of transportation that are used by the employees commuting between home and work on the inter-city level in the studied context. The questionnaire was not limited to determine just the traditional modes, but also included the recent trend towards ridesharing. Moreover, specific information about how the mode was used were also gathered. For instance, the participant was not only asked about the use of the private car mode, but was asked if he/she was driving the car alone, with their family, or traveling

with work colleagues, or those who carry other passengers through ride-sharing applications, such as “Waslani Maak”. Similarly, differentiation was made between the trips where the respondent was going to work as a passenger with his/her work colleague and those who move to work as a passenger by using the mentioned ride-sharing “Waslani Maak” application.

The above considered in order to lead to in-depth understanding of the mode choice and more specifically to ride-sharing patterns, as demonstrated in Table 6.

It is to be noted that the only motorcycle rider (1 participant, 0.4%) was excluded from the analysis for several critical methodological reasons as follows:

1. Inadequate sample size, as with only one observation, the model cannot be built for this alternative and cannot give a reliable statistical representation.
2. Failure to generalize, where data drawn from a single observation cannot be extended to the whole population.
3. Econometric modeling requirements, as sophisticated statistical models including multinomial logit, assume that sufficient number of observations are available, which in turn lead to stable and accurate estimation.
4. Exceptional use nature, where motorcycles are not typically used to travel long distances between governorates in the Palestinian society, especially in the prevailing security and weather conditions.

Based on the above, the final sample size was decreased for analysis to 265 participants, excluding the motorcycle user respondent.

After removing the motorcycle from the analysis and model, four major final mode options were considered. The final grouping helps achieve number of important goals:

1. It guarantees that each alternative has enough number of observations, therefore promoting statistical accuracy and enhancing result credibility.
2. It shows the reality of movement within the Palestinian context in a clear and simple way.
3. It helps to enhance interpretation of results and make comparison easier among the alternatives, by reducing misunderstandings coming from weak alternatives or anomalies of their representation.

Limiting the options to four main modes strengthens the study by highlighting key differences across the transportation modes with respect to relevant aspects such as car ownership, cost, and flexibility. Table 6 and Figure 7, identify the four final options for analysis which represent the current conditions (after October 7 events), which are used for econometric modeling later in the chapter.

Table 6

Distribution of transportation modes used and final modes for analysis

No.	Mode	Description	Before exclusion of the motorcycle		After exclusion of the motorcycle	
			Frequency	Percentage	Frequency	Percentage
1	Private Car	Private car (drive alone)	111	41.7%	111	41.9%
2	Shared Car	Shared car	109	41.0%	109	41.1%
3	Taxi	Public service taxi	32	12.0%	32	12.1%
4	Bus	Public transport bus	13	4.9%	13	4.9%
5	Motorcycle	Motorcycle	1	0.4%	Excluded	
		Total	266	100.0%	265	100%

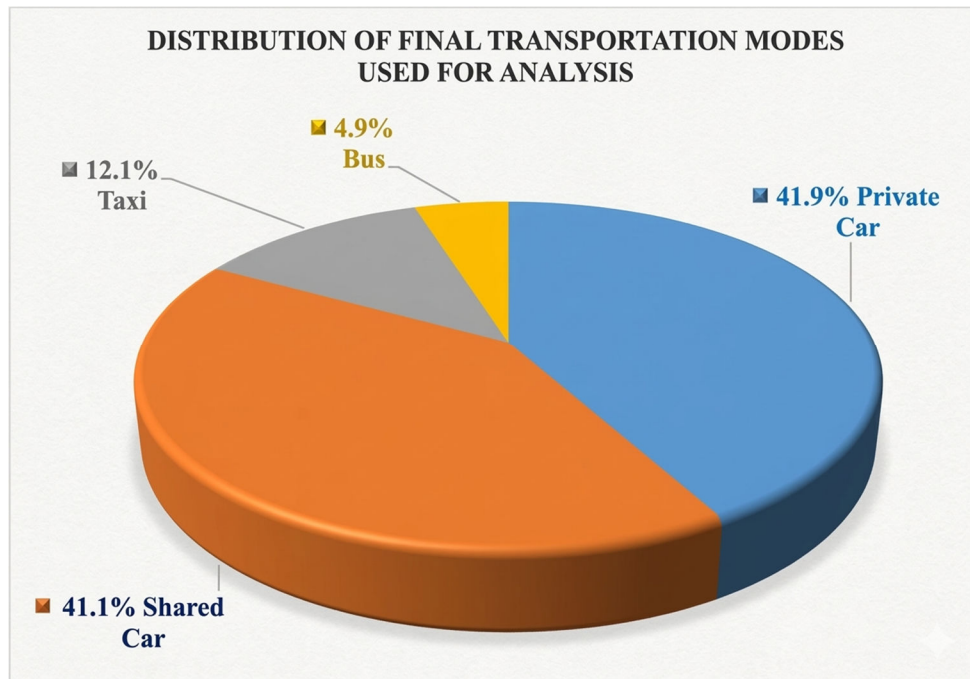
Each of the considered modes is briefly introduced hereafter.

– **The Private Car**

This mode incorporates all employees who commute to work by driving their own cars, consisting of 111 respondents (41.9% of the sample), regarded as the drive alone option. This alternative is the most popular among workers, indicating the high private car ownership in the targeted sample. As indicated before, the growth of private car ownership is largely supported by banking facilitation.

Figure 7

Sample distribution of four final modes for analysis



–The Shared Car

This mode contains respondents who own private cars and drive them to commute to work while taking workmates or other passengers. It also contains those who commute to work as passengers in cars owned by their colleagues or other people. This mode is chosen by 109 respondents (41.1% of the sample). This mode highlights a considerable great demand for new transportation options which offer the travelers with better flexibility and more comfort compared with other non-car drive alone option, such as the public service taxi and bus. This mode is also cheaper compared with the private car and public service taxi. It is to be noted that it helps in decreasing the number of cars on the roads by having more passengers in the vehicle.

–The Public Service Taxi

This mode reflects the use of service (shared) taxis (with 4 or 7 passengers), which is a traditional public transportation mode in Palestine. This option is selected by 32 respondents (12.1% of the targeted sample). This public transportation mode has more frequent and coverage service compared with the bus mode. This makes the service taxi to be more attracting than the bus, despite its fare is not as cheap as that of bus, making it

as a good public transportation mode for those who don't have private cars or have no access to shared car.

– **The Public Transport Bus**

This mode refers to intermediate to large public transportation bus (with 20 to 50 passengers), which is selected by only 13 respondents (4.9% of the targeted sample). This explains the difficulties and challenges facing this public transportation mode in Palestine such as limited routes, lack of proper schedules, and low service quality. Although buses offer the cheapest cost per passenger, their use is restricted because their routes schedules and coverage are infrequent and insufficient to reach at the national or regional levels.

These four choices cover the full range of available transportation modes that employees use to commute from their origins outside the Ramallah-Al Bireh Governorate to their work destinations with Ramallah-Al Bireh urban area, and form a solid basis for creating discrete choice models and studying the factors affecting the decisions on transportation mode. The distribution of transportation modes indicates that employees mostly use private and shared cars, which together make 83% of all trips, showing their dominant role. This distribution reflects the heavy reliance on private transportation versus the weak attractiveness of the traditional public transportation system. The overwhelmingly high preference for private/shared cars, may indicate that there exists a strong preference towards modes offering flexibility and comfort in travel.

On the other hand, the low percentage of use of traditional public transport at 17% shows that this service is very weak and not sufficiently capable to respond to the needs of the employees. Indicating that it will be necessary to improve and modernize the public transportation system and make it more effective.

3.3.2.2 Comparison of Transportation Modes across the Study Periods

The findings reveal that the mobility patterns remained stable for the three periods, before October 7 events, after October 7 events and during COVID-19 period. Transportation mode selections are not essentially impacted by various exceptional events. This stability is underpinned by several critical factors:

Preferences Stability: The distribution is almost the same among the three periods which means that employees' preference for transportation modes depend on steady factors in

terms of personal characteristics and not influenced by temporary or emergency situations.

Limited Alternatives of Transportation: This stability may also be a result of the limited options in terms of commuting from residential areas in other governorates to Ramallah-Al Bireh urban area and have basically not really changed throughout these periods.

3.3.2.3 Return Trip from Work to Residence

The analysis showed that all the participants in this study use the same type of transportation mode for the return journey between workplace and home. It's a sign of uniformity and stability of employees' daily travel habits. This indicates that employees' daily travel habits remain stable and consistent. This stable mode choice for going and returning trips makes the analysis of one trip direction sufficient as mode choice doesn't change for the return trip.

3.3.2.4 Passenger Sharing Patterns among Private Car Owners

The analysis indicated that out of 191 participants who own private cars, 136 participants (71%) like to share their trip by taking passengers, while 55 (29%) like to go alone, as shown in Figure 8a.

3.3.2.5 Travel Time

The results illustrate that most of the participants (106 participants forming 40% of all) have traveled for 90-120 minutes one-way to work and the same travel time for the way back. In contrast, 47 participants (18%) only have 30-60 minutes and 40 participants (15%) have 150-180 minutes of travel as can be extracted from Figure 8b.

These results illustrate that most of trips extend for longer than an hour and a half every day (55%). This is due to the constraints on movement between the Palestinian cities and governorates by the Israeli occupation authorities, which cause traffic delays and problems affect the quality of life of residents as well as their work productivity.

3.3.2.6 Travel Cost

With respect to daily travel costs for transportation, the one-way cost is 20-30 NIS for the highest share of the participating respondents (82 participants forming 31% of all), according to Figure 8c. Next are those with the 10-20 NIS range (62 participants forming 23% of all), and then those with the 30-40 NIS range (36 participants forming 14% of all).

These costs are considered as high compared with the income of the employees, particularly when looking at monthly and annual expenses, and therefore, there is a tendency to possess a private car or to share trips in an attempt to lower these financial burdens.

3.3.2.7 Evaluation of Used Transportation Mode

The results indicate that there a high level of respondents' overall satisfaction concerning the transportation mode used to commute to work, as shown in the Figure 9a. The assessment of speed and comfort obtained the highest level of positive rates of 67% (excellent and very good), which reflect the ability of these modes to achieve the respondents' expectations. On the other hand, the assessment of safety, 46% of the respondents indicated an excellent and very good level. Finally, only 41% of the respondents considered the cost as very good.

Figure 8

Sample distribution by passenger sharing among private car owners, travel time, and travel cost.



Figure 8a

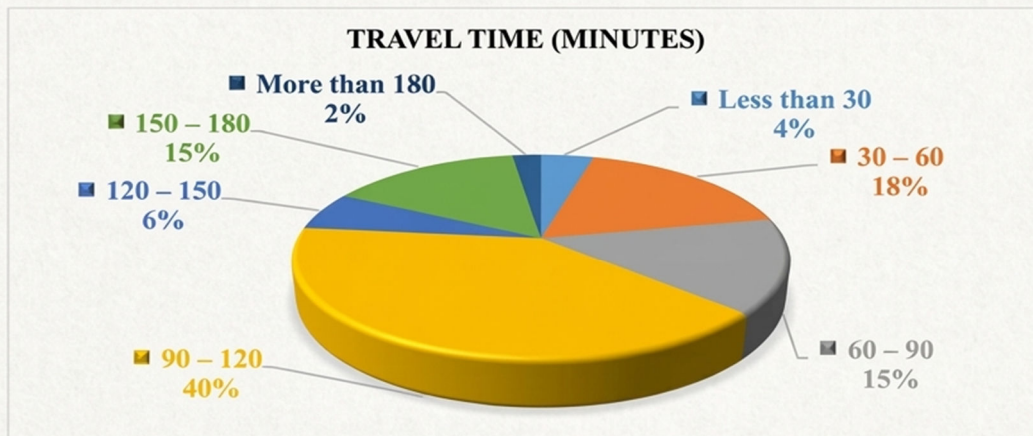


Figure 8b

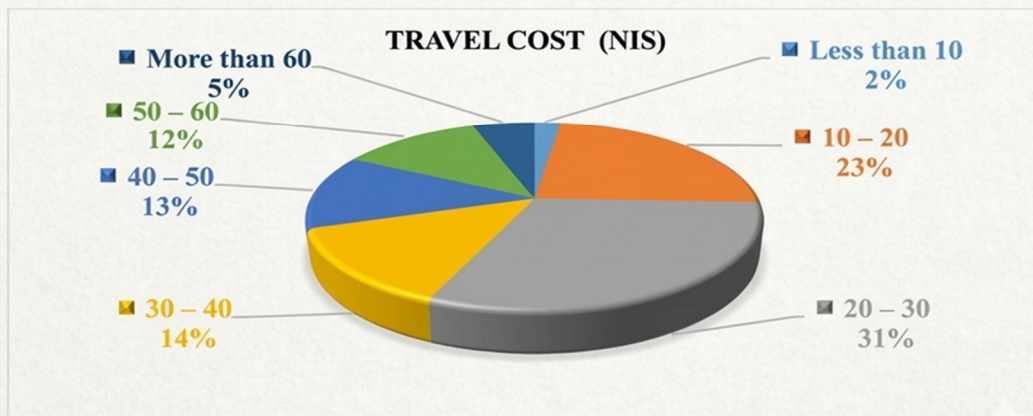


Figure 8c

3.3.3 Public Transportation Analysis

In this part, the reasons of not using public transportation and the evaluation of public transportation modes by the respondents are illustrated as follow:

3.3.3.1 Reasons for Not Using Public Transportation

The respondents indicate that the most important reason for not using public transportation is its unavailability at all times (75% of the sample), poor schedule compliance (73% of the sample), comfort absence (59% of the participants), and its expensiveness (54 % of the participants), as shown in the Figure 9b. Respondents cited other reasons for not using public transportation, such as that the majority of the public transportation vehicles are unfit because most of public vehicles need proper maintenance, as well as the need of the respondent to use more than one mode of transportation to commute work, while others attribute this to owning a car which they use for commuting to work as shown the Figure 9c. These reasons confirm the lack of public transportation services availability and reliability, which does not meet the needs and expectations of the commuters.

3.3.3.2 Evaluation of Public Transportation Modes Service

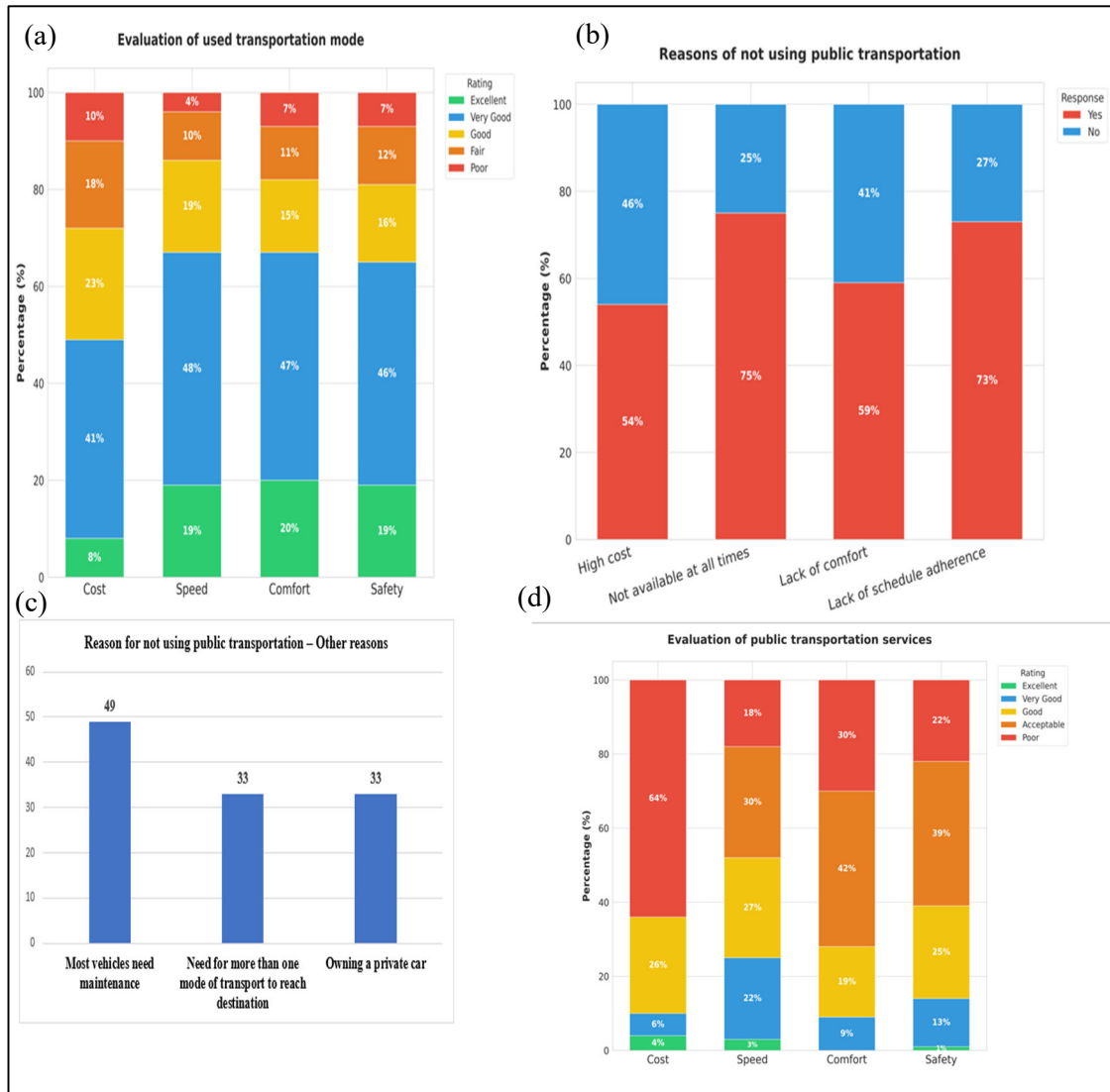
Based on the Figure 9d, the safety was rated as acceptable by 39 % of the respondents, good by 25 %, and poor by 22 %, showing a mixed level of safety assessment. Concerning the evaluation of comfort, 42% of the respondents judged it as acceptable, 19% indicated it good, and 9% considered it very good, while 30% indicated it is poor, thereby confirming the tendency of judging the level of comfort at intermediate levels.

Considering the evaluation of public transportation in terms of speed, 30% of the respondents assessed it as acceptable, 27% as good, 22% assessed it as very good, and rated as poor by 18%. Regarding the public transportation evaluation in terms of cost issues, 64% scored it poor and the other 26% scored it good, showing dissatisfaction related to cost.

Therefore, the evaluation of public transportation modes service showed that people were not well satisfied with comfort, speed, and cost, and that there is mixed assessment for safety.

Figure 9

Sample distribution by evaluation of used transportation mode, reasons of not using public transportation, and evaluation of public transportation service



3.3.4 Modern Bus Public Transportation Scenario

The participants showed a positive response towards having modern bus as an attractive public transportation from their origins outside of the governorate to their work destinations in Ramallah-Al Bireh urban area, as shown in Figure 10a. There were 201 respondents (76%) who indicated that they are ready to use this mode if it is always or usually available, while only 65 respondents (24%) disagreed with this scenario. With respect to rejection of the idea of choosing the modern public transportation bus, Figure 10b illustrated the most common reason was that some of participants preferred to travel with private car (43 participants), then waiting time, lack of convenience, lack of privacy,

and requiring more than one mode of transportation (11 participants). Furthermore, 11 participants stated that it is would be uncomfortable and not fast. These findings reveal the potential of a real shift towards public transportation use if services are developed through having modern and reliable alternatives, which would lead to reduce dependence on private cars and reduce traffic congestion levels

3.3.5 Impact of Exceptional Events on Mobility Patterns

3.3.5.1 Impact of COVID-19 Pandemic

The mobility patterns were affected by the COVID-19 pandemic as revealed by the responding employees, where COVID-19 restricted the mobility patterns for the respondents (147 participants forming 55% of all) as compared to those not affected by (119 participants forming 45% of all) as shown in Figure 1 in Appendix C. The impact of daily commuting habits was observed to be of intermediate impact.

Based on Figure 2 in Appendix C, mobility patterns were impacted by different reasons, where major reason was that some institutions arranged part time work for employees (72 participants), others arranged work for employees within the same governorate (33 participants), or arranged online work from home (29 participants), while some participants chose to live temporarily in Ramallah-Al Bireh urban area and avoided travel to work every day (13 participants).

Figure 10

Sample distribution by modern bus public transportation scenario from governorate headquarters to workplace and Reasons why some participants reject using modern public buses

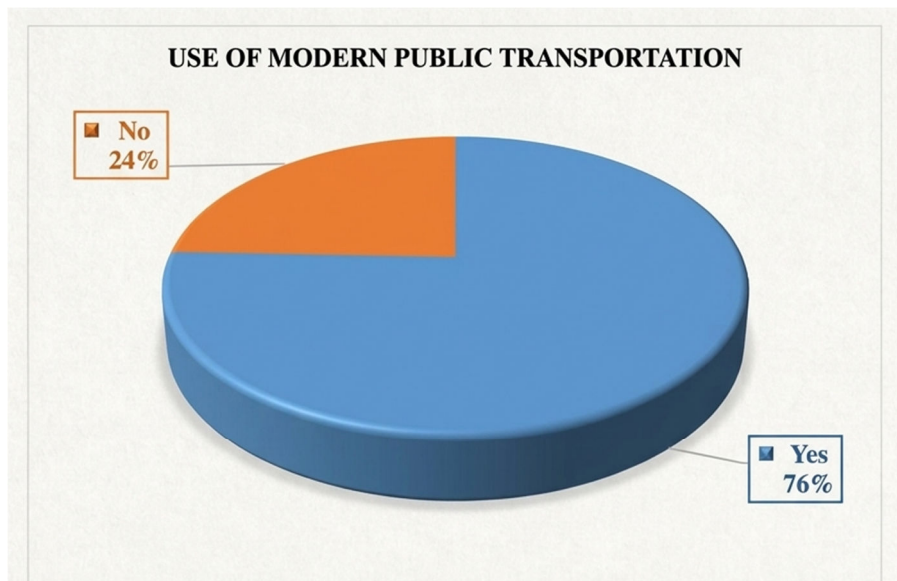


Figure 10a

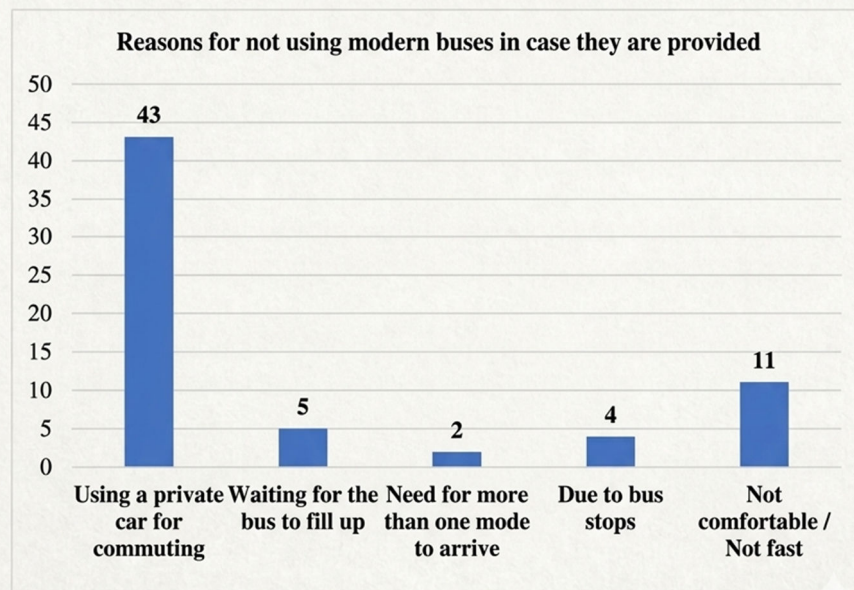


Figure 10b

3.3.5.2 Impact of October 7 Events

The mobility patterns for the majority of participants (195 participants 73% of the total sample) were impacted by October 7 events, while mobility patterns were unchanged for only 71 respondents (27%), as illustrated in Figure 3, Appendix C. This indicates a clear and broad impact larger than COVID 19 impacts on mobility patterns. As illustrated in

Figure 4 in Appendix C, the reasons for the impact were mainly attributed to the institutional arrangements for part time work for employees due to unsafe conditions on external roads caused by Israeli occupation authorities that comes either through military checkpoints or settler attacks, and delays in government salary payments as a result of financial blockade on Palestinian Authority (109 participants forming 54% of all). The other reason was that some employees were being forced to stay in Ramallah-Al Bireh urban area and arrange accommodation there due to the danger of traveling on external roads (74 participants forming 38% of all).

3.4 Mode Choice Model Results

3.4.1 Estimation of Mode Choice Model

The results of estimation and calibration of mode choice using the multinomial logit model through proper mathematical models are presented here. A trial-and-error approach was followed in constructing the models, and several variables and alternatives that could be considered as explanatory variables within the utility functions were examined. The process began with number of trials to construct models that were subsequently re-estimated and enhanced multiple times, while checking both the statistical significance of variables and the sign relevance of the coefficients, as well as overall the explanatory power of the model. Eventually, the best-fit model that can better balance between simplicity, clarity of explanation, and power of the model, was achieved.

It is important to indicate that the analysis of the data and the development of discrete choice models was performed using TransCAD software, as illustrated before, which is commonly utilized for analyzing and modeling transportation demand, including the study of traveler behavior concerning mode choice decisions.

3.4.2 Data Preparation and Sample Size

As mentioned earlier, a structured questionnaire was used to collect data considering employees from the public and private sectors, and the final total sample size was 265. Four predominant mode alternatives were considered; the private car, the shared car, the public service taxi, and the bus.

3.4.3 Modeling Framework for Three Time Periods

This study is unique in its consideration of comparisons of transportation mode choice behavior across three time periods with important variations in operations and constraints aspects, and also due to the differences in travel time and travel cost variables. Eventually, this had resulted in three main models:

1. Normal conditions model (pre 7 October war): This model describes the period prior to the events of October 7, 2023, in which more steady choices considering relatively stable road network conditions, as well as travel cost and time were predictable.
2. Crisis conditions model (post October 7 war): This model reflects the conditions after the events of October 7, 2023, marked with complex political conditions with unpredictable barriers, obstacles and challenges, along with severe financial and economic hardships, and considerable increases in travel time and cost uncertainty.
3. The COVID-19 pandemic period model includes those impacts during the COVID-19 era, which involves lockdowns and social distancing that alter mobility patterns/traveler preferences. It was found that this model has the same variables and factors of normal conditions model (pre 7 October war).

3.4.4 Description of Variables

In order to maintain accuracy, transparency, and clarity, Table 7 presents all variables which were examined in the models, with their coding and description.

Table 7*Description and value of variables used in models*

Parameter	Variable	Description	Value/ Range / Unit
Alternative Specific Constant	β_0_{bus}	Constant	Alternative specific constant for Bus
Trip Attributes	β_1	TT	Travel Time
	β_2	TC/INC	Travel Cost with respect to Income
Attitudinal Variables	β_3	SAFETY	Safety perception (for Private Car)
Socio-economic Variables	β_4	GENDER	Gender
	β_5	M_STATUS	Marital Status
	β_6	CAR_OWN	Car Ownership in the household
	β_7	WORKER_FA M	Worker in Family Number of workers in the household

3.4.5 Model Estimation Results

After several trials, testing, and fine-tuning, three optimal final models were developed and obtained that would preferably describe the three study periods. The final results of the estimates for crisis conditions (post-October 7 events), expressing the current status, are illustrated in the Table 8. The final outputs of all models which were generated utilizing TransCAD are presented in Appendix E.

Table 8*Estimation results of the Post-October 7 model*

Parameter	Estimate	Std. Err.	t (t-Test)
β_1 : Travel Time	-0.094281	0.021676	-4.349547
β_2 : TC/Income	-267.865344	84.773567	-3.159774
β_4 : Gender	0.808397	0.326729	2.474214
β_6 : Car Ownership	-3.950771	0.725120	-5.448436
β_5 : Marital Status	0.421648	0.309455	1.362550
β_3 : Safety	-0.557875	0.421226	-1.324409
β_0 : Constant (Bus)	0.120623	0.520524	0.231734
Model Statistics			
Adjusted rho squared	0.291641		

When analyzing the variables influencing this model, it is necessary to know that each estimated coefficient demonstrates the extent to which the variable affects the utility related to a transportation mode, and consequently, the probability of choosing a particular mode.

Car ownership appears as the strongest factor of all, with a highly negative coefficient and a "T" test value of (-5.448). This effect, which has a 99.9% reliability, not only means that car owners prefer their cars, but it also means that their probability of selecting any other mode of transportation (shared car, public service taxi, and bus) is considerably lower than their likelihood compared with traveling using their own cars. In other words, owning a car would very much hinder the potential to shift to other alternatives. The travel time variable has a negative coefficient ($t = -4.349$), with reliability of over than 99.9%. This indicates that with every travel time to travel by alternative modes of transportation, its attractiveness reduces significantly in comparison with private car. Because the individuals are very sensitive to time, any increase in it makes the private car option (which is supposed to be faster) more attractive.

Similarly, the cost-to-income variable (TC/Income) has a strong negative impact ($t = -3.159$), with reliability over 99.9%. This indicates that when the cost of the alternative mode increases compared to an individual's income, the probability of choosing it decreased sharply.

Regarding the demographic characteristics, the gender variable shows a highly significant positive effect ($t = 2.474$), with a reliability of 98%. This positive effect proves that females prefer alternative modes of transportation over private cars, compared to males. Traveling on external routes can cause a risk to female drivers due to political and security situations, as well as the role of social traditions that can limit women driving long distances. Therefore, alternative modes of transportation become a safer and suitable option for them. Finally, the marital status and safety variables have 80% reliability. The positive influence of marital status ($t = 1.362$) indicates that married people find the alternative modes more attractive than a private car compared to single people. In contrast, the negative impact of safety ($t = -1.324$) is an important indicator that individuals feel that an alternative mode of transportation is less safe than their own car, and this perception reduces the likelihood of choosing it.

Beside the crisis conditions (post-October 7 events) as illustrated above, the pre-crisis conditions (pre-October 7 events) model and COVID-19 period model are shown in Tables 9 and 10.

Table 9

Estimation results of the pre-October 7 model

Parameter	Estimate	Std. Err	t (t-Test)
β_1 : Travel Time	-0.192205	0.031119	-6.176391
β_2 : TC/Income	-544.190958	122.810608	-4.431140
β_4 : Gender	0.858927	0.337808	2.542644
β_6 : Car Ownership	-4.069878	0.807548	-5.039800
β_3 : Safety	-0.590326	0.421226	-1.402882
β_0 : Constant (Bus)	1.014486	0.571855	1.774026
β_7 : Worker in Family	0.306899	0.193386	1.586977
Model Statistics			
Adjusted rho squared	0.302431		

Table 10

Estimation results of the COVID-19 period model

Parameter	Estimate	Std. Err	t (t-Test)
β_1 :Travel Time	-0.192205	0.031119	-6.176391
β_2 : TC/Income	-544.190958	122.810608	-4.431140
β_4 : Gender	0.858927	0.337808	2.542644
β_6 : Car Ownership	-4.069878	0.807548	-5.039800
β_3 : Safety	-0.590326	0.421226	-1.402882
β_0 : Constant (Bus)	1.014486	0.571855	1.774026
β_7 : Worker in Family	0.306899	0.193386	1.586977
Model Statistics			
Adjusted rho squared	0.302431		

It is noticeable that the results of the two models are similar because the travel cost and travel time variables in the two periods are similar, and the choices of the commuters are also similar. Therefore, when examining the details of the variables and comparing them with the reference alternative (the private car), it is observed that travel time stands out as the strongest influencing factor in this model, as it recorded a negative and very high "T" test value (-6.176). This value, which has a reliability of over 99.9%, conclusively confirms that individuals are highly time-sensitive. In other words, the longer the travel

time by alternative modes of transportation, the sharply and significantly less attractive it is. It is immediately followed by the car ownership variable, which shows a significant negative impact ($t = -5.039$), with the same degree of reliability exceeding 99.9%. This supports the finding that owning a car makes it very unlikely to switching to other alternatives. The cost-to-income variable (TC/Income) also has a very strong negative impact ($t = -4.431$), and with the same reliability (more than 99.9%),

In terms of demographic characteristics, the gender variable continues to show a positive and highly statistically significant effect ($t = 2.542$), giving it a reliability score exceeding 98%. This effect confirms once again that females tend to significantly prefer alternative modes of transportation over driving a private car, as moving via external roads may represent a danger to female drivers as a result of political and security conditions, as well as the role of social traditions.

An important observation in this model is the emergence of the variable of the number of workers in the family as an influential factor, as it recorded a positive effect ($t = 1.586$) with a reliability score of approximately 90%. This suggests that families with more working individuals may find alternative modes more efficient or economical because not all working family members can use the same private car to commute to their work, thus they looking for the alternative mode. Finally, the safety variable shows a negative effect ($t = -1.402$) with a reliability score exceeding 80%, which again confirms that individuals feel that the alternative method is less safe than their own car.

The final outputs of all models which generated by TransCAD are presented in Appendix E.

The models demonstrated excellent statistical parameters and highly significant test results. Specifically, the Rho-squared indicates overall model strength, values were very good, at 0.302 for the pre-October 7 events model, and 0.292 for the post-October 7 events model indicating strong explanatory power. The obtained McFadden's pseudo Rho-squared value of 0.30 falls exactly within the range that Mcfadden (1977) characterized as an "excellent fit," where he noted that values between 0.2 and 0.4 reflect a high-quality model. This interpretation is further supported by other applied sources, such as the (UCLA Institute for Digital Research and Education, 2024). Statistical methods resources provide evidence and practical explanation of how McFadden's Rho-squared is

interpreted. Furthermore, recent transportation studies, such as that of Elkafoury et al. (2021), the multinomial logit model developed for Tanta City, Egypt, reported close ranges and treated them as strong and reliable results.

The resulted high values of this index indicate that the developed models possess good explanatory power. These values are not only more than statistically acceptable, but also scientifically reliable, and they can effectively describe the main factors influencing decisions of modal choice in transportation.

Modeling results present prominent variations in the behavior of traveler throughout various time periods, and provide increased understanding of the variation in sensitivity to both time and cost under different scenarios and situations

3.4.5.1 Interpretation of Final Models

As mentioned earlier, the results of the two models (pre-October 7 events model and COVID-19 period model) are similar because the cost and time variables in the two periods are similar. The findings of the two main basic models (pre-October 7 model and post-October 7 model) show the existence of steady variables that influence how travelers decide which mode to use, as well as fundamental differences that indicate changes in travelers' priorities and attitudes.

– Interpretation of Statistically Significant Variables (According to Crisis Conditions Model – Post-October 7 War)

This model highlights the key reasons and variables that effect the mode choice decision making in a context of uncertainty. The variables that are statistically significant (at 80% confidence level or higher) can be explained as:

Travel Time: As expected, this variable has naturally a powerful negative impact ($t=-4.35$) on the attractiveness of any mode of transportation. As the trips travel time for a mode become longer, the less people tend to choose it.

Travel Cost: This variable has a powerful negative impact ($t= -3.16$) on the attractiveness of any mode of transportation. As the trip becomes more expensive for a mode, the less people tend to choose it.

Safety: The negative sign of this variable ($t=-1.32$) for private cars means that the safer local travelers feel when traveling in a private car, the more attractive it appears, relatively to other modes.

Gender: The positive and highly significant sign ($t= 2.47$) of this variable reveals that females usually prefer to choose public and shared modes of transportation (shared car, public service taxi, and bus) compared to males.

Marital Status: The positive sign ($t= 1.36$) implies the married respondents are more likely to use public and shared transportation compared with single respondents.

Private Car Ownership: This is the most significant factor in the model. The highly negative coefficient value (-5.45) confirms that not having private car is the greatest and strongest factor influencing travelers to use other mode of transport.

– Interpretation of Normal Conditions Model (Pre-October 7 War Model)

This model describes passengers' behavior in a steady transportation atmosphere. The statistically significant variables could be explained as follows:

Travel Time and Cost: Like in the other model, both these coefficients have a very strong negative effect ($t= -6.17, -4.43$), and therefore were main determinants of choice as well.

Gender and Private Car Ownership: The influence of these two variables ($t= 2.54, -5.04$) has not changed in its sign nor in its intensity since the previous analysis, which is evidence they are solid social and economic factors determining transport choice decisions regardless of any external situation.

Workers in Family: The positive sign ($t= 1.59$) shows that as the number of workers in the family increases, the tendency to use public or shared transport increases. This could be attributed to the fact that there are many trips and destinations for work, and one car is not enough.

Bus Constant: In contrast to the crisis model (post-October 7 war model), this constant was significantly positive ($t= 1.77$) under normal circumstances. This implies that there was an inherent preference to travel by bus, unexplained by the other possible factors. That could be because travelers are familiar with the routes, and that in normal times they're not expensive.

3.4.5.2 Comparison between the normal conditions (pre-October 7 events) model and the crisis conditions (post-October 7 events) model

Comparing the two models reveals a clear difference related to how traveler behavior adapts to crisis. The fundamental differences can be summarized in the following points:

1. Change in Travelers' Sensitivity to Time and Cost: This is the most important finding. In the normal conditions (pre-October 7 events) model, time and cost coefficients were very high (t-test values of -4.43 and -6.18, respectively). This means travelers were highly sensitive to these variables and sought to make the "optimal" decision that saves time and money.

In the crisis conditions (post-October 7 events) model, the value of these coefficients decreased noticeably (t-test values of -4.35 and -3.16, respectively). This decrease does not mean time and cost became unimportant, but rather the travelers' sensitivity to them decreased. This matches observed reality; when the road network becomes unstable and full of checkpoints and waiting time increases, the traveler's goal shifts from trip optimization to ensuring trip completion. The traveler becomes willing to pay higher costs and take routes requiring longer travel time in exchange for ensuring arrival at their destination and workplace and avoiding long waiting times at crowded or temporarily closed checkpoints. This indicates that priority has shifted from efficiency to reliability.

2. Disappearance of Latent Bus Preference: Under normal conditions (pre-October 7 events), buses had special attractiveness, where 44 respondents explained their preference to this mode (statistically significant constant). But under crisis conditions (post-October 7 events), this preference disappeared, indicating that when uncertainty prevails, loyalties and prior preferences fade, and decisions become based more on tangible and available variables at that moment.

3. Impact of Social Factors: Interestingly, the impact of social factors like gender and car ownership remained stable and strong in both models. This indicates these factors represent deep behavioral constraints or tendencies not easily affected by external and exceptional conditions.

Overall, the models succeeded in identifying the main variables governing transportation mode choice decisions and revealed important behavioral change in travelers' priorities

due to changing conditions, highlighting the importance and meaningful comparative analysis conducted in this study.

3.4.6 Utility Functions

For this study, the base alternative was the private car. This implies the estimation and comparison of utility functions for the other modes (the shared car, the public service taxi, and the bus) are considered with respect to the utility of the private car. On this basis, the utility functions for the private car is taken as the reference, and variable coefficients of other modes can be explained through examining the increase or decrease of their attractiveness with respect to the private car.

According to variables listed in Table 7, the general utility functions were structured as follows:

$$- U_{\text{auto}} = \beta_1 \times (TT_{\text{auto}}) + \beta_2 \times (TC/INC_{\text{auto}}) + \beta_3 \times (SAFETY_{\text{auto}})$$

$$- U_{\text{shcar}} = \beta_1 \times (TT_{\text{shcar}}) + \beta_2 \times (TC/INC_{\text{shcar}}) + \beta_4 \times (\text{GENDER}) + \beta_5 \times (\text{M-STATUS}) \\ + \beta_6 \times (\text{CAR-OWN}) + \beta_7 \times (\text{WORKER-FAM})$$

$$- U_{\text{taxi}} = \beta_1 \times (TT_{\text{taxi}}) + \beta_2 \times (TC/INC_{\text{taxi}}) + \beta_4 \times (\text{GENDER}) + \beta_5 \times (\text{M-STATUS}) \\ + \beta_6 \times (\text{CAR_OWN}) + \beta_7 \times (\text{WORKER-FAM})$$

$$- U_{\text{bus}} = ASC_{\text{bus}} + \beta_1 \times (TT_{\text{bus}}) + \beta_2 \times (TC/INC_{\text{bus}}) + \beta_4 \times (\text{GENDER}) \\ + \beta_5 \times (\text{M-STATUS}) + \beta_6 \times (\text{CAR-OWN}) + \beta_7 \times (\text{WORKER-FAM})$$

The following equations used as the functional forms of utility functions for the multinomial logit model based on model results which were developed to describe the behavior of mode choice across different study periods described in the Tables 8, 9, and 10:

3.4.6.1 Utility Functions for post-October 7th events

The following are the utility functions for post-October 7th events for each of the considered modes:

$$U_{\text{auto}} = - 0.094281 \times TT_{\text{auto}} - 267.865344 \times (TC/Income_{\text{auto}}) - 0.557875 \times Safety_{\text{auto}}$$

$$U_{\text{shcar}} = -0.094281 \times TT_{\text{shcar}} - 267.865344 \times (TC/Income_{\text{shcar}}) + 0.808397 \times \text{Gender} \\ + 0.421648 \times \text{Marital Status} - 3.950771 \times \text{Car Ownership}$$

$$U_{\text{taxi}} = -0.094281 \times TT_{\text{taxi}} - 267.865344 \times (TC/Income_{\text{taxi}}) + 0.808397 \times \text{Gender} \\ + 0.421648 \times \text{Marital Status} - 3.950771 \times \text{Car Ownership}$$

$$U_{\text{bus}} = 0.120623 - 0.094281 \times TT_{\text{bus}} - 267.865344 \times (TC/Income_{\text{bus}}) + 0.808397 \times \text{Gender} \\ + 0.421648 \times \text{Marital Status} - 3.950771 \times \text{Car Ownership}$$

3.4.6.2 Utility Functions for pre-October 7th events

The following are the utility functions for pre-October 7th events for each of the considered modes:

$$U_{\text{auto}} = -0.192205 \times TT_{\text{auto}} - 544.190958 \times (TC/Income_{\text{auto}}) - 0.590326 \times \text{Safety}_{\text{auto}}$$

$$U_{\text{shcar}} = -0.192205 \times TT_{\text{shcar}} - 544.190958 \times (TC/Income_{\text{shcar}}) + 0.858927 \times \text{Gender} \\ - 4.069878 \times \text{Car Ownership} + 0.306899 \times \text{Worker In Family}$$

$$U_{\text{taxi}} = -0.192205 \times TT_{\text{taxi}} - 544.190958 \times (TC/Income_{\text{taxi}}) + 0.858927 \times \text{Gender} \\ - 4.069878 \times \text{Car Ownership} + 0.306899 \times \text{Worker In Family}$$

$$U_{\text{bus}} = 1.014486 - 0.192205 \times TT_{\text{bus}} - 544.190958 \times (TC/Income_{\text{bus}}) \\ + 0.858927 \times \text{Gender} - 4.069878 \times \text{Car Ownership} + 0.306899 \times \text{Worker In Family}$$

3.4.6.3 Utility Functions for COVID-19 Period Model

The following are the utility functions for COVID-19 period for each of the considered modes:

$$U_{\text{auto}} = -0.192205 \times TT_{\text{auto}} - 544.190958 \times (TC/Income_{\text{auto}}) - 0.590326 \times \text{Safety}_{\text{auto}}$$

$$U_{\text{shcar}} = -0.192205 \times TT_{\text{shcar}} - 544.190958 \times (TC/Income_{\text{shcar}}) + 0.858927 \times \text{Gender} \\ - 4.069878 \times \text{Car Ownership} + 0.306899 \times \text{Worker In Family}$$

$$U_{\text{taxi}} = -0.192205 \times TT_{\text{taxi}} - 544.190958 \times (TC/Income_{\text{taxi}}) + 0.858927 \times \text{Gender} \\ - 4.069878 \times \text{Car Ownership} + 0.306899 \times \text{Worker In Family}$$

$$U_{\text{bus}} = 1.014486 - 0.192205 \times TT_{\text{bus}} - 544.190958 \times (TC/Income_{\text{bus}}) \\ + 0.858927 \times \text{Gender} - 4.069878 \times \text{Car Ownership} + 0.306899 \times \text{Worker In Family}$$

3.5 Model Validation

The multi-phase validation process used in this research was followed to guarantee the robustness and reliability of the final models, particularly that of the crisis conditions model (post-October 7 events model) which is at the heart of our analysis.

3.5.1 Phase One: Reasonableness and Calibration Tests

The first phase of validation is as highly integrated and continuous part of the model creation as the model construction itself and can be considered as a form of "logical check." Many attempts and trials were also run during this phase, for which the results are analyzed in terms of two basic criteria:

1. Reasonable Sign of Coefficients: Signs were checked and evaluated for each coefficient to ensure common sense fits with transportation theory. For instance, travel time and travel cost coefficients are anticipated to be always negative as their increase mitigates the mode attractiveness. Any model generating positive signs related to these variables were assumed to be nonsensical and the model was dropped or alternatively adjusted.
2. Statistical Significance: T-test values for each variable were cross-checked so the effect is real and not due to chance. A confidence level of 80% was set as the minimum to retain the relatively acceptable variables in the final models, confirming that the chosen variable has reasonable and practical impact.

It is important to know that many of the major variables in the model were higher than this minimum limit considerably, attaining a confidence level of 95%, and some even reached 99% or more, which greatly increases the model's credibility and strength.

This two-step process of assessment and refinement led to dropping the variables that had no effect or had illogical signs, and ensured that the final model successfully completed

and passed the first phase validation round, became reliable, both logically and statistically.

3.5.2 Phase Two: Prediction Capability Assessment

The second stage of validation is concerned with assessing the model's power of prediction, i.e., how well it actually predicts individuals' behavior.

3.5.2.1 Implementation Steps

The following steps were carried out to implement the process:

Step 1: Model Construction on Complete Sample

As already mentioned, the whole sample (265 observations) was used to estimate and calibrate the parameters of the final model.

Step 2: Random Test Sample Selection

A random sub-sample was selected from the entire sample itself of the size of 25% that is approximately 66 observations. This sub-sample acted as the "test set" for assessing the effectiveness of the model considering the internal validation technique.

Step 3: Applying Equations to Test Sample

The fitted model equations were used to predict each test samples of the 66 observations. For each individual in a given sample, the four utility function values were computed through his/her own trip characteristics and socioeconomic settings for the four existing mode alternatives.

Step 4: Determining Expected Choice

The highest score for a single mode (maximum utility) was recorded for each respondent. This is the "expected desired mode" according to the model. After computing the utility values for each mode, these were transformed into selection probabilities using the multinomial logit model equation:

$$P_i = \frac{e^{u_i}}{\sum_j e^{u_j}} \dots \dots \dots 2$$

where:

P_i: The probability that an individual will select a specific travel mode *i*.

U_i : The "utility" or overall attractiveness of the considered mode i , calculated based on variables such as gender, travel time, and cost.

U_j : The "utility" or overall attractiveness of each of the other modes j , calculated based on variables such as gender, travel time, and cost.

Step 5: Results Comparison and Accuracy Calculation

The "expected choice" of the model was compared to the "actual choice" of the participant in reality (as reported in the filled questionnaire). When there was a match of the two choices, we recorded "correct prediction = 1", if no match, then "incorrect prediction = 0".

3.5.3 Validation Results

The results of the validation process indicated that the model successfully predicted 41 out of 66 choices correctly in the test set sample.

As a result, the model's total prediction accuracy rate is:

$$\text{Accuracy of Prediction} = (41 / 66) \times 100\% = 62.12\%$$

The results show that the model is able to reasonably predict about two out of three of transportation mode choice decisions. All the detailed computations for this procedure are already listed in the Appendix E.

3.5.4 Predictive Capability

The obtained accuracy rate is both logical and acceptable outcome especially for discrete choice models that try to predict complex human behavior and decision. A majority of reference studies in the transportation area indicate that the models with more than 60% prediction accuracy are falls within a normal range and is recognized in the literature on transportation choice modeling and satisfactory to explain. For example, Lin (2021) conducted a study about mode choice analysis and prediction of trip chaining behavior and the accuracy rate of his study was 59.16% by using multinomial logit model. A model accuracy level was about 62.68% as obtained by Zhang et al. (2023) concerning on understanding travel mode choice behavior with the influencing factors analysis and prediction with machine learning method in Shanghai City. Finally, Naser et al. (2025) conducted a multinomial logit model for urban transportation mode choice in Nasiriyah City, Iraq, with an accuracy rate of their study was 62%.

Therefore, the obtained results lie within an acceptable range of validity according to academic results of similar works. This reflects the ability of the model to represent major behavioral patterns in spite of complexity.

Most importantly, this result validates that the model is not only a theoretical setup, but also a practical tool that caught the principal variables driving the individual's decisions in reality to a great extent. It predicts about 62% of the trips in an acceptable manner in a complex and rapidly changing transportation environment, which helps to establish its validity and reliability, providing high confidence in the conclusions made, and particularly those related to changes in travelers' sensitivity to time and cost.

Chapter Four

Conclusions and Recommendations

4.1 Introduction

This chapter presents the main conclusions of the study, highlighting how the economic and political conditions affect transportation choice behavior in Palestine. As a result, this chapter outlines the proposed policy and practical recommendations, sorted according to short-, medium-, and long-term considerations, including developing the public transportation system. The chapter also suggests recommendations for future research, including gender studies and economic analysis as related to mode choice.

4.2 Main Conclusions

4.2.1 Key Findings

The findings of this study yielded a number of critical conclusions regarding the determinants of transportation mode choice in Palestine. These are presented hereafter.

1. **Private Transportation Dominance:** Private and shared cars account for 83% of travelers' mode choice, reflecting refraining from considering the public transportation modes as popular modes, indicating their inadequacy and weakness, while referring at the same time to the travelers' preference for modes that offer greater flexibility or are more comfortable. These above results would create several challenges ahead, because the expectations that the future trend of private vehicle ownership and preference would prevail, is alarming and pointing to the need for integrated urban and traffic planning and policies, where poor planning results in growing traffic congestions and declining public transportation use. The problem becomes worse in the event that road development does not keep up with these growth in the numbers of private vehicles, leading to traffic congestion and added travel time and costs to citizens and travelers.
2. **Effect of Exceptional Events:** 73% of the respondents reported that their travel patterns are strongly affected due to October 7 events, which reflect the complex security and economic challenges faced by the Palestinian employees, where the institutions were forced to organize part-time work due to the danger of commuting through Israeli occupation checkpoints on external roads, in addition to the impact of the severe financial crisis suffered by the Palestinian Government and irregular monthly salary payments. This forced the employees to reduce daily trips and rely on temporary

accommodations in Ramallah-Al Bireh urban area, or part-time work as strategies to adapt to these exceptional conditions without needing to change their preferred transportation modes.

3. **Change in Impact to Mode Specific Variables:** Travelers' influenced by time and cost decreased after the October 7 events, indicating a shift in their priorities from looking for efficiency (optimal time and cost) to guaranteeing reliability (safe trip completion). This shift represents the willingness of travelers to accept increased price and longer travel time in exchange for a guaranteed safe arrival.
4. **Weakness and Limitations of the Public Transportation:** The findings reveal a negative assessment of the public transportation modes with respect to cost (unreliable schedules and comfort), which explains the growing dissatisfaction to use it. These findings can straightforwardly explain the growing dissatisfaction for public transportation and the preference for using private or shared cars, as our previous descriptive analysis indicated that about 83% of travelers adopt private car or shared car options. Poor quality of services offered by public transportation in reference to timing, comfort, cost and safety also make the employees consider safer, more comfortable, and more dependable options, resulting in the increasing dependence on private car, even with the high financial costs involved. This pattern generates a vicious cycle, where the reduced use of public transportation leads to less investments in its development, drop of service quality, and increases in traffic congestion.
5. **Potential for Improvement:** About 76% of the respondents indicated that they are interested in traveling using modern public transportation, indicating a strong foundation for the development of an advanced and more attractive mass transit system.

4.2.2 Scientific Contribution

The current study adds to the scientific literature in several ways:

- **Cross-period Comparative Analysis:** As there were limited studies analyzing travel mode selection behavior in Palestine in general, and for commuting to work at specific, this study contributes to cross-period comparative over throughout different time periods in Palestine.

- Modeling under unstable Conditions: The outcome offers a basis to understand how travelers behave under politically and economically unstable environments.
- Local Application: The study provided application of discrete choice models in Palestine territories context, taking into account local conditions.

4.3 Study Limitations and Challenges

There are limitations related to the conducted study. These are illustrated hereafter.

Geographic Focus:

- The study was restricted to work trips for the employees who travels from the West Bank Governorates to Ramallah-Al Bireh urban area, which could affect the generalization of findings to other regions.

Time Period:

- The study looked at certain time periods and results may be different when the political and economic contexts change over time.

Human Behavior Complexity:

- It is hard to predict human behavior with high accuracy because there are so many unobservable variables that influence on decisions on choice mode.

Rapid Changes:

- Rapidity with which the political and economic conditions change, makes it hard to construct stable long-term models.

4.4 Recommendations

This section presents the main recommendations derived from the study results.

4.4.1 Short-Term Recommendations

The short-term recommendations related to the conducted study. These are illustrated hereafter.

4.4.1.1 Improving Current Public Transportations Services

These include improving schedules and regulated services through:

- Developing programmed services through setting fixed and reliable schedules for all public transportation routes in order to achieve timely and scheduled adherence to service.
- Setting common standards for the quality of the vehicles, regularly arranging for maintenance, and making sure they possess comfortable seats and air conditioning.
- Reviewing and adjusting public transportation prices, so that public transportation can compete better with other modes of transportation.
- The government should plan and implement a framework to support public transportation, which help to reduce its cost and motivate people to use it.

4.4.1.2 Organizing Shared Transportation

This implies organizing ride-sharing applications through:

- Setting up a legal framework for ride-sharing applications to maintain safety and quality standards.
- Establishing and developing regulated, licensed, and organized parking spaces with preferential treatment for shared cars in main locations.

4.4.1.3 Government Encouragement for Shared Transportation

- Encouraging and motivating the Palestinian government ministries, official institutions and private sector enterprises to organize employees in carpooling or vanpooling, and promoting this trend to better manage the demand for travel of the common drive alone of private car mode.
- Offering free parking service for employees who share car with their colleagues when they travel to work. Based on this, applying parking fees on employees that come to work by driving alone their private cars in order to promote ridesharing between employees.

4.4.2 Medium-Term Recommendations

The medium-term recommendations related to the conducted study. These are illustrated hereafter

4.4.2.1 Creating and Developing Modern Public Transportation Network

This involves establishing rapid transit lines, and public transportation sector support through:

- Building and developing Bus Rapid Transit (BRT) lines to link the city center to the urban periphery with modern stations that have all important facilities and requirements. This BRT system combined with park-and-ride facilities located at the city boundaries that allow the employees to park their cars and continue their trips by BRT.
- Applying Modern Technology: Applying modern technologies such as e-payment systems and real-time passenger information on bus arrival and departure times.
- Supporting public transportation sector by the government, and considering investment in this sector as part of the necessary financial support for service quality and expansion.
- Supporting granting concessionary ticket prices for students, the elderly, and disabled people.
- Providing special incentives and promotional package deals to public transport riders including discount monthly/annual fares.

4.4.2.2 Infrastructure Development

Expanding Main Roads:

- Creating Park-and-Ride Facilities, implying constructing organized parking lots in urban areas linked to public transportation system.

4.4.3 Long-Term Recommendations

The long-term recommendations related to the conducted study. These are illustrated hereafter.

4.4.3.1 Sustainable Urban Planning

- Developing integrated regional planning: This is recommended to mitigate the need for long-distance traveling between the cities through a planning for balanced distribution of jobs and services, and promoting development geared towards high-efficiency public transportation linking major urban centers to surrounding residential areas and other governorates.
- Establishing regional multimodal transportation centers: Serving transportation between cities, and providing effective meeting and connection points between different modes of transportation (such as buses, shared taxis, and private modes of transportation) to facilitate employees' long trips to Ramallah-Al Bireh urban area, and improve the efficiency and comfort of these movements.

4.4.3.2 Economic and Environmental Policies

Promote sustainable transportation options, through:

- Developing policies and implementing regulations that support using clean and environmentally friendly modes of transportation.
- Financing policy review, especially as related to bank financing with respect to private cars to keep balance with the development of public transportation.

4.4.4 Policy Implications

The findings have several policy implications that are highlighted as:

- Need for Development of Public Transportation: Imperative to develop a modern and efficient public transportation system in order to minimize the dependence on private vehicles.
- Transportation Planning is important: It is essential to develop comprehensive transportation planning for the short-, medium-, and long-term, to manage and control the continuous rise in private cars.
- Exceptional Circumstances Consideration: There is need of developing contingency transportation plans, taking into account changes in security and economic conditions.

4.4.5 Recommendations for Future Research

- Carry out in-depth research of the impact of gender on transportation mode choice decision in the Palestinian setting.
- Carry out a full economic cost-benefit analysis, considering all the costs and benefits of developing an advanced public transportation system.
- Build and develop dynamic models that show changes in traveler behavior over time.
- Conduct environmental effect analysis to assess the impact of various transportation modes as related to environmental aspects and to suggest sustainable solutions.

List of Abbreviations

Abbreviation	Meaning
COVID-19	Coronavirus Disease 2019
MNL	Multinomial Logit
ASC	Alternative Specific Constant
TT	Travel Time
TC	Travel Cost
INC	Income
PC	Private Car
Auto	Auto car (Private Car)
Shcar	Shared Car
TX	Taxi/Service
PB	Public Bus
LL	Log-Likelihood
ρ^2	Rho-squared
Std. Err.	Standard Error
t-Test	t-Test
GENDER	Gender
M_STATUS	Marital Status
CAR_OWN	Car Ownership
WORKER_FAM	Workers in Family
SAFETY	Safety Perception
BRT	Bus Rapid Transit
U	Utility Function
NIS	New Israeli Shekel
HEATCO	Harmonized European Approaches for Transport Costing and Project Assessment
PNA	Palestinian National Authority
MOT	Ministry of Transportation

References

- Alkafoury, et al., A.-S. M. (2012). *Ahmed Mohamed Abd Elhamed Alkafoury, B., El-Shabrawy Mohamed Ali, M., & Hafez Abbas Afify, A. (2012). Transportation Planning Process for Urban Areas-Case Study Tanta City.* https://www.researchgate.net/publication/273462214_Transportation_Planning_Process.
- Abdulhaq, D. (2016). *Transportation Mode Choice Model for Palestinian Universities Students: A Case Study on An-Najah New Campus, Master's Thesis, An-Najah National University, Nablus, Palestine.* <https://staff.najah.edu/en/publications/7849/>.
- Akter, T., & Alam, B. (2024). *Travel mode choice behavior analysis using multinomial logit models towards creating sustainable college campus: a case study of the University of Toledo, Ohio.* *Frontiers in Future Transportation*, 5. <https://doi.org/10.33>.
- Al-Ahmadi et al., H.-M.-S. (2005). *Development of Intercity Mode Choice Models for Public Transport in Saudi Arabia: Requirements and Responsibilities.* *Journal of King Abdulaziz University-Engineering Sciences*, 16(1), 17–34. <https://doi.org/10.1016/j.jksues.2005.01.001>.
- Al-Ahmadi, H. (2006). *Development of Intercity Mode Choice Models for Saudi Arabia.* *In Journal of King Abdulaziz University: Engineering Sciences* 17(1)1).
- Al-Ahmadi, H. (2006). *Development of Intercity Mode Choice Models for Saudi Arabia.* *Journal of King Abdulaziz University: Engineering Sciences*, 17(1), 3–21.
- Ali, et al., N. (2025). *Modelling the mode choice behaviour of Mobility-as-a-Service (MaaS) users in the Solent of the UK.* *Transportation Research Interdisciplinary Perspectives*, 29, 101335. [https://doi.org/10.1016/j.tri](https://doi.org/10.1016/j.tri.2025.101335).
- Alkaabi, K. (2016). *Modeling travel choice behavior of airport employees for commuting to work at Dubai International Airport, UAE.* *Sustainable Development and Planning VIII*, 1, 577–589. <https://doi.org/10.2495/sdp160481>.
- Alkaabi, K. (2019). *Modelling Traveler's Ground Access Mode Choice OF Dubai International Airport, United Arab Emirates.* *Journal of Air Transport Studies*, 10(1), 87–109. <https://doi.org/10.38008/jats.v10i1.18>.

- Almasri, E., & Alraee, S. (2013). *Factors affecting mode choice of work trips in developing cities: Gaza as a case study*. *Journal of Geographic Information System*, 5(6), 540–546. <https://doi.org/10.4236/jgis.2013.34026>.
- Al-Sahili, K., & Sadeq, A. (2003). *Ridership demand modeling for Palestinian intercity public transport*. *Journal of Public Transportation*, 6(2), 19–35.
- Al-Sahili, K., & Sadeq, A. (2004). *Elasticity of intercity buses in the West Bank*. *An-Najah University Journal for Research – Natural Sciences*, 18(2), 157–171.
- Ashraf, et al., M.-K. (2023). *Analysis of a Students' Travel Mode Choice Behavior: A Case Study in Oman*. In *Proceedings of the Eastern Asia Society for Transportation Studies (Vol. 14)*.
- De Oliveira, M., & Lima, J. (2023). *A multinomial logistic regression model for public transportation use in a medium-sized Brazilian city*. *Production*, 33. <https://doi.org/10.1590/0103-6513.20230027>.
- Deka, D., & Carnegie, J. (2021). *Predicting transit mode choice of New Jersey workers commuting to New York City from a stated preference survey*. *Journal of Transport Geography*, 91, 102965. <https://doi.org/10.1016/J.JTRANGEO.2021.102965>.
- Deneke, et al., Y. (2024). *Transportation Mode Choice Behavior with Multinomial Logit Model: Work and School Trips*. *Transactions on Transport Sciences*, 15(1), 17–27. <https://doi.org/10.5507/tots.2023.019>.
- Elkafoury, et al., A. (2021). *Multinomial Logit Utility Model for Tanta City Transportation System considering Ridesharing Mode*. *Journal of Engineering Research (ERJ)*, 5(2), 65-73. <https://doi.org/10.2495/sdp160481>.
- Fan, et al., M. (2024). *A study on commuters' public transportation mode choice behavior in river valley-type cities considering terrain spatial perception: evidence from Lanzhou, China*. *Scientific Reports*, 14, 13237. [http](http://).
- Ferreira, et al., S. C. (2022). *Travel mode preferences among German commuters over the course of COVID-19 pandemic*. *Transport Policy*, 126, 55–64. <https://doi.org/10.1016/j.tranpol.2022.07.011>.

- Gao, Y., & Zhao, P. (2024). *Tracing long-term commute mode choice shifts in Beijing: four years after the COVID-19 pandemic*. *Humanities and Social Sciences Communications*, 11, 1566. <https://doi.org/10.1057/s41599-024-04103-0>.
- Gunn, E., & Deinne, C. (2025). *Analysis of Gender Differences in Modal Choice among Residents of Coastal Communities of Yenagoa Metropolis in Bayelsa State, Nigeria*. *Journal of Transportation Technologies*, 15(01), 60–74. <https://doi.org/10.4236/jtts>.
- Lin, C.-W. (2021). *Mode Choice Analysis and Prediction of Trip Chaining Behavior: Using Multinomial Logit Model and Validating with Neural Network Machine Learning*. Doctoral dissertation. University of Wisconsin–Madison. <https://search.library.wisc.edu/di>.
- Lodi, et al., C. (2024). *Students' commuting habits to the university: Transportation choices during the Covid-19 era*. *Case Studies on Transport Policy*, 17. <https://doi.org/10.1016/j.cstp.2024.101217>.
- Makkonen, et al., A. I. (2024). *Development of a multifactorial prediction model for commute mode choice in 10,983 Finnish public sector employees: A cross-sectional study*. *BMJ Open*, 14(10). <https://doi.org/10.1136/bmjopen-2023-080276>.
- Mcfadden, D. (1977). *Quantitative Methods for Analyzing Travel Behaviour of Individuals: Some Recent Developments*. *Individuals: Some Recent Developments*. <https://elischolar.library.yale.edu/cowles-disc>.
- Meyer, M., & Miller, E. (2001). *Urban Transportation Planning: A Decision-Oriented Approach*, 2nd Ed., McGraw-Hill https://www.researchgate.net/publication/235363396_Urban_Transportation_Planning_A_Decision-Oriented_Approach.
- Ministry of Transport (MOT). (2016). *Road and Transportation Master Plan: West Bank and Gaza Strip*.
- Naser, et al., I. (2025). *A Multinomial Logit Model for Urban Transportation Mode Choice in Nasiriyah City*. *International Journal of Computational and Experimental Science and Engineering*, 11(3), 3849-3861. <https://doi.org/10>.

- Noman, et al., S. (2024). *Trends of Mode Choice and Promotion of Sustainable Transportation in Mega City of Developing Countries: A Case Study for Karachi*. *Scientific Journal of Silesian University of Technology. Series Transport*, 125, 191–212. <https://doi.org/10.20858/sjsutst.202>.
- Obaid, L., & Hamad, K. (2020). *Modelling Mode Choice at Sharjah University City, United Arab Emirates*. *MATEC Web of Conferences*, 308, 02004. <https://doi.org/10.1051/mateconf/202030802004>.
- Ruiz-Pérez, M., & Seguí-Pons, J. (2020). *Transport mode choice for residents in a tourist destination: The long road to sustainability (the case of mallorca, Spain)*. *Sustainability (Switzerland)*, 12(22), 1–31. <https://doi.org/10.3390/su12229480>.
- UCLA Institute for Digital Research and Education. (2024). *What are pseudo R-squared*. <https://chatgpt.com/c/692aac39-3d80-832c-afa9-dbf573f169d9>.
- Yanar, T. (2023). *Understanding the choice for sustainable modes of transport in commuting trips with a comparative case study*. *Case Studies on Transport Policy*, 11. <https://doi.org/10.1016/j.cstp.2023.100964>.
- Youssef, et al., Z. (2021). *Modeling the modal shift towards a more sustainable transport by stated preference in Riyadh, Saudi Arabia*. *Sustainability (Switzerland)*, 13(1), 1–19. <https://doi.org/10.3390/su13010337>.
- Yu, Y. (2018). *Understanding University Students' Intercity Transport Mode Choice: A Case Study of the University of Waterloo Students' Travel Behavior between the Region of Waterloo and the Greater Toronto and Hamilton Area*. <https://uwspace.uwaterloo.ca/>.
- Zhang, et al., H. (2023). *Understanding Travel Mode Choice Behavior: Influencing Factors Analysis and Prediction with Machine Learning Method*. *Sustainability*, 15, 11414. <https://doi.org/10.3390/su151411414>.

Appendices

Appendix A

Distribution of the Study Population by Sector and Institution

Sector	Institution	Total Employees	Employees in Ramallah-Al Bireh urban area	Commuting Employees	Percentage (%)
Government Sector	Ministry of Public Works & Housing	355	220	83	4.9%
	Ministry of Education and Higher Education	42,092	3652	1,198	70.3%
	Ministry of Local Government	341	157	57	3.3%
	Ministry of Agriculture	1,260	243	90	5.3%
	Ministry of Health	9,219	1662	30	1.8%
	Subtotal	53,267	5934	1,458	85.5%
Banking Sector	Arab Bank	910	491	10	0.6%
	Palestine Islamic Bank	582	298	64	3.8%
	Safa Bank	183	127	10	0.6%
	Arab Islamic Bank	670	364	26	1.5%
	Palestine Investment Bank	308	185	19	1.1%
Subtotal	2,653	1465	129	7.6%	
Insurance Sector	Takaful Insurance	204	96	18	1.1%
	Holy Land Insurance Co.	72	34	1	0.1%
	Al-Mashreq Insurance	228	103	18	1.1%
	Tamkeen Insurance	151	85	7	0.4%
	Al-Baraka Insurance	84	36	4	0.2%
	Ahliea Insurance Group	127	52	12	0.7%
	Trust International Insurance Co.	234	106	18	1.1%
	Palestine Insurance Co.	164	88	17	1.0%
	Global United Insurance	188	69	9	0.5%
	National Insurance Co. (NIC)	223	99	14	0.8%
Subtotal	1,675	768	118	6.9%	
Total	57,595	8167	1,705	100%	

Appendix B

Questionnaire Form

استبانة حول سلوك اختيار وسيلة السفر للموظفين للتنقل إلى العمل في محافظة رام الله/ البيرة

عزيزي الموظف في القطاع العام / القطاع الخاص

تحية طيبة وبعد :

يقوم الباحث عدي حسن عطية صلاحات وتحت إشراف الأستاذ الدكتور سمير أبو عيشة بإعداد رسالة ماجستير بعنوان :

**Modeling mode choice behavior of employees for commuting to work in
Ramallah-Al Bireh**

نمذجة سلوك اختيار وسيلة السفر للموظفين للتنقل إلى العمل في محافظة رام الله/ البيرة

وتهدف هذه الدراسة الى عمل نموذج رياضي لجميع وسائل المواصلات المستخدمة من قبل موظفي القطاع العام / الخاص المتوجهين لأماكن عملهم في مدينة رام الله / البيرة لبحث فرص تحسين أداء هذه الوسائل ومعالجة زيادة أعداد المركبات الخاصة وما تسببه من أزمات مرورية وكذلك التعرف على مدى الإقبال / العزوف عن استخدام وسائل النقل العام ووضع الحلول المناسبة لتطويرها. ومن المؤمل أن تؤدي الدراسة الى توصيات ومقترحات عملية الى المؤسسات والجهات ذات العلاقة لتطوير وتحسين وسائل النقل في الضفة الغربية مما ينعكس إيجابا على راحة الموظفين وجودة عملهم وتخفيف الأعباء الاقتصادية عبر تحقيق التنقل الآمن والمستدام.

يرجى التكرم بتعبئة الاستبيان والإجابة عن الأسئلة المرفقه للمساعدة في جمع البيانات الخاصة بالأطروحة، علماً بأن:

- ✓ المعلومات الواردة في البيانات لأغراض البحث العلمي فقط مع مراعاة السرية التامة.
- ✓ بمجرد تعبئة الاستبيان والاجابة على الأسئلة فهي موافقة على المشاركة في الدراسة البحثية المذكورة وان المشاركة في هذه الدراسة هي تلقائية واختيارية ولا مانع من المشاركة في هذه الدراسة بعد فهم الغرض منها.

مع وافر الاحترام،

الباحث: م. عدي صلاحات

1. الجنس:
 () ذكر () أنثى
2. العمر:
 ()
3. الحالة الاجتماعية:
 () أعزب () متزوج / ة
 () منفصل / ة () أرمل / ة
4. عدد أفراد الأسرة:
 ()
5. كم يبلغ عدد العاملين في الأسرة:
 ()
6. عدد الأبناء العاملين (في حال وجود أبناء):
 ()
7. المهنة: _____
8. مستوى التعليم (آخر درجة حصلت عليها):
 () ثانوية عامة () دون الثانوية العامة
 () بكالوريوس () معهد متوسط
 () ماجستير () دبلوم عالي
 () دكتوراة
9. مكان السكن:
 المدينة: _____ القرية: _____ المخيم:
10. هل تمتلك سيارة خاصة:
 () نعم () لا
11. كم يبلغ معدل دخل العائلة الشهري:
 () شيقل
12. في حال كنت تمتلك سيارة خاصة ، ما الطريقة التي امتلكت بها سيارتك الخاصة:
 () نقداً - كاش - () عن طريق البنك
 () دفعة نقدية + شيكات شخصيه () تمويل عن طريق شركات التمويل

13. كيف تصل يومياً من مكان سكنك الى مقر عملك (في حال استخدام أكثر من وسيلة مواصلات واحدة في نفس الرحلة يمكنك الإشارة الى أكثر من خيار): يرجى الإجابة وفق الجدول التالي لكل حالة.

وسيلة النقل	الفترة الحالية (بعد احداث 7 أكتوبر)	الوضع الطبيعي (قبل احداث 7 أكتوبر)	فترة الكورونا
سيارتك الخاصة (لوحدك أو مع أفراد من العائلة)، كم عدد الركاب الاجمالي بمن فيهم أفراد العائلة: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>
سيارتك الخاصة (مع زميل/زملاء في العمل)، كم عدد الركاب الاجمالي: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>
راكبا في سيارة خاصة (مع زميل/زملاء في العمل)، كم عدد الركاب الاجمالي: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>
سائقا سيارة خاصة تملكها المؤسسة / الشركة التي تعمل بها (مع زميل/زملاء في العمل)، كم عدد الركاب الاجمالي: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>
راكبا في سيارة خاصة تملكها المؤسسة / الشركة التي تعمل بها (مع زميل/زملاء في العمل)، كم عدد الركاب الاجمالي: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>
سيارتك الخاصة (مع آخرين عن طريق مجموعات "وصلني معك" عبر مواقع التواصل)، كم عدد الركاب الاجمالي: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>
راكبا في سيارة خاصة (عن طريق مجموعات "وصلني معك" عبر مواقع التواصل)، كم عدد الركاب الاجمالي: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>
راكبا في باصات النقل العام (باص 20_ 50 راكب)	<input type="text"/>	<input type="text"/>	<input type="text"/>
راكبا في سرفيس النقل العام	<input type="text"/>	<input type="text"/>	<input type="text"/>
غير ذلك: _____	<input type="text"/>	<input type="text"/>	<input type="text"/>

14. هل تعود من مقر عملك الى مكان سكنك بنفس وسيلة التنقل أعلاه:
() نعم () لا ، حدد وسيلة التنقل : _____

15. في حال استخدمت سيارتك الخاصة من مكان سكنك الى مقر عملك:
() تذهب لوحده () تأخذ معك ركاب وزملاء للمشاركة في مصروف المحروقات، يرجى تحديد عدد الركاب _____

16. في حال استخدمت سيارتك الخاصة من مقر عملك الى مكان سكنك:
() تذهب لوحده

() تأخذ معك ركاب وزملاء للمشاركة في مصروف المحروقات، يرجى تحديد عدد الركاب _____
17. كم دقيقة تستغرق رحلة القوم من مكان سكنك الى مقر عملك: _____

18. كم تكلفة المواصلات يوميا من مكان سكنك الى مقر عملك (حسب وسيلة النقل التي تستخدمها):

19. كم دقيقة تستغرق رحلة العودة من مقر عملك الى مكان سكنك: _____

20. كم تكلفة المواصلات يوميا من مقر عملك الى مكان سكنك (حسب وسيلة النقل التي تستخدمها):

21. ما هو تقييمك لوسيلة المواصلات التي تستخدمها حاليا حسب النواحي المذكورة:

التكلفة	ممتاز	جيد جداً	جيد	مقبول	سيئ
التكلفة					
السرعة					
الراحة					
الأمان					

22. في حال كنت لا تستخدم وسائل النقل العام، ما أسباب عدم استخدامك لها (يمكن ذكر أكثر من سبب):

() التكلفة العالية () عدم توافرها في جميع الاوقات
() عدم الراحة () عدم الالتزام بالوقت لانطلاق الرحلة أو جدولة للرحلات
() أسباب أخرى ، يرجى كتابة السبب : _____

23. ما هو تقييمك لوسائل النقل العام بين المحافظات في الضفة الغربية:

التكلفة	ممتاز	جيد جداً	جيد	مقبول	سيئ
التكلفة					
السرعة					
الراحة					
الأمان					

24. لو تم توفير وسائل نقل عام جماعي (بالباصات الحديثة) من مقر محافظتك لمكان عملك تقدم خدماتها بشكل دائم وبأوقات منتظمة، هل تستخدم وسائل النقل العام هذه:

() نعم () لا

25. في حال كانت اجابتك بـ لا في السؤال السابق، يرجى كتابة السبب:

26.

27. هل فترة الكورونا عملت على تغيير على نمط الرحلات والتنقل الى مكان عملك مقارنة بما كانت عليه قبل هذه الفترة:

() لا

() نعم من خلال: () قمت بترتيب المبيت في رام الله/البيرة وعدم التنقل يوميا
() قامت المؤسسة التي اعمل بها بترتيب دوام جزئي في رام الله/البيرة.

() ترتيبات أخرى / يرجى ذكرها

28. هل احداث 7 أكتوبر عملت على تغيير على نمط الرحلات والتنقل الى مكان عملك مقارنة بما كانت عليه قبل هذه الاحداث:

() لا

() نعم من خلال: () قمت بترتيب المبيت في رام الله/البيرة وعدم التنقل يوميا

() قامت المؤسسة التي اعمل بها بترتيب دوام جزئي في رام الله/البيرة.

() ترتيبات أخرى / يرجى ذكرها

Appendix C

Figures

Figure C.1

Sample distribution by COVID-19 pandemic impact on employee mobility patterns

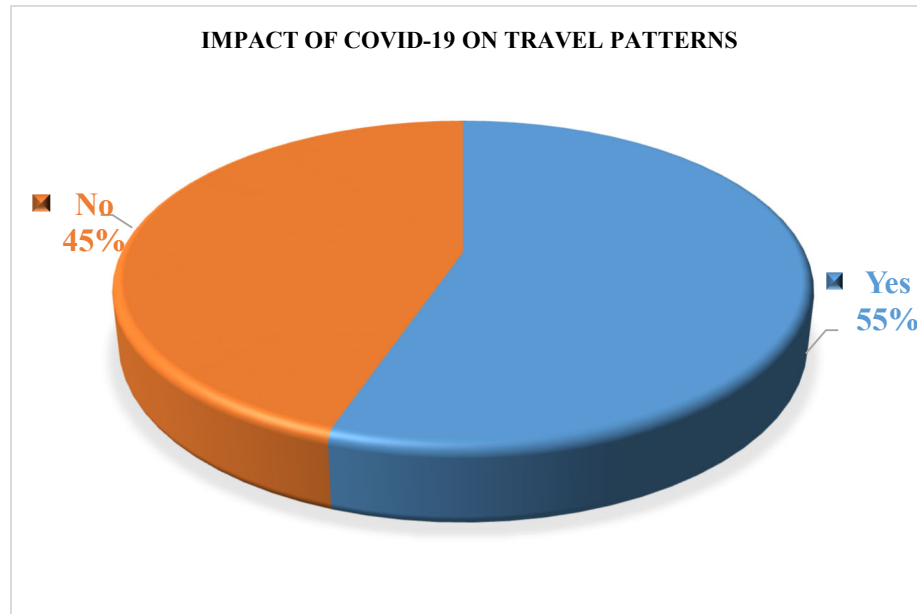


Figure C.2

Reasons for the impact of the COVID-19 pandemic on travel patterns

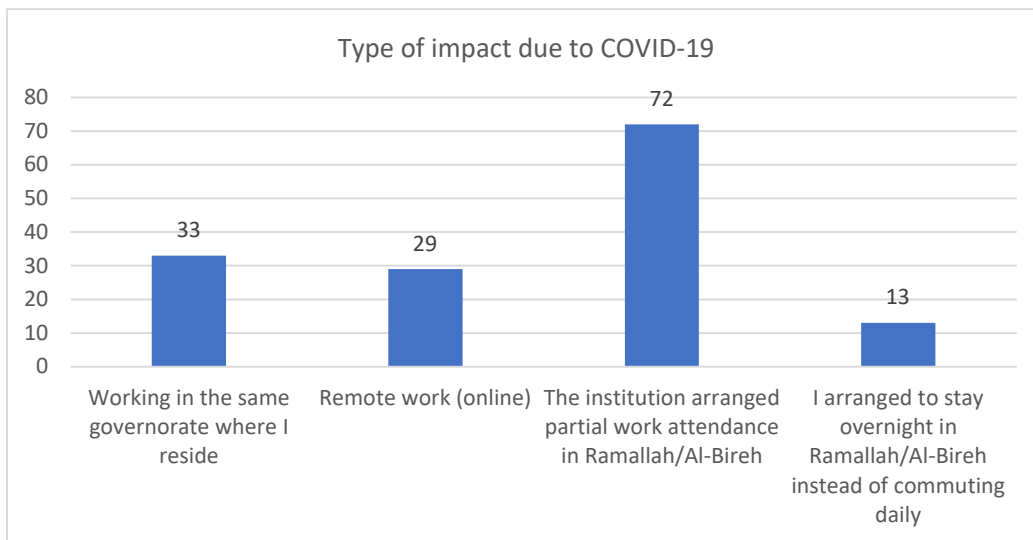


Figure C.3

Sample distribution by October 7 events impact on employee mobility patterns

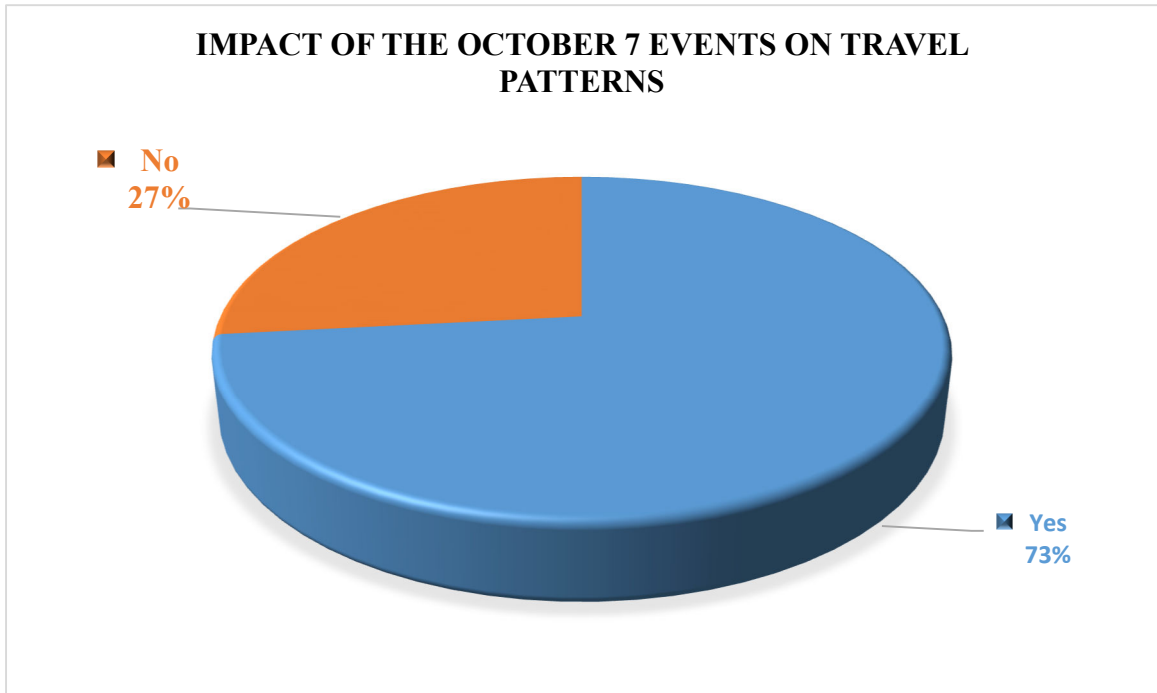
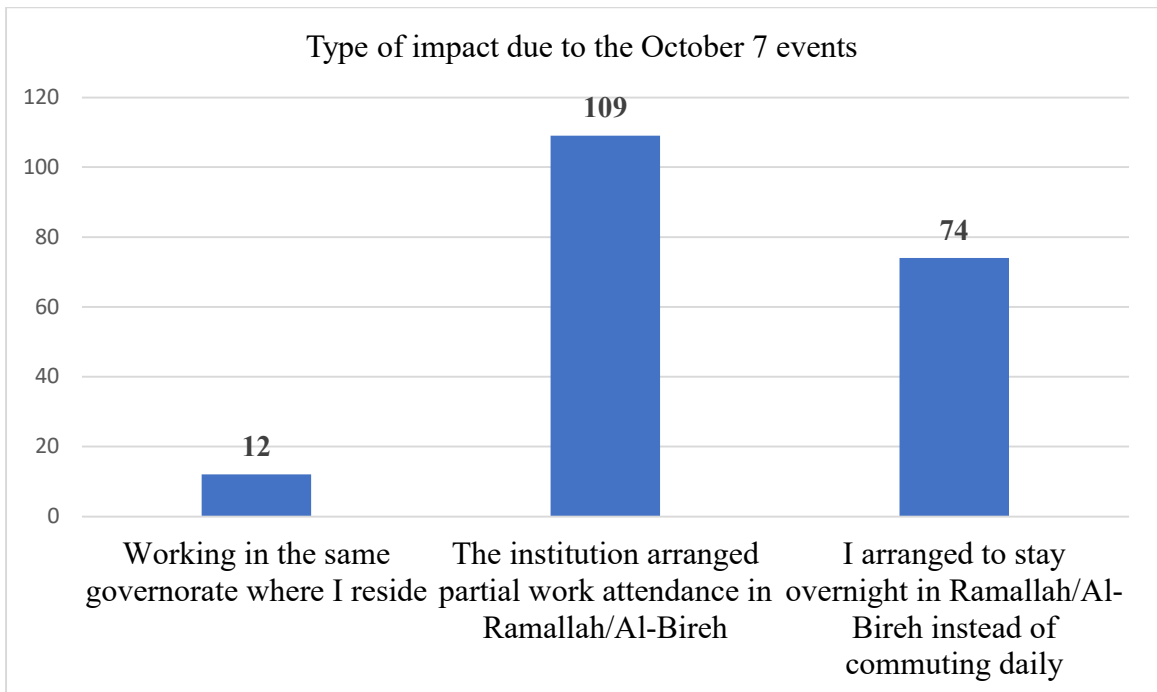


Figure C.4

Reasons for the impact of the October 7 events on travel patterns



Appendix D
Trans CAD Results

Results of the Post-Crisis Model (Post-7 October Model)

Starting Procedure Multinomial Logit Estimation on August 17, 2025 (04:15 PM)

Valid Cases: 265

Choice Distribution

auto	111	41.9
shcar	109	41.1
taxi	32	12.1
bus	13	4.9

Maximum likelihood reached at iteration 21

Parameter	Estimate	Std. Err.	t
Test			
Comfort	0.350919	0.448751	0.781989
Safety	-0.557875	0.421226	-1.324409
[Travel Time]	-0.094281	0.021676	-4.349547
[TC/Income]	-267.865344	84.773567	-3.159774
Gender	0.808397	0.326729	2.474214
Age	-0.003095	0.018166	-0.170360
[Marital Status]	0.421648	0.309455	1.362550
[Family Size]	0.123859	0.123565	1.002380
[Worker in Family]	0.174828	0.181612	0.962647
Job	0.010023	0.123476	0.081177
[Educational Level]	-0.240613	0.270963	-0.887990
[Car Ownership]	-3.950771	0.725120	-5.448436
Constant	0.120623	0.520524	0.231734
Log-likelihood at zero:	-367.368006		
Log-likelihood at end:	-247.228455		
-2 (LL(zero) - LL(end)):	240.279101		
Asymptotic rho squared:	0.327028		

Adjusted rho squared: 0.291641

Total Running Time 487621:15:11.022

Results of the Pre-Crisis (Pre-7 October Model)

Starting Procedure Multinomial Logit Estimation on August 17, 2025 (04:50 PM)

Valid Cases: 265

Choice Distribution

auto	111	41.9
shcar	109	41.1
taxi	32	12.1
bus	13	4.9

Maximum likelihood reached at iteration 21

Parameter	Estimate	Std. Err.	t
Test			
[Travel Time]	-0.192205	0.031119	-6.176391
[TC/Income]	-544.190958	122.810608	-4.431140
Comfort	0.462076	0.453785	1.018270
Safety	-0.590326	0.420795	-1.402882
Gender	0.858927	0.337808	2.542644
Age	-0.001488	0.018582	-0.080088
[Marital Status]	0.273189	0.318009	0.859061
[Family Size]	0.140362	0.127815	1.098164
[Worker in Family]	0.306899	0.193386	1.586977
Job	-0.051160	0.129978	-0.393606
[Educational Level]	-0.229493	0.276588	-0.829730
Carownership	-4.069878	0.807548	-5.039800
Constant	1.014486	0.571855	1.774026

Log-likelihood at zero: -367.368006

Log-likelihood at end: -243.264391

2-(LL(zero) - LL(end)): 248.207229

Asymptotic rho squared: 0.337818

Adjusted rho squared: 0.302431

Total Running Time 487621:50:52.668

Results of the COVID-19 Period Model

Starting Procedure Multinomial Logit Estimation on August 18, 2025 (05:14 PM)

Valid Cases: 265

Choice Distribution

auto 111 41.9

shcar 109 41.1

taxi 32 12.1

bus 13 4.9

Maximum likelihood reached at iteration 21

Parameter	Estimate	Std. Err.	t Test
[Travel Time]	-0.192205	0.031119	-6.176391
[TC/Income]	-544.190958	122.810608	-4.431140
Comfort	0.462076	0.453785	1.018270
Safety	-0.590326	0.420795	-1.402882
Gender	0.858927	0.337808	2.542644
Age	-0.001488	0.018582	-0.080088
[Marital Status]	0.273189	0.318009	0.859061
[Family Size]	0.140362	0.127815	1.098164
[Worker in Family]	0.306899	0.193386	1.586977
Job	-0.051160	0.129978	-0.393606
[Educational Level]	-0.229493	0.276588	-0.829730
Carownership	-4.069878	0.807548	-5.039800
Constant	1.014486	0.571855	1.774026

Log-likelihood at zero: -367.368006
Log-likelihood at end: -243.264391
2-(LL(zero) - LL(end)): 248.207229
Asymptotic rho squared: 0.337818
Adjusted rho squared: 0.302431
Total Running Time 487622:45:30.558

Appendix E

Validation Calculations

Correct Prediction	Max. Utility Function	Bus Utility Function	Taxi Utility Function	Shared Car Utility Function	Private Car Utility Function	Str-Choice	Safety_auto	bus cost per income	taxi cost per income	shear cost per income	auto cost per income	TTBus	TTtaxi	TTshear	TTauto	Car Ownership	Marital Status	Gender	ID
1	shear	-9.19	-7.66	-7.03	-12.1	shear	4	0.0017	0.0026	0.0020	0.0050	120	100	95	90	0	2	2	1
0	shear	-13.1	-12.2	-11	-16	taxi	4	0.0040	0.0055	0.0045	0.0091	150	135	125	120	0	1	2	2
1	shear	-23.5	-22.1	-20.6	-21.5	shear	4	0.0050	0.0064	0.0043	0.0086	220	200	190	180	1	2	2	3
0	shear	-16.9	-15.8	-14.8	-15.2	auto	4	0.0022	0.0030	0.0025	0.0060	150	135	125	120	1	2	1	4
0	shear	-13.6	-12	-11.4	-12.6	auto	5	0.0017	0.0026	0.0020	0.0050	120	100	95	90	1	1	2	5
1	auto	-10.3	-8.78	-7.69	-7.37	auto	4	0.0019	0.0028	0.0022	0.0033	85	65	55	45	1	1	2	6
0	shear	-18.1	-17.2	-16	-17.1	auto	4	0.0049	0.0067	0.0056	0.0133	150	135	125	120	1	1	1	7
1	auto	-24.1	-22.7	-21.2	-21.2	auto	4	0.0044	0.0056	0.0038	0.0075	220	200	190	180	1	2	1	8
0	shear	-13.6	-12.1	-11.5	-12.5	auto	4	0.0019	0.0029	0.0022	0.0067	120	100	95	90	1	1	2	9
1	auto	-14.5	-13	-12.3	-11.8	auto	3	0.0021	0.0033	0.0025	0.0063	120	100	95	90	1	1	1	10
1	shear	-11.9	-10.9	-9.65	-9.76	shear	4	0.0030	0.0040	0.0030	0.0070	90	75	65	60	1	1	1	11
1	shear	-10.2	-11.1	-9.85	-10.2	shear	4	0.0038	0.0050	0.0038	0.0088	70	75	65	60	1	1	1	12
1	shear	-23	-21.8	-20.2	-22.6	shear	4	0.0085	0.0106	0.0064	0.0128	210	190	185	180	1	3	2	13
1	shear	-13.3	-12	-11.2	-13.7	shear	4	0.0038	0.0058	0.0044	0.0111	120	100	95	90	1	3	2	14
1	shear	-25.2	-24	-22.2	-22.4	shear	4	0.0070	0.0090	0.0060	0.0120	220	200	190	180	1	1	1	15
0	shear	-14.9	-13.6	-12.8	-13.5	auto	4	0.0035	0.0054	0.0042	0.0104	120	100	95	90	1	1	1	16
0	shear	-14.9	-13.7	-12.9	-13.1	auto	4	0.0038	0.0058	0.0044	0.0089	120	100	95	90	1	1	1	17
1	shear	-13	-12	-10.9	-15.3	shear	4	0.0037	0.0050	0.0042	0.0067	150	135	125	120	0	1	2	18
1	shear	-21.9	-20.3	-19.5	-20.3	shear	4	0.0027	0.0033	0.0020	0.0040	210	190	185	180	1	2	2	19
0	shear	-10.3	-8.94	-8.2	-12.9	taxi	4	0.0028	0.0043	0.0033	0.0083	120	100	95	90	0	2	1	20
1	shear	-25	-23.8	-22.1	-22.1	shear	4	0.0064	0.0080	0.0055	0.0109	220	200	190	180	1	1	1	21
0	shear	-5.46	-4.74	-3.69	-7.21	taxi	4	0.0006	0.0010	0.0006	0.0010	75	65	55	50	0	2	1	22
1	auto	-9.72	-8.31	-7.15	-6.7	auto	2	0.0028	0.0042	0.0033	0.0050	85	65	55	45	1	3	2	23
1	auto	-22.9	-21.3	-20.6	-20.1	auto	4	0.0020	0.0025	0.0015	0.0035	210	190	185	180	1	1	1	24
1	auto	-14.7	-13.4	-12.7	-12.1	auto	3	0.0031	0.0047	0.0036	0.0073	120	100	95	90	1	1	1	25
1	shear	-14.7	-13.3	-12.6	-12.9	shear	4	0.0028	0.0043	0.0033	0.0083	120	100	95	90	1	1	1	26
0	shear	-14.5	-13	-12.3	-12.4	auto	4	0.0021	0.0033	0.0025	0.0063	120	100	95	90	1	1	1	27
0	shear	-12.3	-11.5	-10.2	-16.2	taxi	4	0.0044	0.0060	0.0050	0.0100	150	135	125	120	0	3	2	28

0	shear	-24.4	-23.4	-21.3	-23.8	auto	4	0.0100	0.0129	0.0086	0.0171	220	200	190	180	1	3	2	29
1	shear	-12.3	-11.3	-10.2	-15.2	shear	4	0.0028	0.0038	0.0031	0.0063	150	135	125	120	0	2	2	30
1	shear	-23.1	-21.7	-20.5	-21.5	shear	4	0.0057	0.0071	0.0043	0.0086	210	190	185	180	1	1	2	31
0	shear	-17.9	-17	-15.8	-16.1	auto	4	0.0042	0.0058	0.0048	0.0096	150	135	125	120	1	1	1	32
0	shear	-14.2	-12.6	-12	-12.2	auto	5	0.0011	0.0017	0.0013	0.0033	120	100	95	90	1	1	1	33
1	auto	-6.71	-6.52	-5.88	-5.04	auto	3	0.0013	0.0019	0.0013	0.0038	40	35	30	25	1	1	1	34
1	auto	-17.5	-16.5	-15.3	-14.7	auto	3	0.0028	0.0038	0.0031	0.0063	150	135	125	120	1	1	1	35
1	shear	-10.8	-9.7	-8.58	-9.14	shear	4	0.0020	0.0027	0.0020	0.0047	90	75	65	60	1	1	2	36
0	shear	-5.78	-4.38	-3.21	-7.84	taxi	4	0.0029	0.0042	0.0034	0.0051	85	65	55	45	0	3	2	37
1	auto	-11.5	-10.3	-9.25	-9.23	auto	4	0.0015	0.0020	0.0015	0.0050	90	75	65	60	1	1	1	38
0	shear	-11.8	-10.8	-9.58	-10.2	auto	5	0.0027	0.0036	0.0027	0.0064	90	75	65	60	1	1	1	39
1	shear	-23.9	-22.5	-21	-21.5	shear	4	0.0050	0.0064	0.0043	0.0086	220	200	190	180	1	1	2	40
1	shear	-14.5	-13	-12.3	-12.4	shear	4	0.0021	0.0033	0.0025	0.0063	120	100	95	90	1	1	1	41
0	shear	-23.7	-22.3	-21.2	-21.5	auto	4	0.0050	0.0063	0.0038	0.0088	210	190	185	180	1	1	1	42
1	auto	-6.01	-5.73	-5.19	-4.45	auto	4	0.0004	0.0007	0.0004	0.0013	35	30	25	20	1	1	1	43
0	shear	-14.4	-13	-12.3	-12.9	auto	5	0.0020	0.0031	0.0024	0.0053	120	100	95	90	1	1	1	44
1	shear	-13	-12	-10.9	-15.3	shear	4	0.0037	0.0050	0.0042	0.0067	150	135	125	120	0	1	2	45
1	shear	-10.8	-9.65	-8.54	-9.06	shear	4	0.0019	0.0025	0.0019	0.0044	90	75	65	60	1	1	2	46
0	shear	-2.27	-1.98	-1.44	-5.26	bus	4	0.0010	0.0013	0.0010	0.0025	40	35	30	25	0	2	1	47
1	shear	-14.5	-13.8	-12.5	-17.4	shear	4	0.0063	0.0086	0.0071	0.0143	150	135	125	120	0	1	1	48
0	shear	-5.41	-5.19	-4.59	-5.95	auto	5	0.0010	0.0015	0.0010	0.0030	40	35	30	25	1	2	2	49
1	shear	-14.5	-13	-12.3	-12.4	shear	4	0.0021	0.0033	0.0025	0.0063	120	100	95	90	1	1	1	50
1	auto	-24.9	-23.5	-21.9	-21.4	auto	4	0.0056	0.0073	0.0048	0.0081	220	200	190	180	1	1	1	51
0	shear	-16.3	-15.1	-14.1	-15.2	auto	5	0.0015	0.0020	0.0017	0.0040	150	135	125	120	1	3	1	52
1	shear	-10.9	-9.75	-8.61	-9.23	shear	4	0.0021	0.0029	0.0021	0.0050	90	75	65	60	1	1	2	53
1	auto	-17	-15.9	-14.8	-14.7	auto	4	0.0024	0.0033	0.0028	0.0044	150	135	125	120	1	2	1	54
1	shear	-22.3	-20.7	-19.9	-20.2	shear	4	0.0025	0.0031	0.0019	0.0038	210	190	185	180	1	1	2	55
1	auto	-14.7	-13.3	-12.6	-12.4	auto	3	0.0028	0.0043	0.0033	0.0083	120	100	95	90	1	1	1	56
1	auto	-14	-12.5	-11.9	-10.3	auto	1	0.0020	0.0031	0.0024	0.0047	120	100	95	90	1	2	1	57
1	shear	-10	-8.47	-7.84	-12.1	shear	4	0.0017	0.0026	0.0020	0.0050	120	100	95	90	0	2	1	58
0	auto	-17.1	-16	-14.9	-14.9	shear	4	0.0028	0.0038	0.0031	0.0050	150	135	125	120	1	2	1	59
1	shear	-6.83	-5.7	-4.59	-9.06	shear	4	0.0019	0.0025	0.0019	0.0044	90	75	65	60	0	1	2	60
0	shear	-21.6	-20.7	-18.5	-24.6	bus	4	0.0133	0.0167	0.0100	0.0200	210	190	185	180	0	2	1	61

1	auto	-10.3	-8.71	-7.63	-6.16	auto	2	0.0017	0.0025	0.0020	0.0030	85	65	55	45	1	1	2	62
1	shear	-13.8	-11.8	-10.7	-15.5	shear	4	0.0031	0.0043	0.0036	0.0071	160	135	125	120	0	1	2	63
1	shear	-19.3	-17.9	-16.5	-21.2	shear	4	0.0044	0.0056	0.0038	0.0075	220	200	190	180	0	2	2	64
0	shear	-13.8	-12.3	-11.6	-12.8	auto	5	0.0024	0.0037	0.0029	0.0057	120	100	95	90	1	1	2	65
0	shear	-19.7	-18.2	-16.8	-21.1	taxi	4	0.0041	0.0053	0.0035	0.0071	220	200	190	180	0	1	2	66



جامعة النجاح الوطنية
كلية الدراسات العليا

نمذجة سلوك اختيار وسيلة السفر للموظفين للتنقل الى العمل في
محافظة رام الله / البيرة

إعداد
عدي حسن عطية صلاحات

إشراف
أ.د. سمير أبو عيشة

قدمت هذه الرسالة استكمالاً لمتطلبات الحصول على درجة الماجستير في هندسة الطرق والمواصلات، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس - فلسطين.

2026

نمذجة سلوك اختيار وسيلة السفر للموظفين للتنقل الى العمل في

محافظة رام الله / البيرة

إعداد

عدي حسن عطية صلاحات

إشراف

أ.د. سمير أبو عيشة

الملخص

خلفية: يُعتبر سلوك اختيار وسيلة المواصلات أحد الاعتبارات الهامة في تخطيط النقل الحضري، خاصة في البلدان النامية. ويواجه التنقل في الضفة الغربية تحديات فريدة تؤثر على اختيار وسيلة النقل، بما يشمل القيود المفروضة على حرية التنقل، والتحديات الاقتصادية، ومحدودية وسائل النقل الجماعي المناسبة. وهذا حفز القيام بإعداد هذه الأطروحة لفهم كيفية تنقل الموظفين الذين يشكلون نسبة كبيرة من السكان ويتنقلون بين المدن.

الأهداف: الغرض من الرسالة هو تحليل أنماط اختيار الموظفين لوسيلة النقل، وفحص العوامل التي تؤثر على سلوك اختيار وسيلة النقل، وفهم اختيار وسيلة النقل لثلاث فترات: الظروف العادية (قبل حرب 7 أكتوبر)، وظروف الأزمة (بعد حرب 7 أكتوبر)، وجائحة كوفيد 19، واقتراح سياسات لتعزيز استخدام وسائل النقل العام.

المنهجية: تم استخدام أساليب البحث العلمي المختلطة (الكمية والنوعية). وقد تم إجراء مسوحات باستخدام استبانة تم توزيعها على عينة مكونة من 266 موظفاً من خارج المحافظة ينتقلون إلى منطقة رام الله/البيرة الحضرية. وقد تم استخدام نماذج الاختيار التي تأخذ بالاعتبار نهج النمذجة متعددة المتغيرات لنمذجة وتفسير سلوك المتنقلين لاختيار وسائل المواصلات. وتمت دراسة وتحليل استخدام أربع وسائل نقل: السيارة

الخاصة، والسيارة المشتركة، وسيارة الأجرة المشتركة، والحافلة. كما تم تحليل تأثير الأحداث غير العادية على سلوك السفر من خلال المقارنة على مدى الفترات الزمنية الثلاث المشار إليها.

النتائج الرئيسية: تعد السيارات الخاصة والمشاركة هي وسائل النقل الرئيسية للموظفين المستهدفين (جذبت 83% من الرحلات)، في حين اجتذبت وسائل النقل العام حصة هامشية فقط من العينة. وقد أظهرت نماذج الظروف الاعتيادية وظروف الأزمات مستويات جيدة من الملاءمة الإحصائية. وبينت النتائج تأثير اختيار وسائل النقل بشكل كبير بوقت السفر وتكلفة السفر والجنس والحالة الاجتماعية وملكية السيارة الخاصة. وانخفضت حساسية المشاركين للوقت والتكلفة في حالات الأزمات، مع ما يرتبط بذلك من تحول في التركيز من البحث عن الكفاءة إلى البحث عن الموثوقية. وقد بين المشاركون أن هناك نقصاً كبيراً في جودة خدمات النقل العام.

الاستنتاجات: هيمنة السيارة الخاصة فيما يتعلق باختيار وسيلة النقل إنعاسكاً لسهولة الحصول على التسهيلات المصرفية لشراء السيارات الخاصة وعدم كفاية وموثوقية خدمات النقل العام. ويمكن الاستنتاج أن الأحداث غير العادية لها تأثير كبير على سلوك السفر، حيث أن المسافرين على استعداد لدفع تكاليف أعلى وبذل أوقات أطول لضمان المزيد من موثوقية الرحلة. وتؤكد النتائج على ضرورة تبني سياسات حكومية تدعم مشاركة الرحلات والنقل الجماعي، وإنشاء نظام نقل عام موثوق.

الكلمات المفتاحية: اختيار وسيلة النقل؛ نمذجة الاختيار المنفصل؛ سلوك السفر؛ النقل العام؛ فلسطين؛

رام الله/البيرة.