PUBLIC ACCEPTABILITY OF TIME-OF-DAY PRICING: THE NEW JERSEY TURNPIKE CASE

by

Sai Vikas Gazula

A Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the degree of

MASTER OF SCIENCE

Major Subject: Civil Engineering

Approved by the
Examining Committee:

____

José Holguín-Veras, Thesis Advisor

____

Jeff Ban, Member

____

Cara Wang, Member

Rensselaer Polytechnic Institute
Troy, New York

December, 2014
(For Graduation December 2014)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

This project would not have been successful without the guidance and help of a number of people who in one way or the other contributed and extended their valuable assistance in the preparation and completion of this study and I would like to thank each and every one of them for making this happen.

I take this opportunity to express my heartfelt gratitude to my advisor, Professor José Holguín-Veras for his continuous encouragement, support and guidance. I consider it a privilege to have been his student and to have worked under his guidance.

Further, I would like to thank the other members of my thesis committee, Prof. Jeff Ban and Prof. Cara Wang, who provided me with their feedback and comments on my study. I, also, thank Prof. Kenneth Simmons for helping me with the methodology and software used for this study. I, also, thank Center for Communication Practices, especially Dr. Barbara Lewis, for providing feedback and comments on my writing.

I want to thank Carlos, Lokesh, Miguel and Trilce, who have worked for a similar study and provided feedback for my work. I would like to thank my other colleagues in our group who helped me. I want to thank my mentor, Felipe for his advice – both academic and otherwise.

I am grateful to all my teachers at Rensselaer Polytechnic Institute, IIT Madras and in my school, who taught me, trusted me, inspired me and helped me build a solid foundation for my future.

I am thankful to all my friends, especially Arun, Bharath, Harikrishnan, Karthik, Nikhil, Nikhila, Pavitra, Raghavan, Rikhiya, Rini, Saideep, Sheshasai, Venkata Ramana, Vikas, and others who have supported me during my ups and downs during the course of project.

I also thank Nolan brothers and K. Vishwanath for providing good entertainment.

Lastly, I am greatly indebted to my family for their unconditional love and support over the years.

ABSTRACT

Time of day pricing reduces the traffic on highway network by discouraging its overuse, especially during peak hours. Public acceptability is one of the important barriers for implementing the congestion pricing. The objective of this paper is to understand the factors or attributes of public that affect their acceptance of the September 2000 time of day pricing initiative that was implemented on the New Jersey Turnpike. Using the methodology of ordinal logit modelling, models were estimated for the respondents' opinions on issues related to travel experience, willingness to pay, and fairness of discounts. Then the final model was selected for each public opinion based on statistical significance and conceptual validity. For the final model selected, sensitivity of the opinion was analyzed for the variables in the model. Results from this study indicate that age had a negative effect on the respondents' opinion about use of toll-revenues for public transit, fairness of discounts to frequent commuters and willingness to pay for faster trip. Education had a positive impact on the issues related to travel experience. Income had a negative effect for impact of tolls on improving traffic condition, while it had a positive impact on issues related to willingness to pay. Owning EZ pass had a positive impact on fairness of EZ pass discounts and willingness to pay for faster trip, while it had a negative effect on use of toll-revenues for public transit improvement.

1. Introduction

This chapter provides a brief description of congestion and the need to mitigate congestion for better transportation. Several measures available to alleviate congestion are discussed and of them, congestion pricing is discussed in detail. The importance of public acceptability for congestion pricing implementation is emphasized.

The rapid increase in number of privately owned vehicles, with increase in urban population, has not been matched with the suitable increase in infrastructure capacity in many cities of the world. This led to large scale traffic congestion problems in major arterials of such cities, resulting in delays, user discomforts, increased air pollution and higher fuel costs. Traffic congestion in the United States costs the average commuter 36 hours and 19 gallons of gasoline per year, for an annual cost of $818 per traveler in 2011 [1]. Individuals fail to internalize the externalities of congestion. It is for this reason that traffic volume often exceeds its capacity resulting in congestion. If there are no measures taken to keep congestion in control, the congestion would increase rapidly due to increase in travel demand with increase in population.

The traditional way to deal the congestion problem of increasing the capacity such that supply is greater than demand is not only expensive, but may not be possible due to space constraints, environmental and political reasons. Increasing the capacity by augmenting physical infrastructure either by building roads or adding additional lanes can actually increase congestion due to induced travel demand. In order to mitigate the existing and growing congestion, effective Transportation Demand Management (TDM) measures should be taken to reduce the car use. The most widely known TDM measures can be divided into coercive and non-coercive measures which are implemented with an aim to restrict driving and improve transport. Non-coercive TDM measures such as improving public transport, parking related measures or park & ride are unlikely to change the driver's behavior to use the car. Hence, coercive measures such as restrictive access, bans or tolls may be necessary to reduce car use [2].

Congestion pricing is a unique coercive TDM measure that would internalize not only the externalities of congestion that are imposed by drivers on others, but also the externalities of noise, air pollution and pavement damage that are imposed by drivers on transportation network. The main objective of congestion pricing is to reduce the traffic on highway network by discouraging its overuse, especially during peak hours. Pricing would result in individuals shifting their time of travel from peak hours to off-peak hours, shifting their mode from individual cars to carpooling or public transit, or finding an alternate route.

Public acceptability is one of the important barriers for implementing the congestion pricing. Coercive measures because of their nature may be opposed by the public. Although congestion pricing would improve their mobility, public are reluctant to accept the pricing and the need for it. People would like to pay for what they wish to acquire than to avoid and drivers perceive themselves as victims than contributors of congestion [3]. There have been many attempts to introduce pricing in form of supplementary licensing in London and Kuala Lampur, electronic road pricing in Hong Kong and Netherlands, package of pricing and investments in Stockholm [4] and road user charging in Edinburgh [5] which were not implemented due to opposition from public. Mayor Michael Bloomberg's 2007 congestion pricing proposal though gained an unlimited support from the public, it was blocked by the small group of car owners in the state legislature [6]. When the opposition from very small group can decide the fate of congestion pricing implementation, there is need for designing the pricing schemes where people find them acceptable. For such designing, policy makers should understand the key factors influencing the acceptability of pricing.

The intent of this paper is to understand the reasons of public to accept the September 2000 time of day pricing initiative that was implemented on the New Jersey Turnpike. Using revealed preference surveys, public opinions with regards to fairness, revenue allocation and willingness to pay are analyzed to understand how a respondent's acceptability changed with their socio-economic characteristics and attitudes.

The remainder of this paper is organized into four chapters. Chapter 2 provides a review of the literature related to the work done in public acceptability of congestion pricing. Chapter 3 describes the descriptive analysis of data used for this study, along with brief description of New Jersey Turnpike time of day pricing initiative. Chapter 4 presents the methodology followed in this study, final models estimated from the revealed preferences surveys. Chapter 5 has some concluding remarks and scope for future research.

2. Literature Review

This chapter provides an analysis of existing literature, discussing key findings from selected literature on the subjects most relevant to this paper. The publications are discussed in chronological order by subject matter.

One of the first studies, Jones [7] deals with the revenue allocation's impact on the public acceptability of pricing. Author found that by hypothecation of revenues to other transport projects, the net support increased. In UK, net support rate for road user charging increased from -27% in case of no revenue hypothecation to +23% in case of allocating revenue to other elements. The author in his other publication, Jones [8] concluded that pledging revenues from tolls for improvement in traffic increased public support. To analyze the preferred options among revenue allocation, Schlag and Schade [9] analyzed the stated preferences from the TransPrice project and found that respondents have more reluctance to accept the pricing measures among all the options of TDM measures. Around 50% of the respondents' reaction was absolute unacceptability of pricing related measures. For the package of pricing and revenues for improvement in public transport, living conditions and facilities for pedestrians and cyclists, there is substantial increase in acceptability of respondents (for total sample) from 19% to 45%. It was observed that the majority of respondents from Athens, Como and York would support the package. For different options available for revenue allocation, majority of respondents preferred allocation of revenues to alternatives that improve transportation and environmental conditions, whereas allocation of revenues for support of budgets was considered unjustified by more than half of the respondents.

While analyzing the reasons for the public reluctance to accept pricing measures, Schlag and Teubel [10] found that there are five major issues which determine public acceptability. Over time, with the implementation of tolls, the public using these toll rings typically exhibit increased acceptance, due to information available and awareness of options. Trondheim displayed such expected response, whereas the MOBILPASS field-trial in Stuttgart point have revealed the opposite of what is usually observed, i.e., acceptance was lower after the trial. In the field-trial, the experiences that improve the acceptance were not found by the users. MIRO asserts the existence of the results which show the increased public acceptance when the toll implementations are accompanied with information campaigns and pilot experiments, due to increased perceived effectiveness and efficiency. The authors suggest that Transportation Demand Management (TDM) measures should address transport problems such that public are prepared to trust these measures albeit new and unfamiliar. Public may not accept the TDM measures due to individual claims that measures are intrusive or frail. A demonstration project in mid-eighties was not implemented in Hong Kong because the public was afraid that data would be misused [11].

Another issue discussed by Schlag and Teubel [10] is equity. For pricing to be acceptable, it should not result in prevention of movement for low income groups. Exceptions for specific groups should not be sensed as unfair by other groups [12]. Low income car owners' feel hindrance in their transport due to pricing measures, especially when there is no satisfactory public transport [13]. One of the crucial points in the equity issues is how the revenue is going to be utilized. Road pricing without relocation of revenues is likely to be regressive [12].

The fundamental question with regards to the public acceptability is whether a policy can be designed that is both efficient and acceptable by public and politicians. Jones [3] tried to answer this by analyzing the concerns of the public with regards to acceptability, to understand how the barriers to acceptability can be addressed. It is very difficult for the public to accept that they should be charged for congestion. Drivers see themselves more as victims of congestion than contributors to it. The public perceived pricing as an extreme measure which was considered not necessary to contain the traffic. Traffic can be contained by either improving public transit or restraining traffic by banning road traffic on major streets or restricting access. The public doubted the reliability and ability of technology with regards to compliance. The public perceived pricing as unfair, because ability to pay and necessity of trip might not match. The public should agree on the need for action considering their concerns over growing mobility problems. The public acceptance would increase when there were no better alternatives and the solution was perceived as effective in terms of reducing traffic problems. A solution that addressed the issue of feasibility practically and technically, would be more acceptable. Rationale and fairness of pricing to users should be addressed by the proposed measure, for it to be acceptance. Area and category of travelers to be charged, times of day of operation, basis of charging and levels of charge are the five key elements of the scheme's design.

In order to answer the same fundamental question as above, Harrington, et al. [14] analyzed the survey responses of southern California residents and found that the public would accept congestion pricing which addressed revenue reallocation and preserved the choice for motorists. The public's acceptance of congestion pricing depends on how much revenues will be given back to the public in the form of other local taxes. For tax rebates as policy enhancements, support grew very moderately from the base 43% to 50%, 54% and 48% for rebates of 25%, 50% and 82% respectively. There was an increase of 9% support from the base policy which imposes tolls on all lanes when tolls are charged on existing high-occupancy vehicle lanes. There was an increase of 17% support from the base policy when a new high-occupancy toll lane is built. Hispanics and Asians have more acceptance of congestion pricing and variants than African-Americans and Caucasians. The model has a negative coefficient for education implying more educated people were doubtful about an untested measure. The model has a positive coefficient for HH size and a negative coefficient for number of cars indicating that household with higher vehicle to family ratio perceived pricing as restrictive.

With the aim of untangling factors that determine the private car users' reluctance to accept road pricing, Jakobsson, et al. [15] used structural equation models to model the determinants from the survey data in the metropolitan area of Sweden. Lower income respondents intend to trim down the car use when there is escalation in travel costs because of the perception that they might not be able to spend as much for to travel at the same level as before. This implied that they perceived that the pricing infringed on their freedom and was unfair for them. The results from the authors' study showed that the respondents were willing to reduce their car use to the extent they believe others would decrease. Fujii, et al. [16] investigated if the infringement on freedom and fairness have the same effect on the road pricing acceptance in other countries as found in Sweden. [15]. Acceptance was higher in Asian countries when compared with that of the sample from Sweden. Fairness substantially improved the acceptance in all samples. Also, the coefficient was largest for fairness in all samples. With perceived fairness, there is an increase in acceptability. Regression coefficient for infringement on freedom is higher for the

Japanese sample when compared to that of Sweden and Taiwan. Importance of fairness and infringement on freedom is reproduced in Japan and Taiwan. Fairness mediates the effects of environmental concerns on acceptance of road pricing. The only significant difference is income. In Taiwan, income appears to play a part in acceptance but not in Japan and Sweden. Authors found that people may accept the future pricing schemes if they perceive the schemes to be fair and effective in solving problems such as pollution and congestion.

So as to analyze the determinants of the public acceptability, Golob [17] tried to observe the patterns in weekly trips and the behavior of the solo car-drivers who paid to use high occupancy toll (HOT) lanes. Four attitudinal variables –allowance of solo drivers on HOT lanes, effectiveness, fairness and safety– were analyzed jointly with mode-choice. Analysis of allowance demonstrated that higher household income, persons from one-worker households and females from the 35-64yr age group showed higher levels of approval whereas, older persons and persons from one-vehicle households showed lower levels of approval for allowance. Regarding fairness, strongest favor was shown by females of the 35-64yr age group and all users below 35yrs age. More highly educated commuters were more likely to perceive the program is effective to reduce congestion. The opposite perception was held by females who are below 35 in age and older than 64, persons from one-vehicle households and from households with a higher number of workers per vehicle. Users of express lanes perceived a greater safety advantage in using those lanes. But, the author found no evidence to link the desire for safe travel and the use of express lanes.

To investigate the factors of the road pricing acceptance, Hårsman [4] reviewed experience from PRIMA project, a DG TREN-supported collaboration among 7 cities. A combined toll ring and transportation investments for improving the road was introduced in Oslo in 1990. The opposition from the public was 65%, 60% and decreased to 50% before, during and 10 years after the trial respectively. One of the key reasons for Oslo's success was the already existing system of financing roads from road tolls. Toll ring had a financing strategy where the benefits were immediately experienced by the motorists. The opening of the tunnel immediately after the implementation of tolls was a strategy that helped Oslo to succeed. The payment system was electronic such that the traffic movement is not affected. The purpose and results of the toll ring system were communicated and marketed for the better understanding of motorists. Rotterdam developed a system to avoid transport delays of goods due to passenger cars. Rotterdam introduced this modified toll system in summer 2000, as a test-case if successful, it would be implemented across Holland. The system failed to pass the proposal. The plans were then to introduce a flat charge instead of time differential pricing. This experience implies that step-wise introduction seems to be necessary for a successful implementation.

Pricing always faced a hostility from the political authorities, owing to lack of confidence and fear of consequences. Viegas [18] tried to have a new look at the intentions of pricing while addressing the reasons of such hostility. Revenues generated from pricing when used for improvements of local roads and public transport supply was seen as logical and effective. The problems of congestion should be resolved at the local roads where those problems start, by the allocation of revenues to public transport reducing the loss of mode shift passengers and benefitting those transit service users. Maximum efficiency to provide the scarcely available resource is possible by the use of marginal cost pricing which is difficult to explain to the public. According to the author, pricing levels must be regulated gradually as we transitioned from chronic congestion to smooth traffic, allowing the traffic agents to have time for reviewing their strategies. All these principles mentioned could be implemented in the form of the plain cordon pricing to the more complex "pay-as-you-go" schemes. The author addressed the question of implementation and suggested a step-by-step approach in which relatively simple schemes were adopted at the initial stages and more technically complex schemes would be adopted later. This gradual procedure would facilitate the acceptability.

With the intention of identifying the reasons for pricing measures' acceptance, lessons from the Norway experience were summarized by Odeck and Bråthen [19]. A result common among all the three cities, Bergen, Oslo and Trondheim, was that the public became less restraint to pricing after implementation compared to that of before implementation. Bergen was different from other toll rings in terms of its price being cheap, whereas Trondheim was unique in terms of the promotional campaign with regards to ability to fund public services from the toll ring revenues. These experiences concluded that for the widespread public acceptability, the public should be made aware of the purpose for which tolls were being collected before the charging itself and of the benefits of toll schemes and market tolls as integral part of transport-planning scheme. To conclude, the more involvement public had in the planning process, better the acceptability was. The use of revenues from the pricing schemes for the improvement in integrated transport could augment the acceptability from the public for the pricing scheme. Informing the public about both the advantages and disadvantages of the scheme along with comparison to other options could enhance the toll schemes.

Pricing packages that differ in the toll cordon charges, the increase in parking charges and the increase in fuel taxes, and how the revenues are utilized were expected to be perceived differently. Schade and Schlag [20] considered a dynamic pricing package A and a normal pricing package B to analyze difference in acceptance for different pricing packages, using knowledge, perceived effectiveness, personal outcome expectations and social norm as independent variables. Of these variables, all four were found to be significant in the case of strategy A. In case of B, the subjective level of knowledge was not effective with all other observations remaining same. The authors found that the social norm was the most influential predictor followed by personal outcome expectations. Respondents perceiving socially important aims approved the strategies whereas the respondents who were aware of the traffic-related problems did not appear to accept the strategies.

Jaensirisak, et al. [21] explained the differences in acceptability between different user groups and differences in acceptability based on the design aspects of the scheme and charging levels. Different groups of respondents had different attitudes. Differences in attitudes resulted in a moderate effect in their acceptability of the system. Car ownership made a difference in acceptance levels. Charging was acceptable to non-car users, to those for whom the congestion problem or the pollution problem seemed to be very serious, to those who perceived present conditions were unacceptable and to those who felt congestion charging would be effective in reducing the congestion problems. People aged 55 or older were reluctant to accept the charging. Acceptance increased with decrease in delay. To design acceptable pricing schemes in Leeds, the options were limited. Schemes that were acceptable by more than 50% would be of a fixed charge of £3 or less per day within inner ring road, whereas various options were available in case of London. Pricing which was differentiated based on distance, time and delay could also be used for London. Differences between the two samples were due to differences in attitudes and socio-economic characteristics. Leeds had people who perceive congestion to be less serious where as in London people believed charging would be effective in reducing the problems they perceived.

The Stockholm congestion pricing referendum, referred as the Stockholm trial was implemented with the objectives of reducing congestion, improving environmental quality and increasing accessibility. Time differential pricing with exclusion for taxis, emergency vehicles, low emission vehicles and motorcycles was charged. Public transport was extended to make it more frequently during rush hours as part of trial. 16 new bus lines and 14 new express buses were introduced and 1500 additional parking places were created near stations. Many authors analyzed the Stockholm trial to identify the factors affecting the public acceptability [22]–[24].

One of the first studies about the Stockholm trial, Eliasson [22] summarized the lessons from the trial, to conclude that there was reduced congestion, increased travel time reliability, reduced emissions and increased bus traffic after the charging trial and reintroduction. The public support was less than 30% before the trial, which increased to just over 50% and nearly 70%, towards the end of trial and after the reintroduction respectively. This increase might be explained by the dramatic change from negative views to positive views in the media. Also, it was observed that propagation of queues upstream decreased after charging, benefitting those who suffer at bottleneck and all upstream traffic from the reduction in travel time. Overall, Stockholm trial had a positive effect on urban environment and visible congestion reduction.

The next study about the Stockholm trial, Schuitema, et al. [23] examined the relative importance of beliefs to explain the variations in acceptability before and acceptance after the implementation in Stockholm. The authors tested hypotheses based on the assumption that acceptance after implementation would be higher than acceptability before charging. The first hypothesis was that Stockholm region residents believed that the trial was more likely to have favorable consequences and less likely to have unfavorable consequences. Testing this hypothesis, the authors found that consequences were more positive than what the public expected before the trial. Congestion, parking and environmental problems decreased more after charges than the public expected. Travel costs increased less than the public expected. The authors hypothesized that levels of acceptability and acceptance would differ due to relative importance of beliefs about the consequences of the charge. Testing this hypothesis, the authors found that acceptability was lower if respondents felt travel costs would increase while acceptance was not significantly related to perceived costs. Unfavorable consequences influenced acceptance less when compared to that of acceptability. Acceptance was more strongly related to favorable consequences than acceptability. Parking problems reduction appeared to be relatively more important among positive consequences. The results from this study, concluded that there was need for trial and for keeping the public informed for them to accept pricing, because trial would give an opportunity for them to experience benefits and information would help them understand positive effects of the charge.

The recent study on the Stockholm trial, Hårsman and Quigley [24], analyzed the patterns of voting by traffic zone, in response to incentives, to find that voters' acceptance for or against the pricing was influenced by their political preferences. Demographic characteristics of voters had an influence on their acceptance, with well-educated and working-age voters inclined to support, whereas immigrants and male-workers were disposed to oppose. The acceptance of the proposal had a positive relation with time-savings and a negative relation with out-of-pocket costs. Private costs and benefits were the important factors that affected voting behavior for the acceptance of the system. Users who experienced the benefits of the pricing measures firsthand were likely to support the pricing. Distance also had an effect on acceptance with people who resided inside the ring supporting the pricing about 2% points more than those who resided outside.

Analyzing the reasons for the failure would be useful in understanding the factors causing the public reluctance. Gaunt, et al. [5] tried to understand the reasons for rejection of road user charging by the residents of Edinburgh and found that mode use, understanding and public attitudes were key factors for rejection. Car ownership influenced the acceptability of the road user charge. Spatial inconsistency was observed in voting tendencies. People from suburbs voted against the charging where car ownership was higher. Daily cyclists were supportive of pricing. Regular car drivers were slightly more reluctant to accept than drivers. Not only drivers, car users in general were very strongly opposed to pricing. The design of the scheme had several complexities that made it difficult for the public to understand. Misperceptions and misconceptions towards the level of charge by the individuals contributed to the rejection of pricing in Edinburgh. More than two-thirds of the inner-cordon residents thought they would be charged while they were not being charged in reality. 20% of the respondents believed that the Edinburgh charge would increase unfairly. Though the public perceived congestion as a problem, the public were not confident enough about the effectiveness of the solution to achieve its' objectives.

A recent study about the public acceptability of pricing, Rentziou, et al. [25], modelled road pricing acceptance from the stated preferences of residents of Athens, Greece. The authors modelled four different models to understand the acceptability of road pricing and found that residents of the pricing area were less likely to accept congestion pricing. From marginal effects, it was evident that the area of residence influenced the acceptability more than the income, age and education did. Younger people were more likely to accept the pricing and it was also observed that users who travel by taxis were more likely to accept than users who travel by cars and motorcycles. With provisions, users who could change their trip timings were more likely, whereas users with increased travel costs were less likely to accept congestion pricing. Frequent users and business users were less likely to accept and car users were more likely to accept after the provisions. Users of carpooling and vanpooling were less likely to accept the pricing. Age, income, and revenue allocation were not significant variables in explaining acceptability under provisions. Higher educated respondents and higher income users perceived congestion pricing as an effective measure, while respondents aged 25 to 44 who travel by car, motorcycles or even by public transport did not perceive it as effective.

3. Descriptive Analysis of Survey Data

This chapter provides a descriptive analysis for the data from revealed preference surveys collected by Ozbay, et al. [26]. This chapter is further divided into three sections. A brief description of September 2000 time of day pricing initiative is presented in the first section. Demographic information of respondents is analyzed and presented in the second section. The public opinion portion of the survey data is analyzed in the final section.

3.1 Time of Day Pricing Initiative Background and Background of Survey– The New Jersey Turnpike Case

The New Jersey Turnpike (NJTP) started in 1951 with 15 interchanges, along a stretch of 118 miles of roadway, which had 100 toll lanes [27]. Currently, the NJTP comprises of 28 interchanges, 366 toll lanes and 148 miles of roadway, including extensions and spurs, starting from the Delaware Memorial Bridge in the south of New Jersey and ending at the George Washington Bridge in New York City [28].

On September 30, 2000, in up to 160 toll lanes of then Turnpike's 341 toll lanes, the Electronic Toll Collection system, in the form of E-Z Pass, was implemented. Concurrent with the opening of E-Z Pass, other initiatives were started, of which the most notable was the introduction of Time of Day Pricing. Time of Day pricing provides an incentive for motorists who do not need to travel during the peak hours, to use the turnpike during less congested off-peak periods by paying a reduced toll [29]. Such pricing can induce changes in the usual travel patterns of commuters to balance flows and to reduce congestion. The changes in travel patterns include shift to either alternative modes, off-peak hours or less congested routes.

A toll increase was implemented on January 1, 2003, after which toll levels for each time period and vehicle type were increased. A summary of the toll increase is displayed in the Table 1, which shows the percentage increase in toll values for passenger cars after the implementation of time of day pricing [30]. Figure 1 shows the map of New Jersey along with the location of the turnpike [31].

Table 1: Increase in Tolls for Passenger Cars after Time of Day Pricing

Type of Payment	Percentage Increase on Jan 1, 2003
Cash Peak and Off-Peak	17%
E-Zpass Peak	10%
E-Zpass Off-Peak	5%

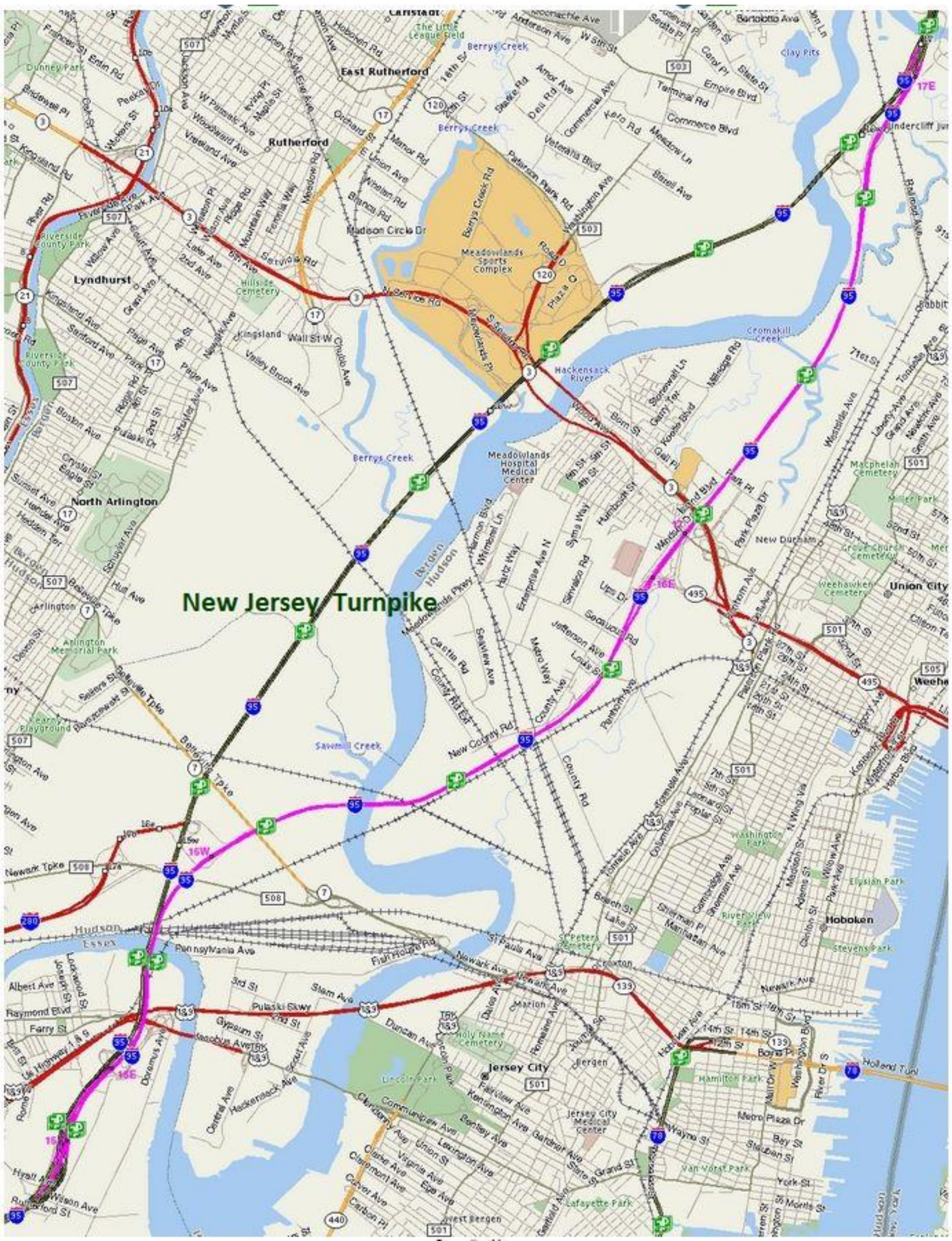

Figure 1: Map of the New Jersey Turnpike (Source: R. C. Martin Jr. [31])

Eagleton Institute of Rutgers University conducted computer aided telephone interviews (CATI), from the beginning of June to middle of July 2004, to obtain the survey data. The travelers of New Jersey Turnpike (NJTP), who used the turnpike on a regular basis, i.e., at least once per week, since the implementation of time of day pricing, in September 2000, were targeted by this survey.

The survey consisted of eight major sections. The first section is Toll users' screen, which gets information about the respondent's use of the NJTP to screen the users into turnpike users or port authority users and current regular users, those who used facility before the time of day pricing initiative and continued to use the facility, or former regular users, those who used the NJTP before the time of day pricing initiative and changed their travel patterns due to pricing. The second section gets information about the most recent trip characteristics of current regular users. The third section gets information about the awareness of respondents about the time of day pricing and toll discounts, whereas the fourth section gets information about impacts of the 2000 time of day pricing initiative. The fifth section obtains information about the most recent trip characteristics of former regular users. The sixth section gets respondents' stated preferences for various hypothetical scenarios. The seventh section gets respondents' opinions on their acceptance, perceived impacts and willingness to pay. Socio-economic characteristics of the respondents are filled in the final section of the survey.

3.2 Descriptive Analysis of Socio-Economic Information

Information of the respondents pertaining to gender, age, race, education level, employment status, household structure, E-Z pass ownership and income level as filled in the survey is analyzed in this section. Some of the aspects of the survey were not filled by the respondents and such aspects are denoted as DNR (did not respond) in this paper.

After separating those who did not use the NJTP on a regular basis, 513 responses were finalized for the survey. Of those responses, 54.19% of the respondents are male and 45.81% of the respondents are female. Of the nine New Jersey counties represented, the majority of the survey respondents lived in either Middlesex (20.61%), Bergen (16.73%), or Monmouth (13.67%) or Union (13.06%) or Essex (12.24%). Of all the counties, Essex, Middlesex and Union had more representation from females when compared to that of males. Table 2 depicts the percentage representation by each gender from each county.

Table 2: Gender by Geographic Location

County	Male	Female
Entire Sample	53.88%	46.12%
Bergen	60.98%	39.02%
Essex	45.00%	55.00%
Hudson	52.83%	47.17%
Middlesex	46.53%	53.47%
Monmouth	74.63%	25.37%
Morris	64.29%	35.71%
Passaix	55.56%	44.44%
Somerset	50.00%	50.00%
Union	42.19%	57.81%
DNR	60.87%	39.13%

The mean age of the respondents who filled in the information about age i.e., 97.08% of the sample, is 44.20 with a standard deviation of 14.58. Hence, there is a diverse age representation in the sample, depicted in Figure 2.

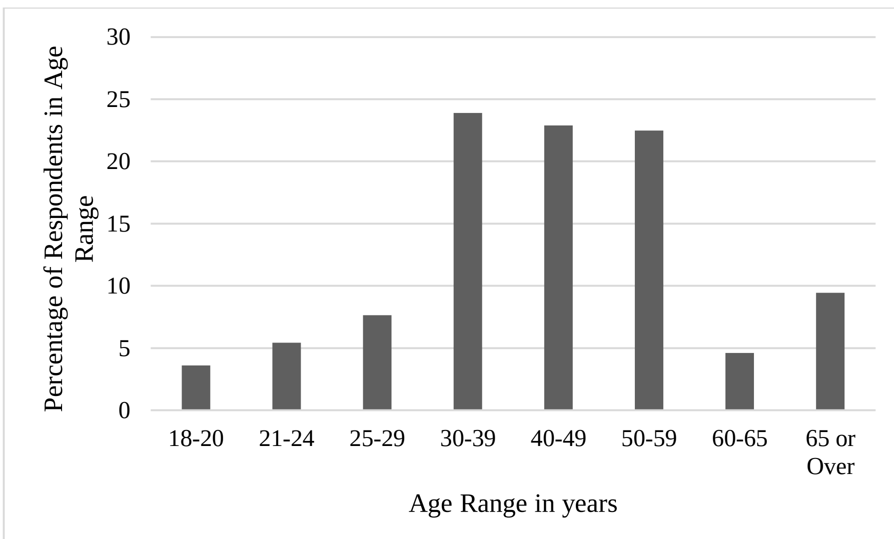

Figure 2: Representation by Age Range

White individuals accounted for 64.52% of the survey respondents, while 13.06% were African American, 4.68% Asian, 13.06% Hispanic, and 4.68% chose not to reveal their race. The percentage of White respondents is highest for each of the county in New Jersey. Of all the counties, Essex (36.67%) and Union (29.69%) counties had most representation from African American respondents, compared to that of the sample representation of 13.06%. There is more representation from Hispanic respondents from Hudson County (30.19%). Table 3 presents the percentage of each race per county.

Table 3: Race by Geographic Location

County	White	African-American	Hispanic	Asian	DNR
Entire Sample	62.77%	13.06%	12.67%	4.68%	6.82%
Bergen	74.39%	2.44%	15.85%	4.88%	2.44%
Essex	41.67%	36.67%	16.67%	3.33%	1.67%
Hudson	58.49%	5.66%	30.19%	3.77%	1.89%
Middlesex	68.32%	7.92%	12.87%	7.92%	2.97%
Monmouth	83.58%	1.49%	8.96%	5.97%	0.00%
Morris	85.71%	7.14%	0.00%	7.14%	0.00%
Passaic	59.26%	25.93%	3.70%	3.70%	7.41%
Somerset	68.18%	18.18%	4.55%	9.09%	0.00%
Union	57.81%	29.69%	7.81%	0.00%	4.69%
DNR	37.50%	0.00%	8.33%	0.00%	54.17%

Approximately half (46.59%) of the survey respondents had graduated with at least a four year college degree, whereas almost everyone, i.e., 97.37% of individuals, had at least a high school education. Figure 3 showed the education level for the total sample of survey respondents, whereas Figure 4 depicted the gender-wise education level, along with the entire sample and Figure 5 illustrated the race-wise distribution. It can be observed that New Jersey residents have a high percentage of individuals with college degrees as well as individuals who are pursuing higher education.

The comparison of education level of female respondents with male respondents showed that a higher percentage of male respondents (48.92%) had graduated with at least a four year college degree when compared to the entire sample (46.59%) and female respondents (43.83%). The percentage of the respondents who had studied until high school was highest for female respondents (27.23%). The comparison of education level from race-wise distribution showed that a higher percentage of White respondents (48.92%) and Asian respondents (75.00%), when compared to the entire sample (46.59%). The percentage of the respondents who had studied until high school was higher for African-American respondents (32.84%) and Hispanic respondents (34.33%).

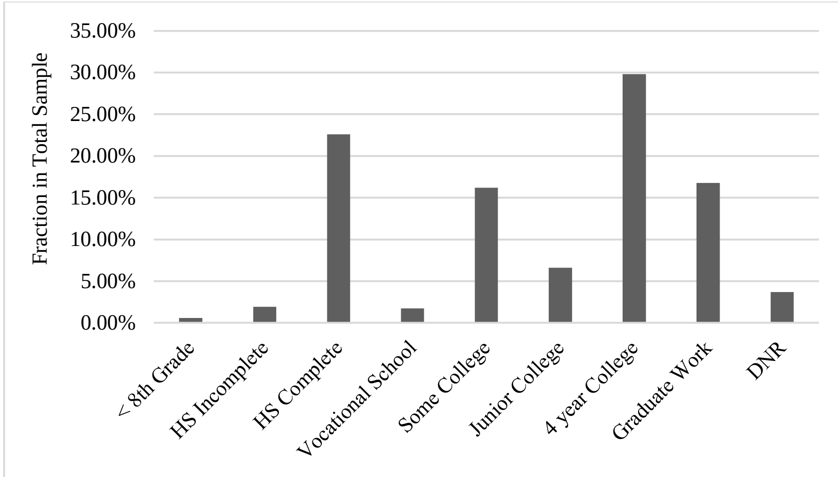

Figure 3: Education Level of Survey Sample

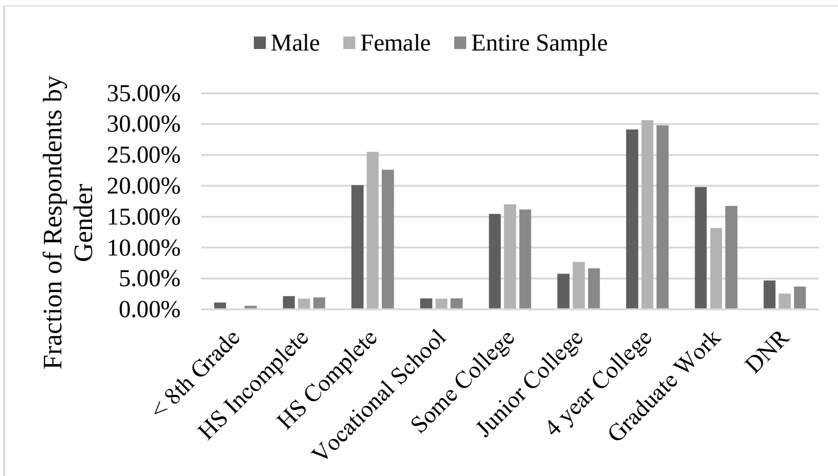

Figure 4: Education Level by Gender

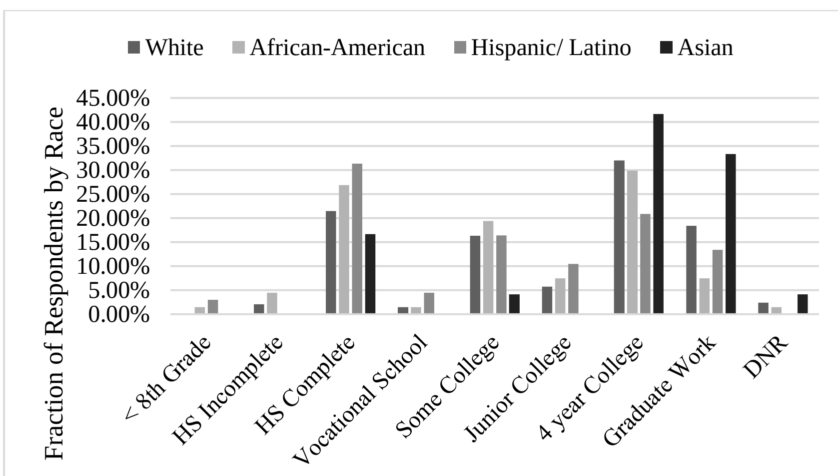

Figure 5: Education Level by Race

Table 4 represents the level of education by county. Residents of Somerset County had 68.18% of the respondents with at least a 4-year college degree, and Monmouth and Morris Counties had 58.21%, and 57.14%, respectively, with at least a 4-year college degree. Passaic County only had 18.52% of the respondents with at least a 4-year college degree.

Table 4: Education Level by Geographic Location

County	HS Incomplete	HS Complete	Vocational School	Some College	Junior College	4 year College	Graduate Work	DNR
Entire Sample	2.65%	23.27%	1.84%	16.53%	6.53%	30.82%	16.73%	1.63%
Bergen	2.44%	21.95%	1.22%	14.63%	4.88%	34.15%	20.73%	0.00%
Essex	3.33%	28.33%	1.67%	16.67%	1.67%	35.00%	11.67%	1.66%
Hudson	1.89%	35.85%	3.77%	20.75%	5.66%	24.53%	7.55%	0.00%
Middlesex	0.99%	21.78%	3.96%	16.83%	4.95%	33.66%	14.85%	2.98%
Monmouth	2.99%	16.42%	0.00%	13.43%	7.46%	34.33%	23.88%	1.49%
Morris	7.14%	21.43%	0.00%	7.14%	7.14%	7.14%	50.00%	0.01%
Passaic	0.00%	33.33%	0.00%	22.22%	18.52%	18.52%	0.00%	7.41%
Sommerset	0.00%	9.09%	0.00%	18.18%	4.55%	40.91%	27.27%	0.00%
Union	6.25%	20.31%	1.56%	17.19%	10.94%	26.56%	15.63%	1.56%
DNR	0.00%	1.72%	0.00%	2.41%	5.88%	1.31%	4.65%	84.03%

Almost half (48.92%) of the respondents were from households with 2 adults, whereas 76.80% of the respondents were from households with two or more adults. More than half (55.67%) of the respondents' households did not have any children. Approximately three-quarters (75.10%) of the respondents were from households with two or more licensed drivers, whereas 73.74% of the respondents were from households with two or more available vehicles for use. The average number of vehicles available for use per household was 2.09, whereas the average number of adults per household and the average number of licensed drivers per household were 2.18 and 2.08 respectively. Availability of vehicles per adult in a household was 1.06, on an average.

About the work-related information, 97.07% conveyed the information about working status, whereas only 75.24% and 77.19% informed their working type and flexibility to work from home, respectively. Of those who filled in the information about work from home flexibility, about 28.28% of the respondents had flexibility to work from home. The majority of the respondents, i.e., 72.28% of those who stated the type of work information, were working either in management work or clerical work. The majority of the respondents, who gave the working status information were working full-time

(69.88%), whereas about 18.88% of the respondents were either retired or not working outside the home. Figure 6 showed the working status distribution for male, female and entire sample, whereas Figure 7 depicted the same across different races and Figure 8 presented the distribution of type of work for male, female and entire sample.

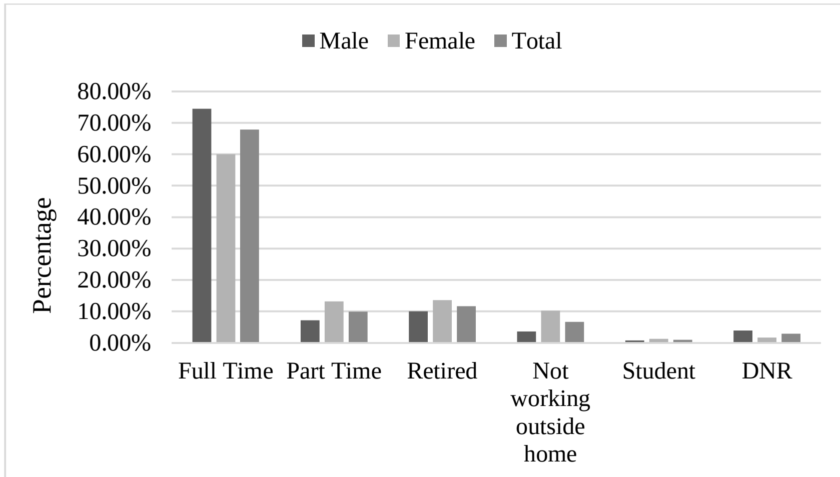

Figure 6: Gender-Wise Working Status Distribution

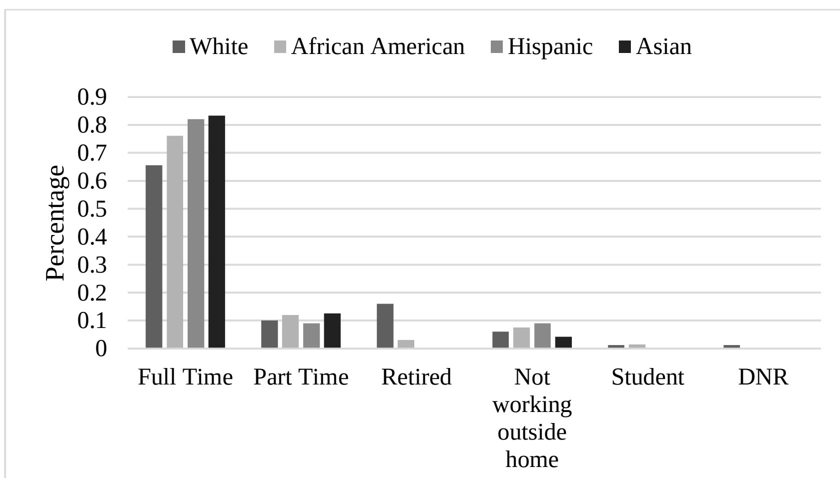

Figure 7: Race-Wise Working Status Distribution

From gender-wise distribution of working status, it can be observed that more percentage of male respondents were working full-time, whereas more percentage of female respondents were working part-time when compared to the sample. From race-wise distribution of working status, it can be observed that less percentage of white respondents were working full-time when compared to other races. More percentage of white retired people responded when compared to other races. From gender-wise distribution of type of work, it can be observed that more percentage of female were in management or clerical work, whereas more percentage of salespersons and drivers were male.

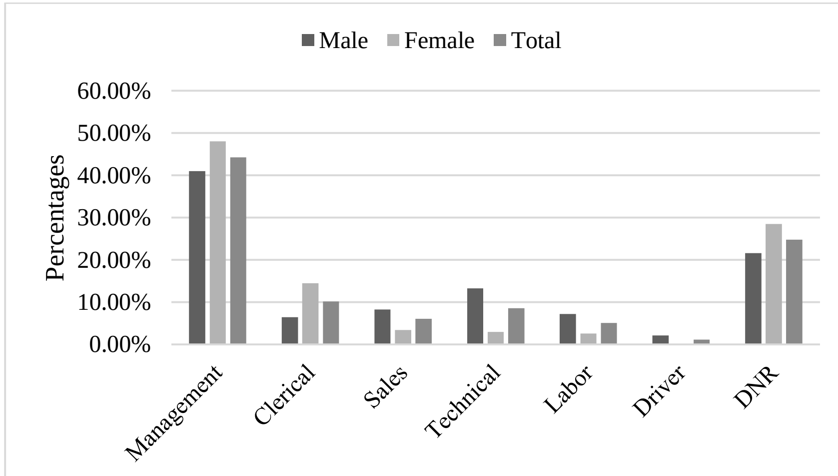

Figure 8: Gender-Wise Type of Work Distribution

Annual household income across the survey data was relatively high, with a mean of $87,284. Figure 9 illustrated the income dispersion for the entire survey sample, whereas Figure 10 depicted the gender-wise income dispersion. Analysis of the gender-wise income dispersion indicated that more female respondents were reluctant to respond with information about their income.

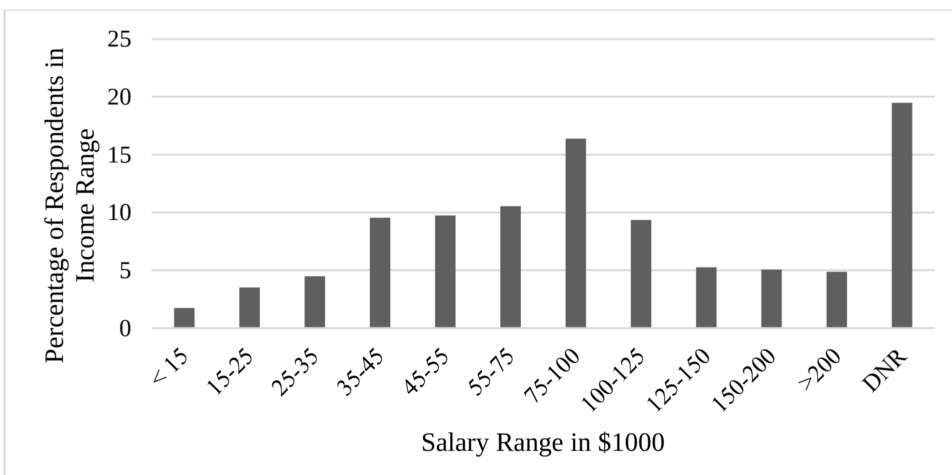

Figure 9: Income Range of Survey Sample (Before Taxes)

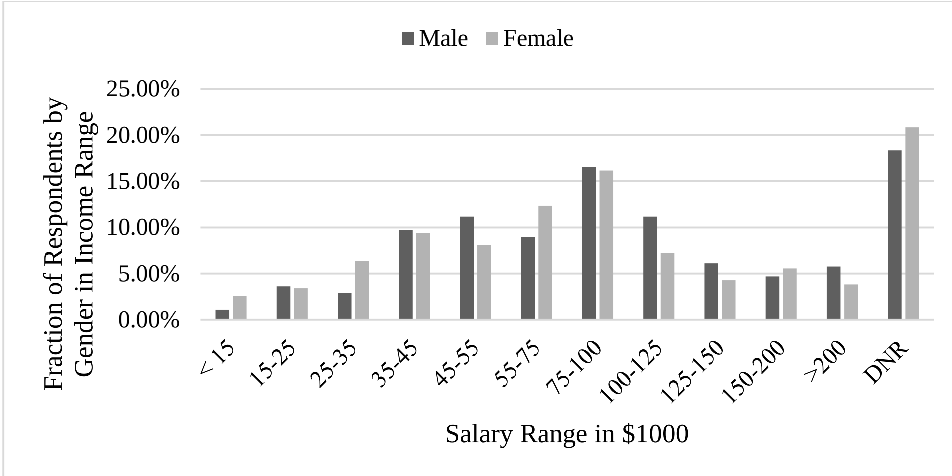

Figure 10: Income Range by Gender (Before Taxes)

Table 5 presents the distribution of income by geographic location. Somerset County showed higher income levels with 72.73% of the respondents. Passaic County showed lower income levels.

Table 5: Distribution of Income (in $1000) by Geographical location

	< 15	15-25	25-35	35-45	45-55	55-75	75-100	100-125	125-150	150-200	>200
Sample	1.8%	3.7%	4.7%	9.8%	10.2%	11.0%	16.9%	9.8%	5.5%	5.1%	4.9%
Bergen	3.7%	2.4%	2.4%	11.0%	7.3%	8.5%	17.1%	9.8%	9.8%	2.4%	6.1%
Essex	3.3%	6.7%	1.7%	11.7%	15.0%	8.3%	8.3%	6.7%	5.0%	6.7%	8.3%
Hudson	0.0%	7.5%	5.7%	18.9%	5.7%	13.2%	18.9%	13.2%	1.9%	1.9%	1.9%
Middlesex	2.0%	2.0%	4.0%	6.9%	7.9%	16.8%	18.8%	5.0%	4.0%	5.9%	4.0%
Monmouth	0.0%	1.5%	6.0%	4.5%	10.4%	6.0%	17.9%	16.4%	7.5%	9.0%	4.5%
Morris	0.0%	0.0%	0.0%	21.4%	14.3%	7.1%	7.1%	14.3%	21.4%	0.0%	0.0%
Passaic	7.4%	11.1%	11.1%	3.7%	22.2%	7.4%	11.1%	7.4%	3.7%	3.7%	3.7%
Somerset	0.0%	0.0%	0.0%	0.0%	9.1%	9.1%	27.3%	9.1%	4.5%	13.6%	9.1%
Union	0.0%	3.1%	9.4%	12.5%	10.9%	14.1%	20.3%	10.9%	1.6%	3.1%	4.7%
DNR	0.0%	0.0%	0.0%	4.3%	0.0%	0.0%	4.3%	0.0%	0.0%	4.3%	4.3%

More than half (59.06%) of the respondents had E-Z Pass, and only 39.76% were aware of the discounts for E-Z pass users and 83.49% of the E-Z Pass owner-respondents did not provide the information pertaining to who paid for the E-Z pass. All the respondents gave the information about the use of the turnpike, and around 94.15% of the respondents were current turnpike users. Only 2% of the respondents did not fill in the information about the number of years they were using the turnpike, and the average experience of the respondents in using the turnpike was around 13 years.

Analyzing the household structure provided indicated that household size was small with 2.18 adults and 0.79 children, on an average. Household car ownership was around

2.09 cars per household with 2.09 licensed drivers per household. The number of cars matched the number of licensed drivers with on average 1.07 cars for a licensed driver, per household.

A middle-aged full-time working white male with household income (before taxes) above $80K, education of at least a four year college degree, and owner of E-Z Pass, was the typical respondent of the survey.

A comprehensive analysis of the information related to gender, age, race, education level, employment status, household structure, E-Z pass ownership and income level is presented in this section. Next section discusses the public opinion of the respondents.

3.3 Analysis of Public Opinion Surveys

Opinions of the respondents on their acceptance about fairness of pricing and discounts, perceived impacts and willingness to pay more tolls for the faster and reliable trip, as conveyed in the survey are analyzed in this section. Opinions are reported as their agreement i.e., whether they strongly agree, somewhat agree, somewhat disagree or strongly disagree with each.

Table 6: Summary of Respondents' Opinion

Public Opinion on	Percent Responded	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
Fairness of Time of Day pricing	96.88%	11.87%	13.68%	19.92%	54.53%
Fairness of Discounts to users of E-Z Pass	97.27%	60.52%	22.44%	4.61%	12.42%
Fairness of Discounts to Frequent Commuters	97.66%	50.30%	24.15%	9.58%	15.97%
Revenues to be used for Public Transit	94.93%	30.80%	27.31%	15.20%	26.69%
Time of Day pricing improved traffic congestion	97.27%	29.06%	26.05%	13.63%	31.26%
Willingness to pay for faster trip	96.69%	21.98%	26.61%	15.32%	36.09%
Willingness to pay for reliable trip	93.96%	18.88%	27.18%	20.75%	33.20%

Table 6 summarized the opinion of respondents on various issues along with the percentage of total 513 respondents who gave their opinion about the issue. Fraction of respondents who reported their opinion is given by each cell in Table 6. The majority of the respondents (82.97%) showed their agreement, i.e., at least somewhat agreed, for acceptance of discounts to E-Z Pass as fair, whereas very few respondents (25.55%) felt it was fair to price tolls based on time of day.

This section is further divided into subsections to analyze each of the issue's opinion variations with gender, income-range, education, race, age-range and working status. Cross-tabulation is done for the opinion against income-range, age-range and educational level. In these tables, the fraction of respondents in the cell represent the respondents who filled both the opinion and respective variable. Bar charts are produced for the opinion by gender, race and working status. In these figures, the fraction of respondents represent the respondents who filled the respective variable.

3.3.1 Fairness of Time of Day Pricing

Time of day pricing was not perceived as fair by the majority of the respondents. Figure 11 illustrates the agreement of the respondents by gender. It can be observed that the male respondents (26.26% of 278 respondents) found time of day pricing more fair when compared to the female respondents (22.98% of 235 respondents) and the entire sample (24.76% of 513 respondents).

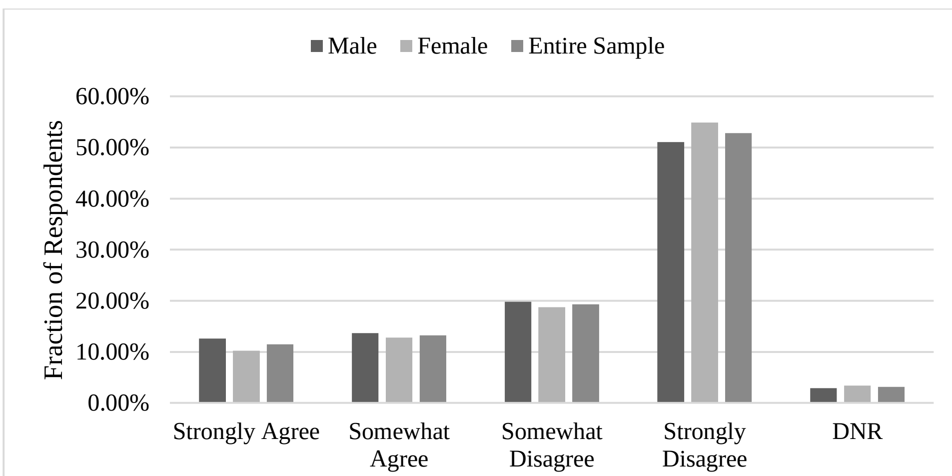

Figure 11: Fairness of Time of Day Pricing by Gender

Table 7 presents the respondents' opinion about fairness of time of day pricing by income range. The agreement was relatively high for the respondents whose income was above the mean income.

Table 7: Fairness of Time of Day Pricing by Income

Income (1000$) Range	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Number of Valid Observations
< 15	22.22%	44.44%	11.11%	22.22%	9
15-25	44.44%	22.22%	16.67%	16.67%	18
25-35	56.52%	17.39%	8.70%	17.39%	23
35-45	65.22%	17.39%	10.87%	6.52%	46
45-55	63.04%	19.57%	10.87%	6.52%	46
55-75	50.94%	20.75%	16.98%	11.32%	53
75-100	42.86%	29.76%	15.48%	11.90%	84
100-125	48.94%	19.15%	21.28%	10.64%	47
125-150	62.96%	11.11%	7.41%	18.52%	27
150-200	45.83%	16.67%	16.67%	20.83%	24
>200	56.52%	13.04%	17.39%	13.04%	23

Table 8 presents the respondents' perception about fairness of time of day pricing by their last grade of education. The agreement was a bit high for the respondents who had education till high school (24.61% of 130 such respondents who gave their opinion) when compared to those who had education above high school and did up to four year college (21.05% of 266 such respondents who gave their opinion). As expected, the respondents who had done graduate work (40% of 85 respondents who had done graduate work and gave their opinion) had more agreement when compared to the entire sample (25.6% of 481 respondents who gave their opinion).

Table 8: Fairness of Time of Day Pricing by Educational Level

Education Level	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Number of Valid Observations
< 8th Grade	0.00%	0.00%	0.00%	100.00%	2
HS Incomplete	42.86%	14.29%	14.29%	28.57%	7
HS Complete	55.36%	23.21%	9.82%	11.61%	112
Vocational School	55.56%	11.11%	33.33%	0.00%	9
Some College	62.65%	14.46%	8.43%	14.46%	83
Junior College	67.65%	14.71%	8.82%	8.82%	34
4 year College	56.38%	22.82%	12.75%	8.05%	149
Graduate Work	41.18%	18.82%	25.88%	14.12%	85

Figure 12 illustrates the agreement of the respondents by race. It can be observed that the least fraction of agreement was seen for African-American respondents (25.37% of 67 respondents) whereas the highest agreement was seen for Asian respondents (45.83% of 24 respondents).

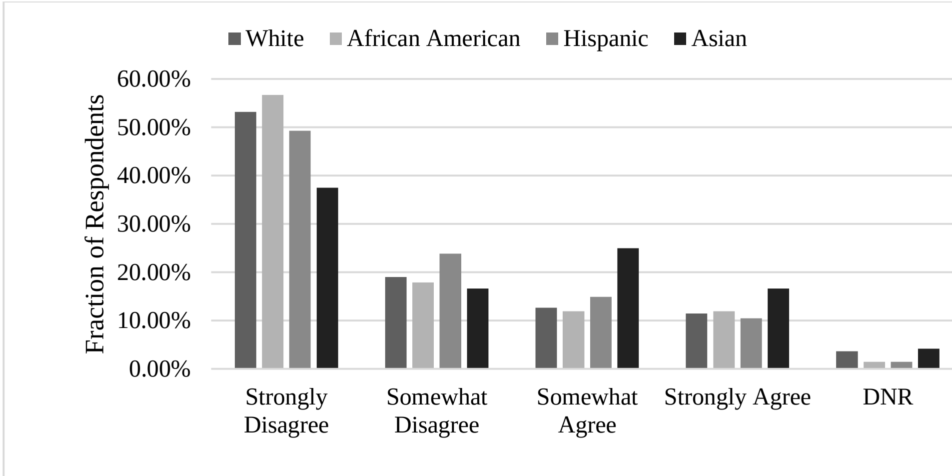

Figure 12: Fairness of Time of Day Pricing by Race

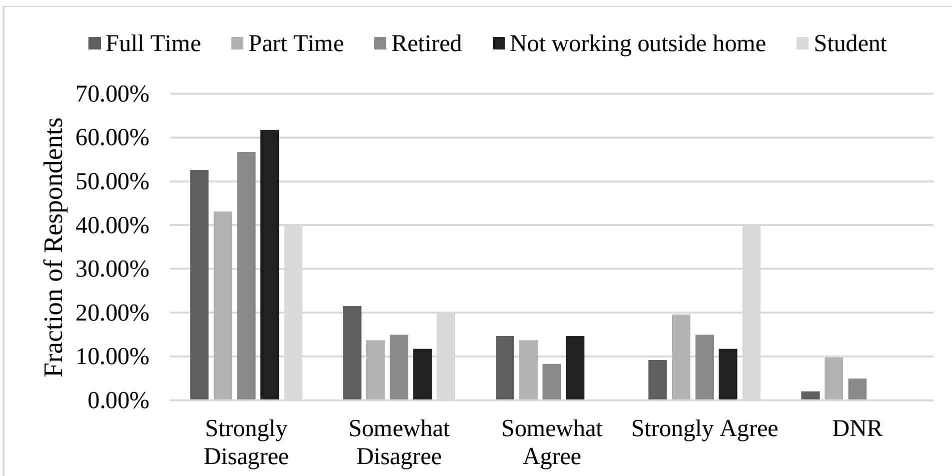

Figure 13: Fairness of Time of Day Pricing by Working Status

Figure 13 depicts the fairness of time of day pricing by working status, whereas Table 9 presents the fairness of time of day pricing by age range. Analyzing the fairness of time of day pricing by working status, the full-time working respondents had least agreement (23.85% of 348 full-time working respondents), whereas part-time working respondents had better agreement (33.33% of 51 part-time working respondents). On examining the fairness of time of day pricing by age range, the respondents who were in the fifties age-group (31.19% of 112 respondents) and those who aged 18 to 20 years (38.89% for 18 respondents), had better agreement when compared to others, whereas the respondents aged 40 to 49 years (19.82% of 114 respondents) had the least agreement. No particular trend was observed in agreement with the age.

Table 9: Fairness of Time of Day Pricing by Age Range

Age Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
18-20	50.00%	11.11%	11.11%	27.78%	18
21-24	55.56%	18.52%	14.81%	11.11%	27
25-29	55.56%	22.22%	16.67%	5.56%	38
30-39	56.78%	20.34%	12.71%	10.17%	119
40-49	56.76%	23.42%	9.91%	9.91%	114
50-59	48.62%	20.18%	19.27%	11.93%	112
60-65	61.90%	9.52%	9.52%	19.05%	23
65 or Over	53.49%	18.60%	11.63%	16.28%	47

Of all the working types, respondents who did office or clerical work (30.77% of 52 respondents who gave opinion and did such work) and professional or management work (27.15% of 221 respondents who gave opinion and did such work) showed more agreement when compared to the entire sample (25.40% of 378 respondents who gave both information and opinion). Respondents who could work from home exhibited more agreement (28.97% of 107 respondents who gave opinion and could work from home) when compared to those whose work did not allow such flexibility (24.55% of 277 respondents who gave opinion and could not work from home). Respondents who owned E-Z Pass (27.21% of 294 respondents who gave opinion and owned E-Z Pass) showed more agreement when compared to those who did not own E-Z Pass (23.15% of 203 respondents who did not own E-Z Pass and gave opinion).

3.3.2 Fairness of E-Z Pass Discounts

The majority of the respondents found giving discounts to E-Z pass users, as fair. Figure 14 illustrates the agreement of the respondents by gender. It can be observed that the male respondents (83.81% of 278 respondents) found discounts to E-Z pass users more fair when compared to the female respondents (77.02% of 235 respondents) and the entire sample (80.70% of 513 respondents).

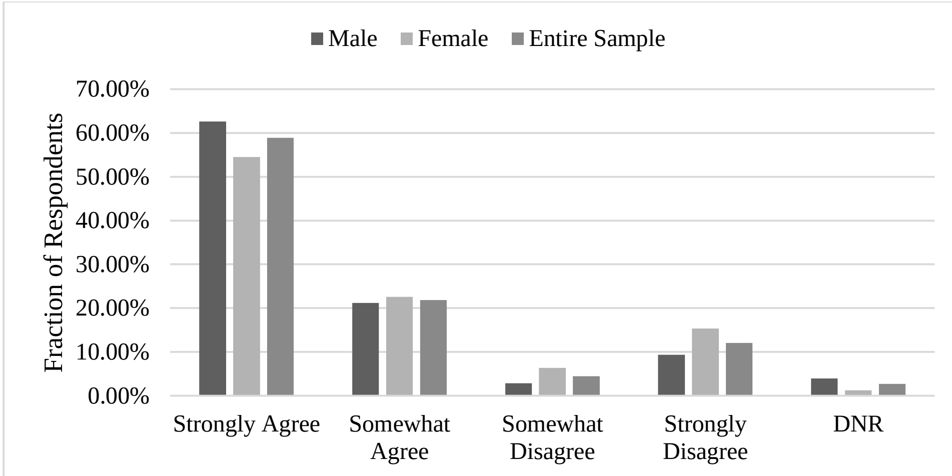

Figure 14: Fairness of Discounts to E-Z Pass Users by Gender

Table 10 presents the respondents' opinion about discounts to E-Z pass users by income range, whereas Table 11 shows the respondents' perception about the same by their last grade of education. The agreement was relatively high for the respondents whose income was above the mean income. Those with lower incomes ranges showed least agreement.

Table 10: Fairness of Discounts to E-Z Pass Users by Income Range

Income ($1000) Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 15	22.22%	11.11%	44.44%	22.22%	9
15-25	17.65%	17.65%	17.65%	47.06%	17
25-35	27.27%	9.09%	18.18%	45.45%	22
35-45	10.87%	2.17%	23.91%	63.04%	46
45-55	14.58%	0.00%	22.92%	62.50%	48
55-75	9.26%	5.56%	24.07%	61.11%	54
75-100	7.23%	4.82%	14.46%	73.49%	83
100-125	8.33%	6.25%	25.00%	60.42%	48
125-150	3.70%	3.70%	18.52%	74.07%	27
150-200	13.04%	0.00%	21.74%	65.22%	23
>200	0.00%	4.00%	24.00%	72.00%	25

The agreement was a bit high for the respondents who had education till high school (82.44% of 131 such respondents who gave their opinion) when compared to those who had education above high school and did up to four year college (81.2% of 266 such respondents who gave their opinion). As expected, the respondents who had done graduate work (93.02% of 86 respondents who had done graduate work and gave their opinion) had more agreement when compared to the entire sample (83.6% of 483 respondents who gave their opinion).

Table 11: Fairness of Discounts to E-Z Pass Users by Education Level

Education Level	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 8th Grade	0.00%	0.00%	0.00%	100.00%	2
HS Incomplete	25.00%	25.00%	0.00%	50.00%	8
HS Complete	11.61%	4.46%	30.36%	53.57%	112
Vocational School	11.11%	0.00%	11.11%	77.78%	9
Some College	17.07%	6.10%	21.95%	54.88%	82
Junior College	9.09%	3.03%	15.15%	72.73%	33
4 year College	13.25%	4.64%	20.53%	61.59%	151
Graduate Work	4.65%	2.33%	18.60%	74.42%	86

Figure 15 illustrates the agreement of the respondents by race, whereas Figure 16 depicts the fairness of discounts to E-Z pass users by working status. It can be observed that the least fraction of agreement was seen for African-American respondents (71.64% of 67 respondents) whereas the highest agreement was seen for Asian respondents (91.67% of 24 respondents). Analyzing the fairness of discounts to E-Z pass users by working status, the full-time working respondents had an agreement of 82.76% (of 348 respondents who were working full time), whereas students (5 students in sample) were in full agreement.

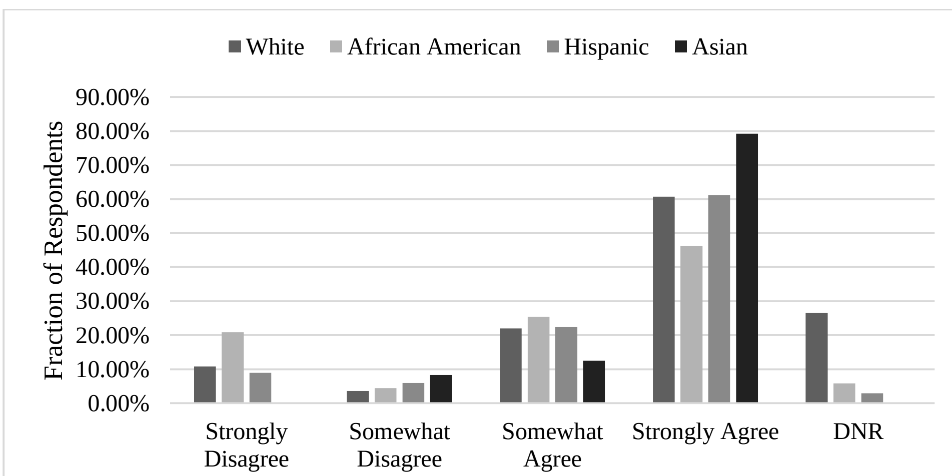

Figure 15: Fairness of Discounts to E-Z Pass Users by Race

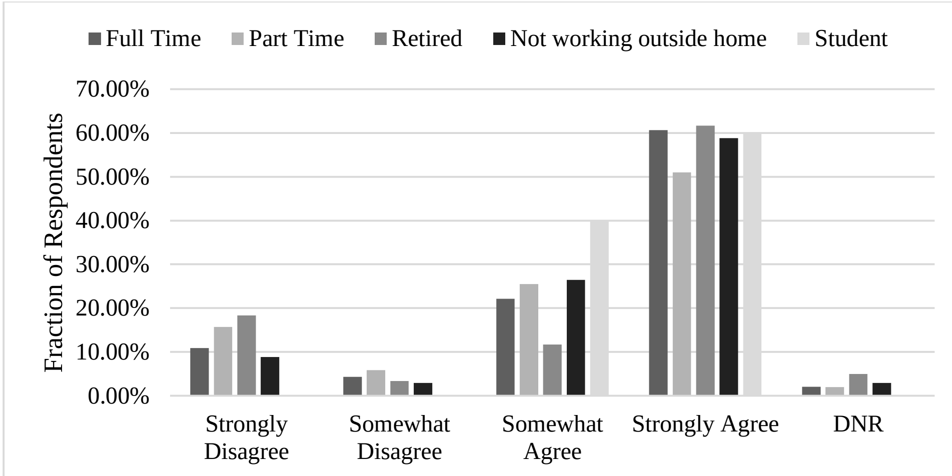

Figure 16: Fairness of Discounts to E-Z Pass Users by Working Status

Table 12 presents the fairness of discounts to E-Z pass users by age range. On examining the fairness of time of day pricing by age range, the respondents who were in the thirties age-group had highest agreement (88.14% of 119 respondents) whereas, the respondents aged 21 to 24 years had least agreement (69.23% of 27 respondents). No particular trend was observed in agreement against the age.

Table 12: Fairness of Discounts to E-Z Pass Users by Age Range

Age Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
18-20	5.56%	11.11%	27.78%	55.56%	18
21-24	26.92%	3.85%	26.92%	42.31%	27
25-29	13.16%	2.63%	23.68%	60.53%	38
30-39	9.32%	2.54%	26.27%	61.86%	119
40-49	8.93%	6.25%	24.11%	60.71%	114
50-59	13.64%	3.64%	18.18%	64.55%	112
60-65	14.29%	4.76%	14.29%	66.67%	23
65 or Over	13.95%	6.98%	13.95%	65.12%	47

Of all the working types, respondents who did professional work showed more agreement (87.05% who gave their opinion and were doing such work) when compared to the entire sample (84.47% who gave both the work type information and opinion). Respondents who could work from home exhibited less agreement (82.5% of 109 respondents who could work from home) when compared to those whose work did not allow such flexibility (84.28% of 280 respondent who could not work from home).

Respondents who owned E-Z Pass (92.28% of 298 E-Z Pass owner-respondents who gave their opinion) showed more agreement when compared to those who did not own E-Z Pass (69.15% of 201 respondents who did not own E-Z Pass and gave their opinion). Respondents who were aware of E-Z Pass discounts (91.5% of 200 such respondents) showed more agreement when compared to those who were not aware of (83.95% of 299 such respondents). The majority (95% of 141 such respondents) of those who owned E-Z Pass and were aware of the discounts showed an agreement.

3.3.3 Fairness of Discounts for Frequent Commuters

Discounts for frequent commuters were perceived as fair by three-quarters of the respondents who reported their opinion in survey. Figure 17 illustrates the agreement of the respondents for the fairness of discounts to frequent commuters by gender. From gender-wise distribution, it can be observed that the female respondents (74.89% of 235 respondents) found time of day pricing more fair when compared to the male respondents (70.86% of 278 respondents) and the entire sample (72.71% of 513 respondents). More than half (51.91%) of the female respondents were in strong agreement with the provision of discounts to frequent commuters.

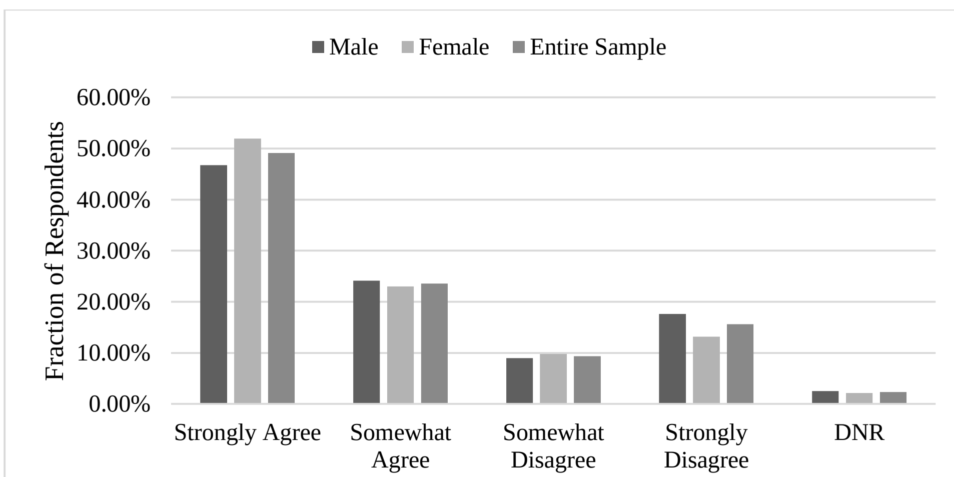

Figure 17: Fairness of Discounts for Frequent Commuters by Gender

Table 13 presents the agreement of the fairness of discounts to frequent commuters by income range, whereas Table 14 depicts the same by education of their last grade. The agreement was relatively high for the respondents whose income was above the mean income. Those who did not respond with income were not in agreement with time of day pricing.

Table 13: Fairness of Discounts to Frequent Commuters by Income Range

Income ($1000) Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 15	22.22%	11.11%	33.33%	33.33%	9
15-25	16.67%	5.56%	33.33%	44.44%	18
25-35	13.64%	9.09%	13.64%	63.64%	22
35-45	8.70%	4.35%	21.74%	65.22%	46
45-55	14.29%	4.08%	18.37%	63.27%	49
55-75	16.98%	5.66%	28.30%	49.06%	53
75-100	10.84%	9.64%	24.10%	55.42%	83
100-125	21.28%	10.64%	23.40%	44.68%	47
125-150	14.81%	14.81%	25.93%	44.44%	27
150-200	24.00%	12.00%	20.00%	44.00%	25
>200	16.00%	12.00%	28.00%	44.00%	25

Table 14: Fairness of Discounts for Frequent Commuter by Education

Education Level	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 8th Grade	0.00%	0.00%	0.00%	100.00%	2
HS Incomplete	11.11%	0.00%	22.22%	66.67%	9
HS Complete	12.50%	8.04%	25.89%	53.57%	112
Vocational School	11.11%	11.11%	0.00%	77.78%	9
Some College	20.73%	9.76%	24.39%	45.12%	82
Junior College	14.71%	2.94%	29.41%	52.94%	34
4 year College	13.16%	9.87%	23.68%	53.29%	152
Graduate Work	22.62%	14.29%	19.05%	44.05%	84

From Table 14, The agreement was a bit high for the respondents who had education till high school (80.03% of 132 such respondents who gave their opinion) when compared to those who had education above high school and did up to four year college (75.37% of 268 such respondents who gave their opinion). Contrary to expectations, the respondents who had done graduate work (63.09% of 84 respondents who had done graduate work and gave their opinion) had less agreement when compared to the entire sample (74.58% of 484 respondents who gave their opinion).

Figure 18 illustrates the agreement of the respondents by race, whereas Figure 19 depicts the perceived fairness of discounts to frequent commuters by working status. It can be observed that the least fraction of agreement was seen for African-American respondents (68.66% of 67 respondents) whereas the highest agreement was seen for Hispanic respondents (80.6% of 67 respondents).

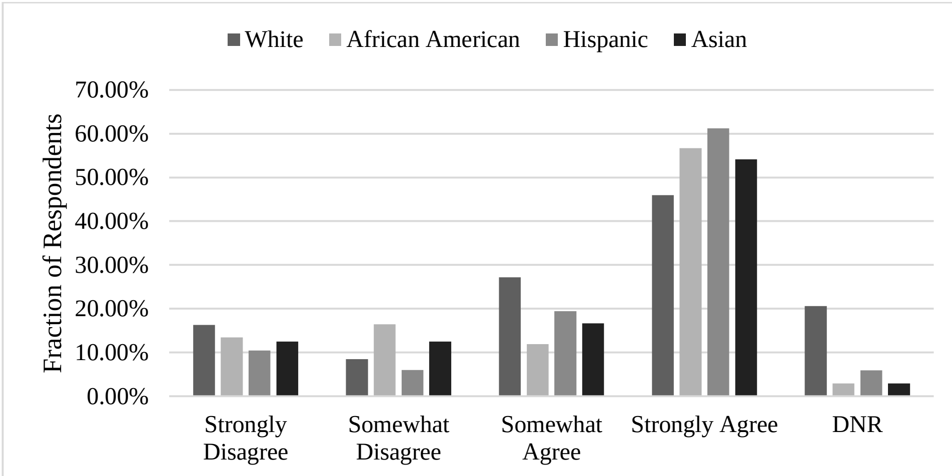

Figure 18: Fairness of Discounts for Frequent Commuters, by Race

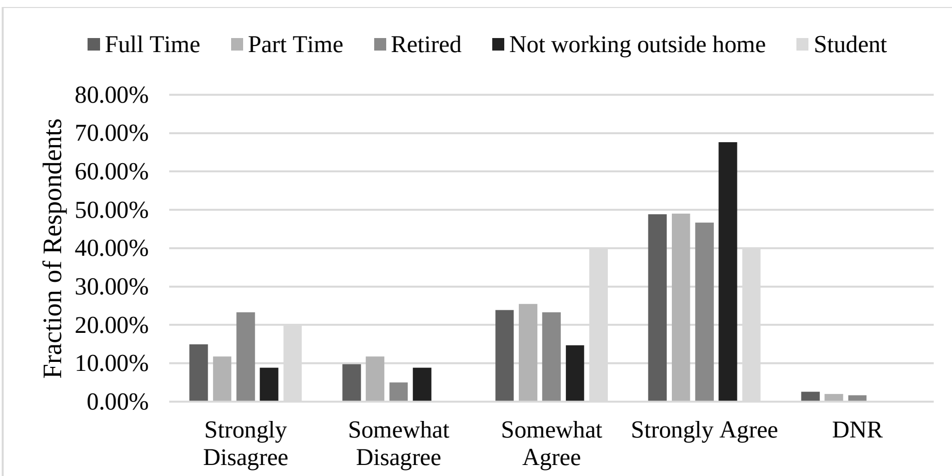

Figure 19: Fairness of Discounts for Frequent Commuters, by Working Status

Analyzing the fairness of discounts for frequent commuters by working status, the full-time working respondents had an agreement of 72.76% (of 348 respondents who worked full-time), whereas retired respondents (70.00% of 60 retired-respondents) had least agreement. Those who did not work outside home had better agreement (82.35% of 34 such respondents) in comparison with others.

Table 15 presents the perceived fairness of discounts for frequent commuters by age range. The respondents aged 18 to 24 years had highest agreement (88.89% of 45 respondents) whereas, the respondents aged 60 to 65 years had least agreement (61.9% of 23 respondents). No particular trend was observed in agreement against the age.

Table 15: Fairness of Discounts for Frequent Commuters by Age Range

Age Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
18-20	5.56%	5.56%	27.78%	61.11%	18
21-24	3.70%	7.41%	25.93%	62.96%	27
25-29	8.11%	5.41%	18.92%	67.57%	38
30-39	15.13%	9.24%	21.85%	53.78%	119
40-49	17.27%	14.55%	28.18%	40.00%	114
50-59	18.92%	8.11%	21.62%	51.35%	112
60-65	19.05%	19.05%	9.52%	52.38%	23
65 or Over	15.56%	4.44%	33.33%	46.67%	47

Of all the working types, respondents who did clerical work showed more agreement (88% of 50 respondents who were doing such work and gave their opinion) when compared to the entire sample (75.33% of 377 respondents who gave both the work-type information and opinion). Respondents who could work from home exhibited less agreement (74.73% of 110 respondents who could work from home and gave their opinion) when compared to those whose work did not allow such flexibility (75.45% of 277 respondents who could not work from home and gave their opinion). Respondents who owned E-Z Pass (78.78% of 297 E-Z Pass owner-respondents who gave their opinion) showed more agreement when compared to those who did not own E-Z Pass (73.04% of 204 who did not own E-Z Pass and gave their opinion).

3.3.4 Use of Toll-Revenues for Public Transit Improvement

More than half (55.17% of 513 respondents, 58.11% of 487 respondents who gave their opinion) of the respondents, were in agreement with toll-revenues should be used for the improvement of public transit. Figure 20 illustrates the agreement of the respondents, to use the toll-revenues for the improvement of public transit by gender. It can be observed that the male respondents (55.76% of 278 respondents) found use of toll-revenues for the improvement of public transit more agreeable when compared to the female respondents (54.47% of 235 respondents) and the entire sample (55.17% of 513 respondents).

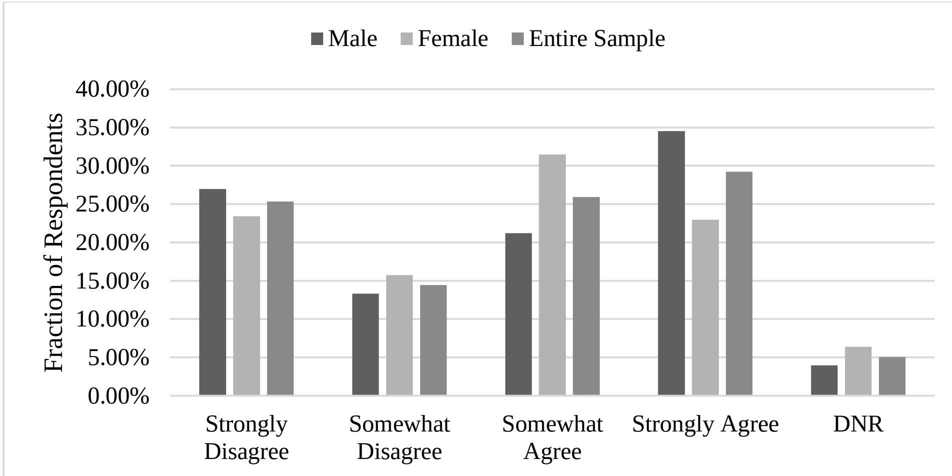

Figure 20: Use of Toll-Revenues to Improve Public Transit by Gender

Table 16 presents the respondents' opinion about using toll-revenues by income range, whereas Table 17 shows the respondents' perception about the same by their last grade of education. The agreement was relatively high for the respondents whose income was above the mean income but the people from highest income range showed least agreement. Those with lower income ranges showed least agreement. There was no particular trend in agreement with income range.

Table 16: Use of Toll-Revenues to Improve Public Transit by Income Range

Income ($1000) Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 15	22.22%	22.22%	11.11%	44.44%	9
15-25	23.53%	17.65%	11.76%	47.06%	17
25-35	34.78%	8.70%	39.13%	17.39%	23
35-45	22.22%	17.78%	26.67%	33.33%	45
45-55	28.26%	17.39%	17.39%	36.96%	46
55-75	17.65%	13.73%	37.25%	31.37%	51
75-100	25.61%	19.51%	36.59%	18.29%	82
100-125	29.17%	14.58%	20.83%	35.42%	48
125-150	26.92%	19.23%	23.08%	30.77%	26
150-200	12.50%	20.83%	25.00%	41.67%	24
>200	34.78%	13.04%	21.74%	30.43%	23

From Table 17, the agreement was a bit high for the respondents who had education till high school (44.44% of 132 such respondents who gave their opinion) when compared to those who had education above high school and did up to four year college (43.79% of 268 such respondents who gave their opinion). Contrary to expectations, the respondents who had done graduate work (34.12% of 85 respondents who had done graduate work and gave their opinion) had less agreement when compared to the entire sample.

Table 17: Use of Toll-Revenues to Improve Public Transit by Education

Education Level	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 8th Grade	0.00%	0.00%	0.00%	100.00%	2
HS Incomplete	25.00%	25.00%	0.00%	50.00%	8
HS Complete	27.27%	18.18%	28.18%	26.36%	110
Vocational School	25.00%	0.00%	37.50%	37.50%	8
Some College	33.33%	16.00%	26.67%	24.00%	75
Junior College	24.24%	24.24%	18.18%	33.33%	33
4 year College	27.33%	12.67%	30.00%	30.00%	150
Graduate Work	22.35%	11.76%	28.24%	37.65%	85

Figure 21 illustrates the agreement of the respondents by race, whereas Figure 22 depicts the agreement for using the toll-revenues for public transit improvement by working status. It can be observed that the least fraction of agreement was seen for White respondents (53.47% of 331 White respondents) whereas the highest agreement was seen for Asian respondents (75% of 24 Asian respondents). Analyzing the agreement for using the toll-revenues for public transit improvement by working status, the full-time working respondents had an agreement of 54% (of 348 respondents who were working full time), whereas part-time workers (51 such respondents in sample) had an agreement of 62.75%.

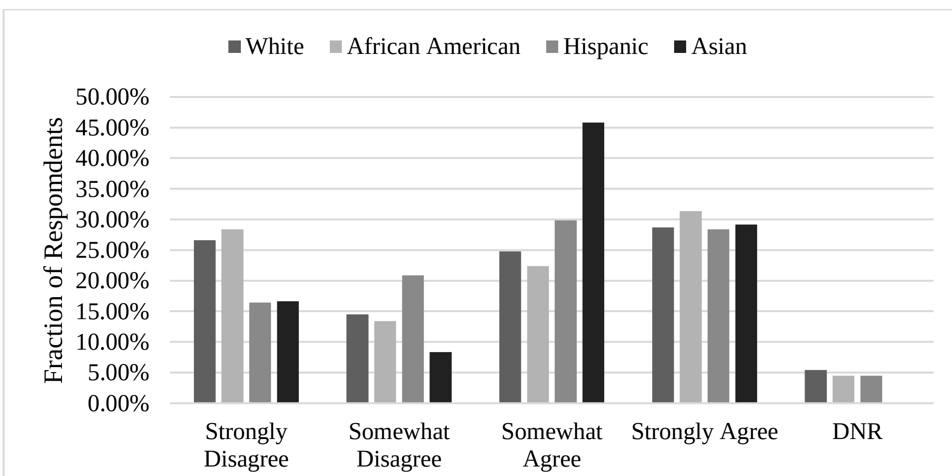

Figure 21: Use of Toll-Revenues for Public Transit Improvement by Race

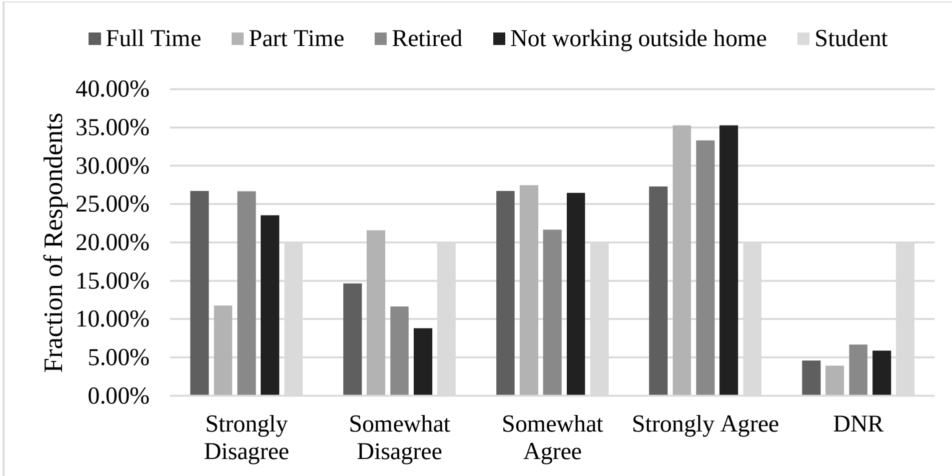

Figure 22: Use of Toll-Revenues to Improve Public Transit by Working Status

Table 18 presents the perceived fairness of discounts for using toll-revenues for public transit improvement by age range. The respondents aged 18 to 20 years had highest agreement (76.5% of 18 such respondents) whereas, the respondents aged 40 to 49 years had least agreement (50% of 114 respondents). No particular trend was observed in agreement against the age.

Table 18: Use of Toll-Revenues for Public Transit Improvement by Age

Age Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
18-20	5.88%	17.65%	35.29%	41.18%	18
21-24	11.54%	15.38%	50.00%	23.08%	27
25-29	19.44%	16.67%	38.89%	25.00%	38
30-39	26.72%	14.66%	27.59%	31.03%	119
40-49	32.08%	17.92%	27.36%	22.64%	114
50-59	28.18%	13.64%	23.64%	34.55%	112
60-65	42.86%	9.52%	9.52%	38.10%	23
65 or Over	18.60%	16.28%	20.93%	44.19%	47

Of all the working types, respondents who did clerical or office work showed less agreement (54% of 50 respondents who were doing such work and gave their opinion) when compared to the entire sample (58.22% of 371 respondents who gave both the work-type information and opinion). Respondents who could work from home exhibited less agreement (53.7% of 108 respondents who could work from home and gave their opinion) when compared to those whose work did not allow such flexibility (59.56% of 272 respondents who could not work from home and gave their opinion). Respondents who owned E-Z Pass (56.75% of 297 E-Z Pass owner-respondents who gave their opinion) showed less agreement when compared to those who did not own E-Z Pass (60.1% of 198 who did not own E-Z Pass and gave their opinion).

3.3.5 Improvement in Traffic Condition due to Turnpike Tolls

More than half (53.61% of 513 respondents, 55.11% of 499 respondents who gave their opinion) of the respondents, were in agreement with the tolls helped for the improvement of traffic condition. Figure 23 illustrates the agreement of the respondents, to impact of tolls on the improvement of traffic condition by gender. It can be observed that the male respondents (55.76% of 278 respondents) found use of toll-revenues for the improvement of public transit more agreeable when compared to the female respondents (51.06% of 235 respondents) and the entire sample (53.61% of 513 respondents).

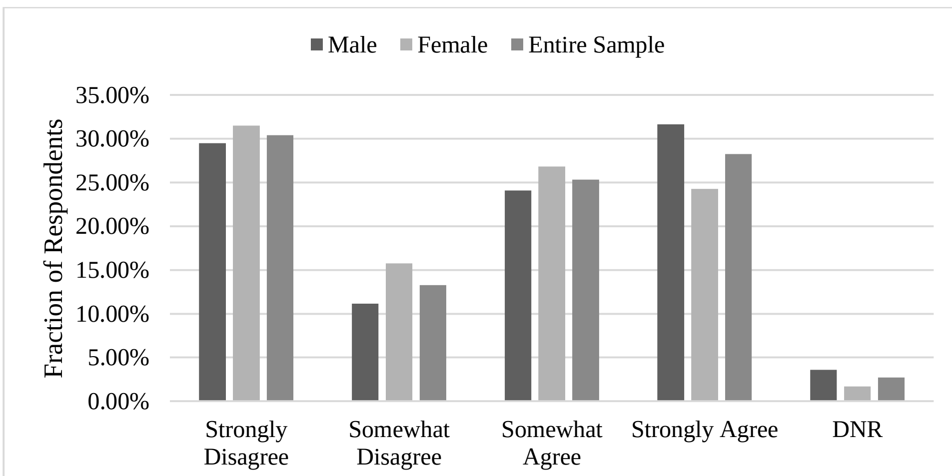

Figure 23: Improvement in Traffic Condition due to Tolls by Gender

Table 19 presents the respondents' opinion about tolls helping the traffic condition by income range, whereas Table 20 shows the respondents' perception about the same by their last grade of education. The agreement was relatively less for the respondents whose income was above the mean income but the people from highest income range showed higher agreement. Those with lower income ranges showed higher agreement. There was no particular trend in agreement with income range. The agreement was a bit high for the respondents who had education till high school (57.89% of 133 such respondents who gave their opinion) when compared to those who had education above high school and did up to four year college (50.56% of 265 such respondents who gave their opinion). As expected, the respondents who had done graduate work (64.7% of 85 respondents who had done graduate work and gave their opinion) had more agreement when compared to the entire sample.

Table 19: Improvement in Traffic Condition due to Tolls by Income Range

Income ($1000) Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 15	22.22%	11.11%	44.44%	22.22%	9
15-25	16.67%	11.11%	50.00%	22.22%	18
25-35	30.43%	4.35%	30.43%	34.78%	23
35-45	30.43%	10.87%	23.91%	34.78%	46
45-55	31.25%	8.33%	20.83%	39.58%	48
55-75	27.78%	18.52%	18.52%	35.19%	54
75-100	21.69%	14.46%	31.33%	32.53%	83
100-125	33.33%	14.58%	29.17%	22.92%	48
125-150	44.44%	18.52%	11.11%	25.93%	27
150-200	37.50%	8.33%	20.83%	33.33%	24
>200	26.09%	13.04%	26.09%	34.78%	23

Table 20: Improvement in Traffic Condition due to Tolls by Education

Education Level	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 8th Grade	0.00%	0.00%	0.00%	100.00%	2
HS Incomplete	33.33%	11.11%	11.11%	44.44%	9
HS Complete	31.86%	10.62%	30.09%	27.43%	113
Vocational School	33.33%	11.11%	11.11%	44.44%	9
Some College	35.80%	16.05%	25.93%	22.22%	81
Junior College	41.18%	17.65%	20.59%	20.59%	34
4 year College	32.67%	13.33%	25.33%	28.67%	150
Graduate Work	21.18%	14.12%	28.24%	36.47%	85

Figure 24 illustrates the agreement of the respondents by race, whereas Figure 25 depicts the perceived impacts of tolls on traffic condition improvement by working status. It can be observed that the least fraction of agreement was seen for African-American respondents (52.24% of 67 African-American respondents) whereas the highest agreement was seen for Asian respondents (66.67% of 24 Asian respondents). Analyzing the agreement for impacts of tolls on traffic condition improvement by working status, the full-time working respondents had an agreement of 53.45% (of 348 respondents who were working full time), whereas part-time workers (51 such respondents in sample) had an agreement of 60.75%.

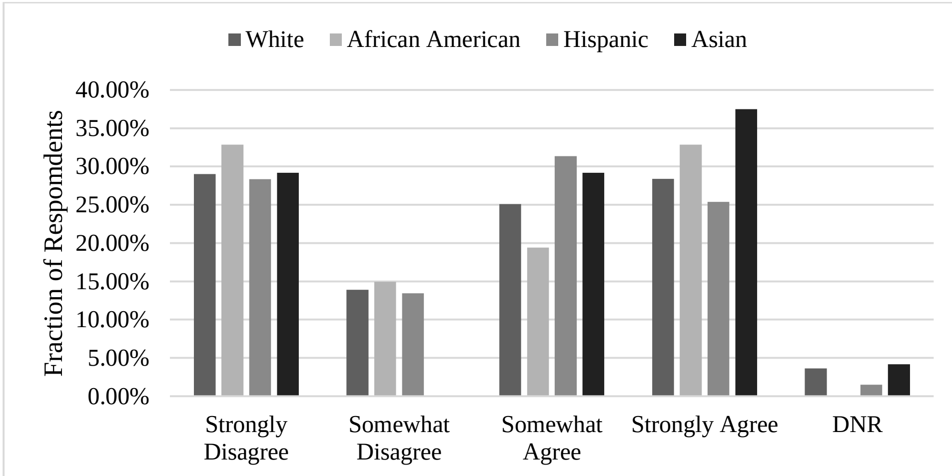

Figure 24: Improvement in Traffic Condition due to Tolls by Race

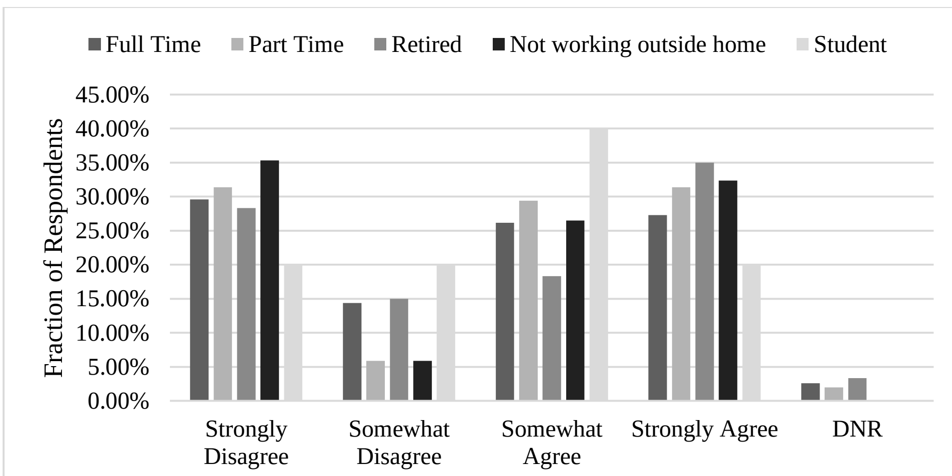

Figure 25: Improvement in Traffic Condition due to Tolls by Working Status

Table 21 presents the perceived impacts of tolls on traffic condition improvement. The respondents aged 25 to 29 years (62.16% of 38 respondents) and aged 65 or over (67.44% of 47 respondents) had higher agreement whereas, the respondents aged 21 to 24 years had least agreement (48.15% of 27 respondents). No particular trend was observed in agreement against the age.

Table 21: Improvement in Traffic Condition due to Tolls by Age Range

Age Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
18-20	38.89%	11.11%	22.22%	27.78%	18
21-24	44.44%	7.41%	25.93%	22.22%	27
25-29	24.32%	13.51%	45.95%	16.22%	38
30-39	33.05%	14.41%	26.27%	26.27%	119
40-49	33.64%	17.27%	25.45%	23.64%	114
50-59	27.93%	10.81%	26.13%	35.14%	112
60-65	38.10%	4.76%	4.76%	52.38%	23
65 or Over	16.28%	16.28%	25.58%	41.86%	47

Of all the working types, respondents who did clerical or office work (58.82% of 51 respondents who were doing such work and gave their opinion) and professional or management kind of work (57.02% of 221 respondents who were doing such work and gave their opinion) showed more agreement when compared to the entire sample (55.17% of 377 respondents who gave both the work-type information and opinion). Respondents who could work from home exhibited more agreement (66.36% of 110 respondents who could work from home and gave their opinion) when compared to those whose work did not allow such flexibility (51.62% of 277 respondents who could not work from home and gave their opinion). Respondents who owned E-Z Pass (56.61% of 295 E-Z Pass owner-respondents who gave their opinion) showed more agreement when compared to those who did not own E-Z Pass (52.94% of 204 who did not own E-Z Pass and gave their opinion).

3.3.6 Willingness to Pay for Faster Trip

Not even half (46.98% of 513 respondents, 48.58% of 496 respondents who gave their opinion) of the respondents, were willing to pay for faster trip. Figure 26 illustrates the agreement of the respondents, to willingness to pay for a faster trip. It can be observed that the male respondents (49.64% of 278 respondents) were more willing to pay for faster trip when compared to the female respondents (43.83% of 235 respondents) and the entire sample.

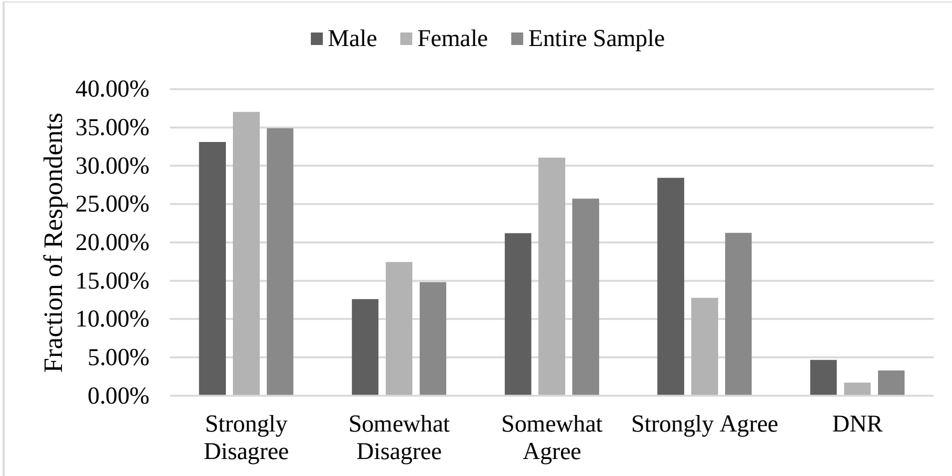

Figure 26: Willingness to Pay for Faster Trip by Gender

Table 22 presents the respondents' willingness to pay for a faster trip by income range, whereas Table 23 shows the respondents' agreement for the same by their last grade of education. The agreement was relatively high for the respondents whose income was above the mean income but the people from higher income ranges showed a slightly lower agreement. Those with lower income ranges showed lower agreement.

Table 22: Willingness to Pay for Faster Trip by Income

Income ($1000) Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 15	55.56%	22.22%	22.22%	0.00%	9
15-25	33.33%	22.22%	16.67%	27.78%	18
25-35	39.13%	8.70%	13.04%	39.13%	23
35-45	31.91%	14.89%	36.17%	17.02%	47
45-55	39.58%	10.42%	27.08%	22.92%	48
55-75	42.59%	14.81%	29.63%	12.96%	54
75-100	32.93%	19.51%	25.61%	21.95%	82
100-125	33.33%	10.42%	35.42%	20.83%	48
125-150	44.00%	8.00%	24.00%	24.00%	25
150-200	12.50%	16.67%	25.00%	45.83%	24
>200	20.00%	16.00%	20.00%	44.00%	25

The agreement was a bit less for the respondents who had education till high school (45.86% of 133 such respondents who gave their opinion) when compared to those who had education above high school and did up to four year college (46.44% of 267 such respondents who gave their opinion). As expected, the respondents who had done graduate work (58.75% of 80 respondents who had done graduate work and gave their opinion) had more agreement when compared to the entire sample.

Table 23: Willingness to Pay for Faster Trip by Education

Education Level	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 8th Grade	0.00%	0.00%	0.00%	100.00%	2
HS Incomplete	77.78%	0.00%	11.11%	11.11%	9
HS Complete	37.17%	14.16%	24.78%	23.89%	113
Vocational School	55.56%	22.22%	11.11%	11.11%	9
Some College	33.75%	11.25%	28.75%	26.25%	80
Junior College	44.12%	26.47%	11.76%	17.65%	34
4 year College	37.25%	16.99%	27.45%	18.30%	153
Graduate Work	25.00%	16.25%	33.75%	25.00%	80

Figure 27 illustrates the agreement of the respondents by race, whereas Figure 28 depicts the willingness to pay for faster trip by working status. It can be observed that the least fraction of agreement was seen for African-American respondents (34.33% of 67 African-American respondents) whereas the higher agreement was seen for Asian (54.17% of 24 Asian respondents) and Hispanic (53.73% of 67 Hispanic respondents) respondents. Analyzing the agreement for willingness to pay for faster trip by working status, the full-time working respondents had an agreement of 48.56% (of 348 respondents who were working full time), whereas part-time workers (51 such respondents in sample) had an agreement of 52.94%.

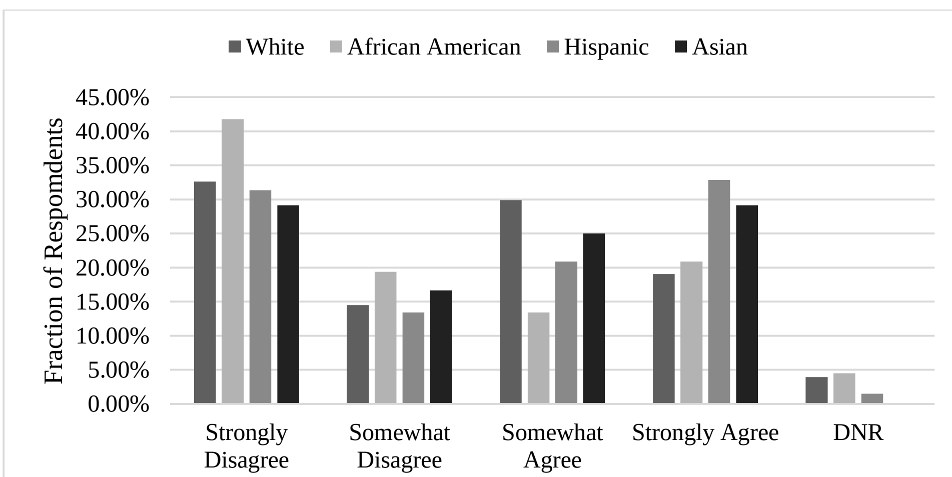

Figure 27: Willingness to Pay for Faster Trip by Race

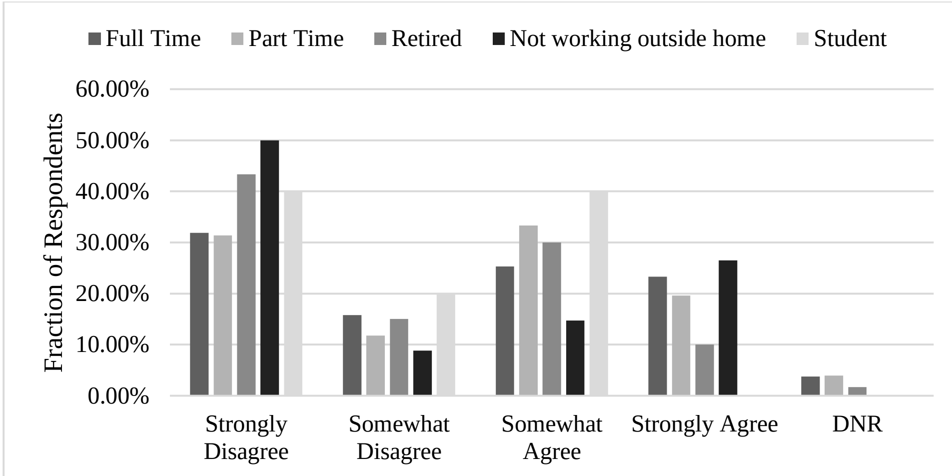

Figure 28: Willingness to Pay for Faster Trip by Working Status

Table 24 presents the willingness to pay for faster trip by age. The respondents in their thirties (54.24% of 119 respondents) had higher agreement whereas, the respondents aged 65 years or above had least agreement (38.64% of 47 respondents).

Table 24: Willingness to Pay for Faster Trip by Age

Age Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
18-20	27.78%	11.11%	55.56%	5.56%	18
21-24	22.22%	25.93%	18.52%	33.33%	27
25-29	34.21%	15.79%	34.21%	15.79%	38
30-39	30.51%	15.25%	22.88%	31.36%	119
40-49	33.96%	17.92%	29.25%	18.87%	114
50-59	45.45%	10.00%	20.91%	23.64%	112
60-65	35.00%	15.00%	50.00%	0.00%	23
65 or Over	40.91%	20.45%	20.45%	18.18%	47

Of all the working types, respondents who did clerical or office work (59.62% of 52 respondents who were doing such work and gave their opinion) and professional or management kind of work (52.51% of 219 respondents who were doing such work and gave their opinion) showed more agreement when compared to the entire sample (51.34% of 372 respondents who gave both the work-type information and opinion). Respondents who could work from home exhibited more agreement (53.27% of 107 respondents who could work from home and gave their opinion) when compared to those whose work did not allow such flexibility (50.18% of 275 respondents who could not work from home and gave their opinion). Respondents who owned E-Z Pass (49.49% of 293 E-Z Pass owner-respondents who gave their opinion) showed less agreement when compared to those who did not own E-Z Pass (54.19% of 203 who did not own E-Z Pass and gave their opinion).

3.3.7 Willingness to Pay for Reliable Trip

Less than half (43.27% of 513 respondents, 46.05% of 488 respondents who gave their opinion) of the respondents, were willing to pay for reliable trip. Figure 29 illustrates the agreement of the respondents, to willingness to pay for reliable trip. It can be observed that the male respondents (44.60% of 278 respondents) were more willing to pay for reliable trip when compared to the female respondents (41.70% of 235 respondents) and the entire sample.

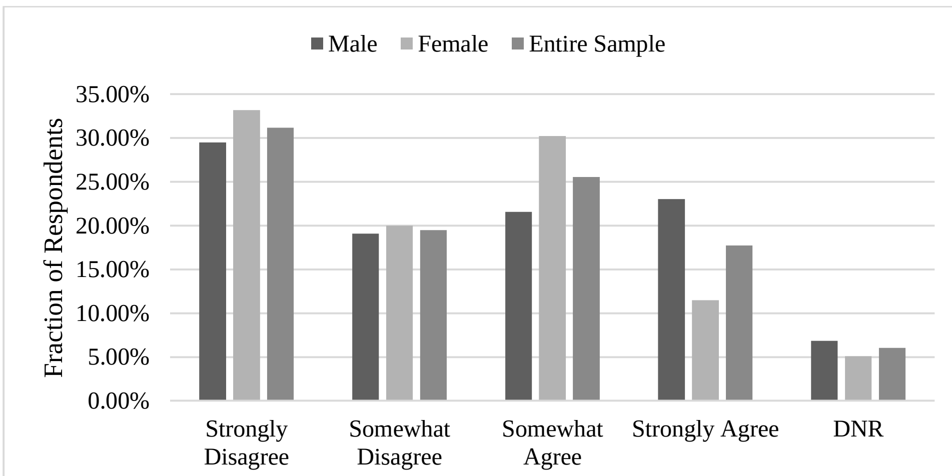

Figure 29: Willingness to Pay for Reliable Trip by Gender

Table 25 presents the respondents' willingness to pay for reliable trip by income range, whereas Table 26 shows the respondents' agreement for the same by their last grade of education. The agreement was relatively high for the respondents whose income was above the mean income but the people from higher income ranges showed a slightly lower agreement. Those with lower income ranges showed lower agreement. The agreement was a bit less for the respondents who had education till high school (42.31% of 130 such respondents who gave their opinion) when compared to those who had education above high school and did up to four year college (45.35% of 258 such respondents who gave their opinion). As expected, the respondents who had done graduate work (52.56% of 78 respondents who had done graduate work and gave their opinion) had more agreement when compared to the entire sample.

Table 25: Willingness to Pay for Reliable Trip by Income

Income (1000$) Range	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Number of Valid Observations
< 15	22.22%	22.22%	11.11%	44.44%	9
15-25	23.53%	17.65%	11.76%	47.06%	17
25-35	34.78%	8.70%	39.13%	17.39%	23
35-45	22.22%	17.78%	26.67%	33.33%	45
45-55	28.26%	17.39%	17.39%	36.96%	46
55-75	17.65%	13.73%	37.25%	31.37%	51
75-100	25.61%	19.51%	36.59%	18.29%	82
100-125	29.17%	14.58%	20.83%	35.42%	48
125-150	26.92%	19.23%	23.08%	30.77%	26
150-200	12.50%	20.83%	25.00%	41.67%	24
>200	34.78%	13.04%	21.74%	30.43%	23

Table 26: Willingness to Pay for Reliable Trip by Education

Education Level	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
< 8th Grade	0.00%	0.00%	0.00%	100.00%	2
HS Incomplete	62.50%	0.00%	25.00%	12.50%	8
HS Complete	29.73%	27.03%	26.13%	17.12%	111
Vocational School	55.56%	22.22%	22.22%	0.00%	9
Some College	27.50%	25.00%	28.75%	18.75%	80
Junior College	45.45%	21.21%	18.18%	15.15%	33
4 year College	36.55%	16.55%	26.90%	20.00%	145
Graduate Work	28.21%	19.23%	34.62%	17.95%	78

Figure 30 illustrates the agreement of the respondents by race, whereas Figure 31 depicts the willingness to pay for reliable trip by working status. It can be observed that the least fraction of agreement was seen for White respondents (40.79% of 331 White respondents) whereas the higher agreement was seen for Asian (58.33% of 24 Asian respondents) respondents. Analyzing the agreement for willingness to pay for reliable trip by working status, the full-time working respondents had an agreement of 44.25% (of 348 respondents who were working full time), whereas part-time workers (51 such respondents in sample) had an agreement of 50.98% and students were not at all in agreement for willingness to pay for reliable trip.

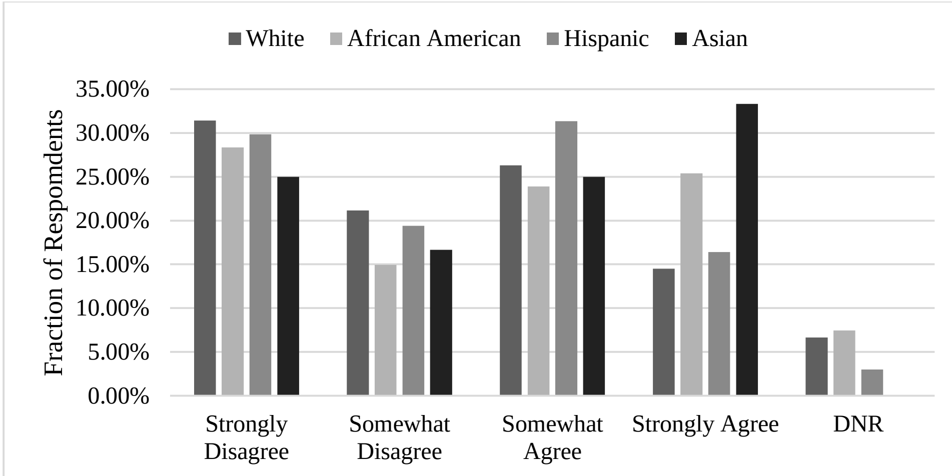

Figure 30: Willingness to Pay for Reliable Trip by Race

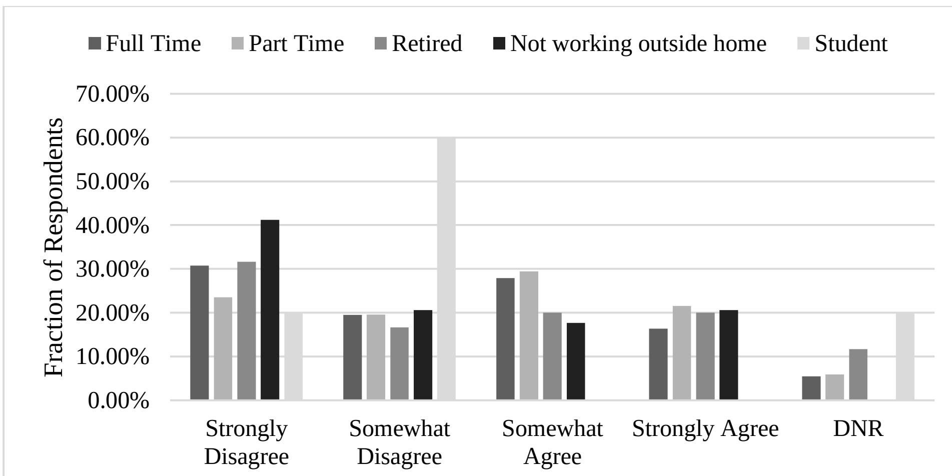

Figure 31: Willingness to Pay for Reliable Trip by Working Status

Table 27: Willingness to Pay for Reliable Trip by Age

Age Range	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Number of Valid Observations
18-20	23.53%	23.53%	29.41%	23.53%	18
21-24	46.15%	15.38%	15.38%	23.08%	27
25-29	19.44%	22.22%	41.67%	16.67%	38
30-39	28.70%	22.61%	29.57%	19.13%	119
40-49	33.64%	26.36%	25.45%	14.55%	114
50-59	38.46%	12.50%	27.88%	21.15%	112
60-65	33.33%	27.78%	27.78%	11.11%	23
65 or Over	32.56%	23.26%	20.93%	23.26%	47

Table 27 presents the willingness to pay for reliable trip by age. The respondents aged 18 to 20 years (52.94% of 18 respondents) and the respondents aged 18 to 20 years (58.33% of 38 respondents) had higher agreement whereas, the respondents aged 21 to 24 years (38.46% of 27 respondents) and the respondents aged 60 to 65 years (38.89% of 23 respondents) had lower agreement.

Of all the working types, respondents who did clerical or office work (42.86% of 49 respondents who were doing such work and gave their opinion) showed less agreement when compared to the entire sample (52.34% of 365 respondents who gave both the work-type information and opinion). Respondents who could work from home exhibited more agreement (53.27% of 107 respondents who could work from home and gave their opinion) when compared to those whose work did not allow such flexibility (51.69% of 374 respondents who could not work from home and gave their opinion). Respondents who owned E-Z Pass (51.23% of 285 E-Z Pass owner-respondents who gave their opinion) showed less agreement when compared to those who did not own E-Z Pass (57.87% of 197 who did not own E-Z Pass and gave their opinion).

A comprehensive analysis of the public opinion of the respondents with respect to gender, age, race, education level, employment status, E-Z pass ownership and income level is presented in this section. The next chapter presents the final models for these public opinions and the analysis of those opinions with respect to different variables.

4. Modelling Results

This chapter provides the results of the ordered logit discrete choice models, to explain the users' opinions on several issues. This chapter is further divided into three sections. A brief description of methodology followed in the paper is presented in the first section. Final models for each of the public issues are presented in different subsections of the second section. Sensitivity analysis of the final models is provided in the final section.

4.1 Methodology

Survey respondents specified their opinions on a scale of 1 to 4, from strongly agree to strongly disagree, for the issues of interest. The ordinal categorical variables cannot be explained using the usual multinomial choice models because treatment of an ordinal variable as a measurement in a cardinal sense would result in erroneous estimation. Ordinal logistic modelling is done when the dependent variables are rank-based responses.

The assumption of Ordinary Least Squares that error term has mean zero cannot be met for the ordinal rank dependent variable. Hence to deal with this, a different kind of variable is defined in theoretical interest, and a clear distinction is made between the defined variable, Y and observed ordinal rank variable, Z [32]. An assumption that defined variable is of interval level enables us to estimate the variable of theoretical interest using a linear model given in the equation below.

$$Y = X\beta + u \tag{1}$$

The error term u is assumed to be a multivariate normal with zero mean and $\sigma^2 I$ as the variance covariance matrix, for an ordered probit model.

$$u = N(0, \sigma^2 I) \tag{2}$$

For an ordinal rank dependent variable with M responses R_1, R_2….. R_M, the estimation of the ordinal variable depends on the estimated variable of theoretical interest. It is assumed that there are M+1 real numbers, μ_0, μ_1, μ_2…..μ_M, satisfying $\mu_0 = -\infty$, $\mu_M = \infty$ and $\mu_0 \leq \mu_1 \leq \mu_2 \leq \ldots\ldots \leq \mu_M$, such that

$$Z_j \in R_i \Leftrightarrow \mu_{i=1} < Y_j \leq \mu_i \tag{3}$$

for $1 \leq j \leq n$ (number of observations in data) and $1 \leq i \leq M$

From (1) and (3), $\mu_{i=1} < Y_j \le \mu_i \Leftrightarrow \mu_{i=1} < X_j\beta + u_j \le \mu_i$

$$\frac{\mu_{i=1} - \sum_{i=0}^{k} \beta_i X_{ij}}{\sigma} < \frac{u_j}{\sigma} < \frac{\mu_i - \sum_{i=0}^{k} \beta_i X_{ij}}{\sigma} \tag{4}$$

Based on the distribution of error term as assumed in (2), equation (4) transforms to

$$\Pr(Z_j \in R_i) = \Phi[\frac{\mu_i - \sum_{i=0}^{k} \beta_i X_{ij}}{\sigma}] - \Phi[\frac{\mu_{i=1} - \sum_{i=0}^{k} \beta_i X_{ij}}{\sigma}] \tag{5}$$

The model given in (5) is under-identified and hence either the intercept, β_0 or the constant, μ_1 is taken as zero. Further derivation takes β_0 as 0. Assuming that error distribution is standardized, we can take σ as 1. Now equation (5) transforms to

$$\Pr(Z_j \in R_i) = \Phi[\mu_i - \sum_{i=1}^{k} \beta_i X_{ij}] - \Phi[\mu_{i=1} - \sum_{i=1}^{k} \beta_i X_{ij}] \tag{6}$$

Model parameters $\mu_1, \mu_2 \ldots . \mu_{M-1}, \beta_1, \beta_2 \ldots . \beta_k$ are estimated using maximum likelihood approach, where the likelihood is maximized.

Using the random utility function (7) and independently and identically distributed extreme value random variables, in place of (1) and (2) respectively, we can obtain the ordered logit model using maximum likelihood approach [33], with (3) remaining the same.

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{7}$$

Each discrete choice model would usually be estimated using commercial econometric software. In this study, to estimate the ordered public opinions, STATA would be used for the ordinal logit modelling using the "ologit" command. The estimation results from STATA would include, but not be limited to, coefficients along with their robust standard errors, cut-points, pseudo R^2, chi-square, constants-only log-likelihood and log-likelihood at convergence [34].

The maximum likelihood estimates would be computed in STATA. The maximum likelihood estimates are consistent, asymptotically efficient and asymptotically normally distributed [35]. Hence, hypothesis tests and confidence intervals can be applied to the ordered logit models, as in the usual statistical studies. However, the measures of fit, such as R^2 and adjusted R^2, cannot be applied in the same sense for the ordered logit models. Instead, pseudo R^2 that measures improvement in value of log-likelihood, relative to a constant-only model can be used as a representative of measure of fit. Also, the fraction correctly predicted can be used for explanatory power of the model.

A brief review of methodology is provided in this section. Next section presents the models for public opinions.

4.2 Final Models for Public Opinions

Ordinal logit models are estimated to explain the factors and/or attributes of respondents that play a significant role in their opinion on several issues. After testing the models for the statistical significance and conceptual validity, the final models are presented in this section for the issues of interest, one in each sub-section.

In the survey collected by Ozbay, et al. [26], public opinions on various issues are ordered from strongly agreed (scale - 1) to strongly disagreed (scale - 4). For easier interpretation of coefficients, the data is transformed such that the order is from strongly disagreed (scale - 1) to strongly agreed (scale - 4). Due to this transformation, the coefficients can be interpreted with ease such that a positive (negative) coefficient on a variable would mean that increase in the variable would increase (decrease) the agreement of the issue of interest.

4.2.1 Fairness of Time of Day Pricing

The ordinal variable of the public opinion "Fairness of Time of Day Pricing" is analyzed to explain the perceived fairness among the respondents using the demographics and recent trip characteristics. Table 28 presents the final ordinal logit model for the respondents' opinions on the fairness of time of day pricing. Interactions of demographic information are analyzed to understand how the perceptions change for particular set of respondents.

Table 29 presents the predicted percentages and the fraction correctly predicted for the valid number of observations used in the final model. More than half of the valid observations used were correctly predicted.

The continuous variables present in the model are turnpike experience, turnpike experience for female, age of female, and number of children in household. With more turnpike experience, there was more reluctance to accept that time of day pricing was fair. The coefficient for number of children in household is positive. This indicates that households with more children felt that the time of day pricing was fair.

Table 28: Final Model for Fairness of Time of Day Pricing

Variable	Description	Type/Scale	Coefficient	t-Statistic
wfhfl	Work from Home Flexibility	Binary	0.3732462	1.61
nchil	No. of Children in HH	Number	0.328222	3.69
tpexp	Experience of Turnpike	Years	-0.036461	-2.43
fmale	Female	Binary	-1.3821	-1.81
agefm	Age*Female	Years	0.0134671	0.97
ezdis	Aware of EZ Pass Discounts	Binary	0.7923913	3.65
fgrad	Graduate Education*Female	Binary	1.51576	3.85
ftime	Full Time Working Status	Binary	-0.7341664	-1.94
labor	Labor Working Type	Binary	-0.7877259	-1.19
mgmto	Management Work Type	Binary	0.926459	2.97
clerk	Clerical Work Type	Binary	0.5960474	1.31
fmgmt	Female*Management Work Type	Binary	-0.9243433	-1.74
ftexp	Turnpike Experience*Female	Years	0.0471072	2.26
$\mu 1$			0.1010375	
$\mu 2$			1.208782	
$\mu 3$			2.342957	
Number of Valid Observations			369	
Pseudo R-squared			0.0737	
Constants only log-likelihood			-403.4	
Convergence log-likelihood			-435.5	
Wald $\chi 2$			61.38	
Significance of Model (Prob > $\chi 2$)			2.97E-08	

Table 29: Predictions of Final Model for Fairness of Time of Day Pricing

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	53.64	64.96	77.89%
Somewhat Disagree	21.29	29.92	39.24%
Somewhat Agree	14.56	4.85	18.52%
Strongly Agree	10.51	0.27	2.56%
Total			53.10%

Coefficients of binary indicators present in the model explain the agreement of the respondents with specific characteristics, on fairness of time of day pricing. The perceived fairness of time of day pricing varied with the gender. Female respondents found time of day pricing unfair with all the other variables the same, when compared to that of male respondents. Race had no significant effect on opinion about fairness of time of day pricing. The respondents who could work from home had more agreement for time of day pricing than those who did not. The respondents who were working full time were reluctant to accept time of day pricing as fair. Different work types have different effects of agreement on time of day pricing. The respondents who were doing labor type of work had more reluctance than respondents of other working types. The respondents who were doing professional or management type of work had more acceptance than respondents of clerical or office type of work. Respondents who either did professional or management or clerical or office type of work were of the opinion that time of day pricing is fair when compared to respondents of other working types. Respondents who were aware of EZ Pass discounts perceived time of day pricing as fair.

Coefficients of interaction variables present in the model explain the variation of agreement due to a specific variable for a particular set of the respondents. The increase in turnpike experience had different effect based on the gender. Female respondents have relatively less reluctance due to more turnpike experience compared to that of male respondents. The overall effect of turnpike experience for female respondents is positive indicating that female respondents with more experience found time of day pricing more fair. The age of the respondent had different effect based on the gender. Though age has no effect on agreement for the entire sample, the perceived fairness of time of day pricing of female respondents increased with age. Education had no effect on the perceived fairness of time of day pricing. However, female respondents with graduate education found time of day pricing more fair. Female respondents who were doing management type of work were more reluctant to accept the time of day pricing, than the males who were doing same type of work. The overall effect of management type of work is almost zero for female respondents, indicating that doing management work has almost no effect on agreement of fairness of time of day pricing for female respondents.

4.2.2 Fairness of E-Z Pass Discounts

The ordinal variable of the public opinion "Fairness of E-Z Pass Discounts" is analyzed to explain the perceived fairness among the respondents using the demographics and recent trip characteristics. Table 30 and **Error! Reference source not found.** present the final two ordinal logit models for the respondents' opinions on the fairness of providing discounts to E-Z Pass users. All the coefficients are significant in both the models, and they have similar pseudo R^2. Interactions of demographic information are analyzed to understand how the perceptions change for a particular set of respondents.

Table 31 and Table 33 present the predicted percentages and the fraction correctly predicted for the valid number of observations used in both the final models, respectively. Comparing the correctly predicted fractions, it is observed that model 1 has slightly better explanatory power. More than half of the valid observations used were correctly predicted.

Table 30: Final Model 1 for Fairness of EZ Pass Discounts

Variable	Description	Type/Scale	Coefficient	t-Statistic
ezown	EZ Pass Ownership	Binary	1.845271	6.11
ezdis	Aware of EZ Pass Discounts	Binary	0.711131	2.04
fmale	Female	Binary	-1.299432	-3.1
asian	Asian	Binary	0.3640389	1.12
hilat	Hispanic/Latino	Binary	0.9941563	1.41
nadlt	Number of Adults in Household	Number	0.1628174	1.35
incik	Income	$1,000	-0.0043756	-1.55
incfm	Income*Female	$1,000	0.0123776	2.84
ezoad	EZ Pass Owner, aware of discounts	Binary	-0.6732554	-1.44
ptime	Part Time Working Status	Binary	-0.5017361	-1.33
labor	Labor Working Type	Binary	-0.6398013	-1.43
$\mu 1$			-1.37309	
$\mu 2$			-0.96558	
$\mu 3$			0.475789	
Number of Valid Observations			388	
Pseudo R-squared			0.103	
Constants only log-likelihood			-342.2	
Convergence log-likelihood			-381.5	
Wald $\chi 2$			70.67	
Significance of Model (Prob > $\chi 2$)			8.49E-11	

Table 31: Predictions of Final Model 1 for Fairness of EZ Pass Discounts

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	10.57	0	0.00%
Somewhat Disagree	3.87	0.26	0.00%
Somewhat Agree	21.91	27.58	40.00%
Strongly Agree	63.66	72.16	83.40%
Total			61.86%

Table 32: Final Model 2 for Fairness of EZ Pass Discounts

Variable	Description	Type/Scale	Coefficient	t-Statistic
ezown	EZ Pass Ownership	Binary	2.341914	0.4481139
fmale	Female	Binary	0.0069036	0.0031173
asian	Asian	Binary	-1.046728	0.3719497
hilat	Hispanic/Latino	Binary	0.4258629	0.3284344
nadlt	Number of Adults in Household	Number	0.9771386	0.6923682
incfm	Income*Female	$1,000	0.1452137	0.1158213
ezoad	EZ Pass Owner, aware of discounts	Binary	-0.0067787	0.0030972
ptime	Part Time Working Status	Binary	0.0089543	0.0036175
labor	Labor Working Type	Binary	-0.6033845	0.4113895
inceo	Income*EZ Pass Ownership	$1,000	-0.3756109	0.3870797
incea	Income*Aware of EZP Discounts	$1,000	-0.6572466	0.4473483
$\mu1$			-1.147951	
$\mu2$			-0.740589	
$\mu3$			0.7036163	
Number of Valid Observations			388	
Pseudo R-squared			0.105	
Constants only log-likelihood			-341.6	
Convergence log-likelihood			-381.5	
Wald $\chi2$			70.67	
Significance of Model (Prob > $\chi2$)			9.11E-11	

Table 33: Predictions of Final Model 2 for Fairness of EZ Pass Discounts

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	10.57	0	0.00%
Somewhat Disagree	3.87	0.52	0.00%
Somewhat Agree	21.91	30.15	42.35%
Strongly Agree	63.66	69.33	81.38%
Total			61.08%

Final Model 1 presented in Table 30 is explained further in this sub-section. The continuous variables present in the model are income of the respondent, income for female and number of adults in household. With more income, there was more reluctance to accept the discounts for EZ Pass users as fair. The coefficient for number of adults in the household is positive. This indicates that households with more adults felt that provision of discounts to EZ Pass users was fair.

Coefficients of binary indicators present in the model explain the agreement of the respondents with specific characteristics, on fairness of discounts to EZ Pass users. Respondents who owned EZ Pass perceived EZ Pass discounts as fair. Respondents who were aware of EZ Pass discounts agreed that EZ Pass discounts were fair. The perceived fairness of EZ Pass discounts varied with the gender. Female respondents found EZ Pass discounts unfair with all the other variables remaining the same, when compared to male respondents. Race had significant effect on opinion about fairness of EZ Pass discounts. Asian and Hispanic respondents had more agreement for EZ Pass discounts than White and African-American respondents. Of Hispanic and Asian respondents, Hispanic respondents were in more agreement than Asian respondents. The respondents who were working part time, were reluctant to accept EZ Pass discounts as fair. Different work types have different effect on agreement on EZ Pass discounts. The respondents who were doing labor type of work had more reluctance than respondents of other working types.

Coefficients of interaction variables present in the model explain the variation of agreement due to a specific variable for a particular set of respondents. The overall effect of both owning EZ Pass and being aware of EZ Pass discounts was in more favor of EZ pass discounts than either owning or being aware of discounts alone. The increase in income had a different effect based on the gender. Female respondents have relatively less reluctance due to more income compared to that of males. The overall effect is positive. Hence the female respondents with more income perceived EZ Pass discounts as fair.

4.2.3 Fairness of Discounts for Frequent Commuters

The ordinal variable of the public opinion “Fairness of Discounts for Frequent Commuters” is analyzed to explain the perceived fairness among the respondents using the demographics and recent trip characteristics. Table 34 presents the final ordinal logit model for the respondents’ opinions on the fairness of discounts for frequent commuters. Interactions of demographic information are analyzed to understand how the perceptions change for particular set of respondents.

Table 35 presents the predicted percentages and the fraction correctly predicted for the valid number of observations used in the final model. Around 40% of the valid observations used were correctly predicted.

Table 34: Final Model for Fairness of Discounts to Frequent Commuters

Variable	Description	Type/Scale	Coefficient	t-Statistic
ntpur	Number of Trips in month	Number	0.0284975	2.29
tpexp	Turnpike Experience	Years	0.0152488	1.47
asian	Asian	Binary	0.5171508	1.48
fmale	Female	Binary	0.2248743	1.11
ageyr	Age	Years	-0.0166831	-1.96
ntwoh	Not Working Outside Home Work Type	Binary	0.6192531	1.32
clerk	Clerical Work Type	Binary	0.9476919	2.26
ntric	Number of Trips*Clerk	Number	-0.0458308	-1.69
$\mu 1$			-1.78245	
$\mu 2$			-1.131307	
$\mu 3$			-0.0866141	
Number of Valid Observations			395	
Pseudo R-squared			0.0239	
Constants only log-likelihood			-462.1	
Convergence log-likelihood			-473.5	
Wald $\chi 2$			19.27	
Significance of Model (Prob > $\chi 2$)			0.0135	

Table 35: Predictions of Final Model for Fairness of Discounts to Frequent Commuters

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	15.44	0	0.00%
Somewhat Disagree	10.13	0.25	0.00%
Somewhat Agree	22.78	50.13	58.89%
Strongly Agree	51.65	49.62	58.33%
Total			43.54%

The continuous variables present in the model are turnpike experience, age, number of trips in a month, and number of trips in a month for a clerk. With more turnpike experience, there was more acceptance for discounts to frequent commuters. The coefficient for number of trips in a month is positive. This indicates that respondents who travelled more frequently felt that provision of discounts to frequent commuters was fair. The older respondents found discounts to frequent commuters as more unfair than younger respondents.

Coefficients of binary indicators present in the model explain the agreement of the respondents with specific characteristics on fairness of discounts to frequent commuters. The perceived fairness of discounts to frequent commuters varied with the gender. Female respondents found discounts to frequent commuters more fair with all the other variables being the same when compared to male respondents. Race had significant effect on opinions about fairness of discounts to frequent commuters. Asian respondents had more agreement for discounts to frequent commuters than White, African-American, and Hispanic respondents. Working status had no effect on the agreement. Different types of work have different effects of agreement on discounts to frequent commuters. The respondents who were not working outside their home had more reluctance than respondents of other working types. The respondents who did clerical or office work had more agreement than respondents of other working types.

Coefficients of interaction variables present in the model explain the variation of agreement due to a specific variable for a particular set of respondents. The increase in number of trips in a month had a different effect based on the working type. Clerical type of work respondents have relatively less reluctance due to more trips in a month compared to that of other working types. The overall effect of the number of trips in a month for a clerk is negative, indicating that clerical type of work respondents who travel more frequently felt that provision of discounts to frequent commuters were more unfair, compared to those clerical type of work respondents who travelled less frequently.

4.2.4 Use of Toll-Revenues to Improve Public Transit

The ordinal variable of the public opinion “Use of Toll-Revenues to Improve Public Transit” is analyzed to explain the perceived fairness among the respondents using the demographics and recent trip characteristics. Interactions of demographic information is done to understand how the perceptions change for particular set of respondents. Table 36 presents the final ordinal logit model for the respondents’ opinion on fairness of using revenues to improve the public transport.

The continuous variables present in the model are turnpike experience, age, number of children in household and total travel time for recent trip. With more turnpike experience, there was more acceptance for using toll-revenues to improve public transit. The coefficient for number of children in household is positive. This indicates that households with more children felt that use of toll-revenues to improve public transit, as fair. The older respondents found use of toll-revenues to improve public transit as more unfair when compared to younger respondents. The respondents who had travelled for more time in their recent trip found it unfair to use toll-revenues for improvement of public transit.

Coefficients of binary indicators present in the model explain the agreement of the respondents with specific characteristics, on fairness of using toll-revenues for improvement of public transit. The perceived fairness of use of toll-revenues to improve public transit did not vary with the gender and race. Different work types have different effect of agreement on use of toll-revenues to improve public transit. The respondents who did technical or labor work had more agreement than respondents of other working types. Of technical and labor working type respondents, labor working type respondents had more agreement for use of toll-revenues to improve public transit. Respondents who owned EZ Pass perceived use of toll-revenues to improve public transit as unfair. Respondents who were aware of EZ Pass discounts felt that it was unfair to use toll-revenues for improvement of public transit. The respondents who were working part time, and retired had more acceptance for use of toll-revenues to improve public transit. Both retired and part-time working respondents have similar acceptance.

Coefficients of interaction variables present in the model explain the variation of agreement due to a specific variable for a particular set of respondents. The overall effect of both owning EZ Pass and being aware of EZ Pass discounts has no effect on agreement, although the effect was in favor of using toll-revenues for public transit improvement when compared to either owning or being aware of discounts alone.

Table 36: Final Model for Use of Toll-Revenues to Improve Public Transit

Variable	Description	Type/Scale	Coefficient	t-Statistic
gradw	Graduate Education	Binary	1.003567	3.56
rtttt	Recent Trip Total Travel Time	Minutes	-0.0015726	-2.02
nchil	No. of Children in HH	Number	0.1039088	1.12
tpexp	Experience of Turnpike	Years	0.0224895	2.16
ageyr	Age	Years	-0.0176344	-1.91
ptime	Part Time Working Status	Binary	0.8906517	2.9
retdp	Retired	Binary	0.879613	2.18
techw	Technical Working Type	Binary	0.5464401	1.58
labor	Labor Working Type	Binary	0.7821985	1.68
ezown	EZ Pass Ownership	Binary	-0.6282681	-2.37
ezdis	Aware of EZ Pass Discounts	Binary	-0.3915492	-1.18
ezoad	EZ Pass Owner, aware of discounts	Binary	0.9829192	2.42
$\mu1$			-1.447512	
$\mu2$			-0.6660672	
$\mu3$			0.5092745	
Number of Valid Observations			380	
Pseudo R-squared			0.0355	
Constants only log-likelihood			-498.5	
Convergence log-likelihood			-516.9	
Wald $\chi2$			32.98	
Significance of Model (Prob > $\chi2$)			0.000974	

Table presents the predicted percentages and the fraction correctly predicted for the valid number of observations used in the final model. Around 30% of the valid observations used were correctly predicted.

Table 37: Predictions of Final Model for Use of Turnpike Revenues to Improve Public Transit

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	26.58	3.95	9.90%
Somewhat Disagree	16.05	26.05	34.43%
Somewhat Agree	26.32	62.63	74.00%
Strongly Agree	31.05	7.37	12.71%
Total			31.58%

4.2.5 Improvement in Traffic Condition due to Turnpike Tolls

The ordinal variable of the public opinion "Improvement in Traffic Condition due to Turnpike Tolls" is analyzed to explain the perceived fairness among the respondents using the demographics and recent trip characteristics. Table 38 presents the final ordinal logit model for the respondents' opinion on acceptance of impact of tolls on traffic condition. Interactions of demographic information is done to understand how the perceptions change for particular set of respondents.

Table 39 presents the predicted percentages and the fraction correctly predicted for the valid number of observations used in the final model. Around 30% of the valid observations used were correctly predicted.

The continuous variables present in the model are age of female and income. With more income, there was more reluctance to accept that the tolls improved traffic condition. Age had no effect on agreement on entire sample, but had effect for female respondents.

Table 38: Final Model for Turnpike Tolls improved Traffic Condition

Variable	Description	Type/Scale	Coefficient	t-Statistic
wfhfl	Work from Home Flexibility	Binary	0.6473295	2.7
black	African American	Binary	0.4474604	1.42
tpuse	Use of Turnpike Indicator	Binary	-0.6526813	-1.53
gradw	Graduate Education	Binary	0.7967631	2.65
incik	Income	$1,000	-0.00434	-2.05
agefm	Age*Female	Years	0.0353339	2.98
clerk	Clerical Work Type	Binary	1.470124	1.98
mgmto	Management Working Type	Binary	1.381372	2.95
drvrp	Driver Work Type	Binary	2.133246	1.69
labor	Labor Working Type	Binary	0.7256336	1.23
techw	Technical Work Type	Binary	1.452603	2.67
ftech	Female who does technical work	Binary	-2.07573	-2.06
fmgmt	Female who does management work	Binary	-1.935503	-3.67
fclrk	Female who does clerical work	Binary	-1.636703	-2.01
$\mu 1$			0.1138498	
$\mu 2$			0.7603559	
$\mu 3$			1.976427	
Number of Valid Observations			308	
Pseudo R-squared			0.0477	
Constants only log-likelihood			-394.6	
Convergence log-likelihood			-414.4	
Wald $\chi 2$			39.67	
Significance of Model (Prob > $\chi 2$)			0.000287	

Table 39: Predictions of Final Model for Turnpike Tolls improved Traffic Condition

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	30.19	10.06	18.28%
Somewhat Disagree	13.64	20.45	28.57%
Somewhat Agree	26.3	63.64	72.84%
Strongly Agree	29.87	5.84	10.87%
Total			31.82%

Coefficients of binary indicators present in the model explain the agreement of the respondents with specific characteristics, on agreement of tolls impacting traffic condition. The respondents who could work from home had more agreement for impact of tolls on traffic condition than who could not. Different work types have different effect of agreement on impact of tolls on improving traffic condition. The respondents who did driving or clerical or technical or professional or labor work had more agreement than respondents of other working types. Of these working type respondents, the highest acceptance was for driving working type respondents. The effect of other working types varied with gender. African-American respondents perceived that there is improvement in traffic condition due to implementation of tolls. Respondents who had graduate education felt that traffic condition improved due to tolls. The respondents who were using turnpike had more reluctance to accept that tolls improved traffic condition.

Coefficients of interaction variables present in the model explain the variation of agreement due to a specific variable for a particular set of the respondents. The age of the respondent had different effect based on the gender. Though age has no effect on agreement for the entire sample, the perceived impacts of tolls for female respondents increased with age. As explained above, the effect of working type varied with gender. The overall effect of technical work type, management work type and clerical work type was negative for female respondents. Female technical working type respondents and female management working type respondents had similar reluctance to accept that tolls improved traffic condition, and such reluctance was less for clerical working type female respondents.

4.2.6 Willingness to Pay for Faster Trip

The ordinal variable of the public opinion “Willingness to Pay for Faster Trip” is analyzed to explain the perceived fairness among the respondents using the demographics and recent trip characteristics. Table 40 presents the final ordinal logit model for the respondents’ willingness to pay for faster trip. Interactions of demographic information is done to understand how the perceptions change for particular set of respondents.

Table 41 presents the predicted percentages and the fraction correctly predicted for the valid number of observations used in the final model. Around 30% of the valid observations used were correctly predicted.

Table 40: Final Model for Willingness to Pay for Faster Trip

Variable	Description	Type/Scale	Coefficient	t-Statistic
incik	Income	$1,000	0.0031585	1.39
fmale	Female	Binary	-1.270289	-3.74
wfhfl	Work from Home Flexibility	Binary	1.036116	2.72
ageyr	Age	Year	-0.0342763	-3.21
fmfle	Female who could work from home	Binary	-0.9913287	-1.86
techw	Technical Working Type	Binary	1.304155	2.03
mgmto	Management Working Type	Binary	0.9745201	2.78
clerk	Clerical Work Type	Binary	1.394461	3.16
ftech	Female who does technical work	Binary	1.824825	2.81
ntrit	Number of Trips*Techw	Number	-0.056055	-1.73
ftexp	Turnpike Experience*Female	Years	0.0378785	2.41
$\mu 1$			-1.340587	
$\mu 2$			-0.624934	
$\mu 3$			0.8070143	
Number of Valid Observations			273	
Pseudo R-squared			0.064	
Constants only log-likelihood			-345.9	
Convergence log-likelihood			-369.5	
Wald $\chi 2$			48.2	
Significance of Model (Prob > $\chi 2$)			0.00000131	

Table 41: Predictions of Final Model for Willingness to Pay for Faster Trip

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	31.14	12.82	21.18%
Somewhat Disagree	15.02	31.5	41.46%
Somewhat Agree	28.57	48.35	52.56%
Strongly Agree	25.27	7.33	14.49%
Total			31.50%

The continuous variables present in the model are age, number of trips in a month for a technical working type respondent, turnpike experience for female respondent and income. With more income, there was more willingness to pay for faster trip. The older respondents were not willing to pay for a faster trip when compared to younger respondents

Coefficients of binary indicators present in the model explain the agreement of the respondents with specific characteristics, on willingness to pay for faster trip. The respondents who could work from home had more willingness to pay for faster trip than who could not. Different work types have different effect of willingness to pay for faster trip. The respondents who did driving or clerical or technical or professional work had more willingness to pay for faster trip than respondents of other working types. Of these working type respondents, the highest acceptance was for clerical working type respondents, followed by technical work type respondents, and then professional working type respondents. The effect of technical working type respondents varied with gender and number of trips in a month. Race, education and working status had no effect on willingness to pay for a faster trip. Female respondents were not willing to pay for faster trip with all the other variables remaining the same, when compared to male respondents.

Coefficients of interaction variables present in the model explain the variation of agreement due to a specific variable for a particular set of the respondents. The turnpike experience of the respondent had different effect based on the gender. Though turnpike experience has no effect on agreement for the entire sample, the willingness to pay for faster trip for female respondents increased with turnpike experience. As explained above, the effect of technical working type varied with gender and number of trips in a month. The overall effect of technical work type was positive for female respondents. Female technical working type respondents had more willingness to pay for faster trip than other working type female respondents. The number of trips in a month of the respondent had different effect based on the working type. Though number of trips in a month had no effect on agreement for the entire sample, the willingness to pay for faster trip for technical working type respondents decreased with number of trips in a month. The female respondents who could work from home had more willingness to pay for faster trip than male respondents with such flexibility.

4.2.7 Willingness to Pay for Reliable Trip

The ordinal variable of the public opinion "Willingness to Pay for Reliable Trip" is analyzed to explain the perceived fairness among the respondents using the demographics and recent trip characteristics. Table 42 presents the final ordinal logit model for the respondents' willingness to pay for reliable trip. Interactions of demographic information is done to understand how the perceptions change for particular set of respondents.

Table 43 presents the predicted percentages and the fraction correctly predicted for the valid number of observations used in the final model. More than a quarter of the valid observations used were correctly predicted.

Table 42: Final Model for Willingness to Pay for Reliable Trip

Variable	Description	Type/Scale	Coefficient	t-Statistic
ntpur	Number of Trips in a month	Number	-0.0173546	-1.43
hilat	Hispanic/Latino	Binary	0.7197039	1.44
incik	Income	$1,000	0.0046649	2.14
clerk	Clerical Work Type	Binary	2.417289	3.47
mgmto	Management Work Type	Binary	0.7752691	1.92
rtttt	Recent Trip Total Travel Time	Minutes	0.0034161	2.28
ttclr	Travel Time*Clerk	Minutes	-0.0086908	-3.35
ttbla	Travel Time of African American	Minutes	-0.0045698	-1.44
incbl	Income of African American	$1,000	0.0171854	3.07
inmgm	Income*Management	$1,000	-0.004555	-1.25
inclk	Income*Clerk	$1,000	-0.0126451	-2.06
ingra	Income*Graduate	$1,000	0.004088	1.7
$\mu 1$			0.3221748	
$\mu 2$			1.198897	
$\mu 3$			2.648689	
Number of Valid Observations			319	
Pseudo R-squared			0.0418	
Constants only log-likelihood			-413.2	
Convergence log-likelihood			-431.3	
Wald $\chi 2$			34.13	
Significance of Model (Prob > $\chi 2$)			0.000644	

Table 43: Predictions of Final Model for Willingness to Pay for Reliable Trip

Opinion	Actual Percentages	Predicted Percentages	Correctly Predicted
Strongly Disagree	34.8	9.4	12.61%
Somewhat Disagree	19.75	53.61	57.14%
Somewhat Agree	27.27	23.82	29.89%
Strongly Agree	18.18	13.17	22.41%
Total			27.90%

The continuous variables present in the model are number of trips in a month, recent trip total travel time, income, income of African-American respondent, income of management working type respondent, income of clerical working type respondent, income of respondent with graduate education, total travel time for recent trip of African-American respondent, total travel and time for recent trip of clerical working type respondent. With more income, there was more willingness to pay for reliable trip. The effect of income varied with race, education and working type. The respondents who travelled for more time were willing to pay for a reliable trip when compared to those who travelled for less time in recent trip. The effect of travel time varied with race and working type. The respondents who travelled frequently were not willing to pay for a reliable trip when compared to those who travelled less frequently.

Coefficients of binary indicators present in the model explain the agreement of the respondents with specific characteristics, on willingness to pay for reliable trip. The respondents who could work from home had more willingness to pay for faster trip than who could not. Different work types have different effect of willingness to pay for faster trip. The respondents who did driving or clerical or professional work had more willingness to pay for reliable trip than respondents of other working types. Of these both working type respondents, the highest acceptance was for clerical working type respondents. The effect of clerical working type respondents varied with income and total travel time of recent trip. Education and working status had no effect on willingness to pay for a reliable trip. Hispanic respondents were more willing to pay for reliable trip, when compared to other respondents. However, race had a different effect due to income and total travel time for recent trip.

Coefficients of interaction variables present in the model explain the variation of agreement due to a specific variable for a particular set of the respondents. As explained above, the income of the respondent had different effect based on education, race and working type whereas the effect of travel time varied based on working type and race. Though education had no effect on had agreement for the entire sample, the willingness to pay for reliable trip for graduate respondents increased more with income, when compared to other respondents. African-American respondents whose income was more, were more willing to pay for a reliable trip, than others with similar income. However, their willingness to pay for reliable trip decreased with increase in recent trip's total travel time, with overall effect of travel time being negative for African-American respondents. The overall effect of income and total travel time for recent trip is negative for clerical working type respondents. It indicates that the willingness to pay for reliable trip decreased with increase in income and recent trip's total travel time for clerical working type respondents. The overall effect of income is almost zero for professional working type respondents, which indicated that income had very little effect on willingness to pay for reliable trip for professional working type respondents.

Final models for different public opinions are provided in this section. Next section presents the sensitivity analysis of these final models of public opinions.

4.3 Sensitivity Analysis

Ordinal logit models estimated are further analyzed to understand the effect of variables' increment on the agreement of the public opinion. Elasticities are presented for the sensitivity analysis of opinion with respect to variables in the final model. Further, the elasticities of variables from each model are compared to understand the impact of variable on different public opinions.

4.3.1 Elasticities

Elasticity is a measure of sensitivity of variable to a change in another variable. Elasticities, presented in this sub-section, are measures of the increment of probability of agreement or disagreement due to increase of variable by one unit. Elasticities are computed for the continuous variables for a typical respondent, i.e., at the mean values of variables present in the model. For the binary variables, the elasticities presented are the differences in margins.

The elasticities of variables for the public opinion "Fairness of Time of Day Pricing" from the final model presented in Table 28, are illustrated in Table 44.

Table 44: Elasticities for Final Model of Fairness of Time of Day Pricing

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
wfhfl	Work from Home Flexibility	Binary	0.0346	-0.0803
nchil	No. of Children in HH	Number	0.2612	-0.1301
tpexp	Experience of Turnpike	Years	-0.4041	0.2012
fmale	Female	Binary	-0.1177	0.2808
agefm	Age*Female	Years	0.2205	-0.1098
ezdis	Aware of EZ Pass Discounts	Binary	0.0711	-0.1736
fgrad	Graduate Education*Female	Binary	0.1991	-0.3066
ftime	Full Time Working Status	Binary	-0.0779	0.1559
labor	Labor Working Type	Binary	-0.0535	0.1627
mgmto	Management Work Type	Binary	0.0777	-0.1943
clerk	Clerical Work Type	Binary	0.0604	-0.1276
fmgmt	Female*Management Work Type	Binary	-0.0711	0.1919
ftexp	Turnpike Experience*Female	Years	0.2345	-0.1168

The highest positive impact on the agreement on fairness of discounts to frequent commuters was from number of children in household, whereas the highest negative impact was due to turnpike experience. For a typical respondent, the probability to agree with time of day pricing increased significantly with increase in number of children in household, increase in age for female, and being a female graduate. For a typical respondent, the probability to agree with time of day pricing decreased significantly with increase in turnpike experience and being female. The decrease in agreement due to turnpike experience was less for a typical female respondent than a typical male respondent. The increase in agreement due to other variables was small.

The highest positive impact on the disagreement on fairness of time of day pricing was for being female, whereas the highest negative impact was for being a female graduate. All the variables in the model have a significant impact on the disagreement.

The probability to disagree increased with increase in turnpike experience and decreased with age for a typical female respondent and number of children in household. The disagreement towards time of day pricing decreased significantly with the respondent being aware of EZ pass discounts. The reluctance to accept time of day pricing decreased with the respondent doing management type of work, for male respondents.

The elasticities of variables for the public opinion “Fairness of EZ Pass Discounts” from the final model 1 presented in Table 30, are illustrated in Table 45, whereas the elasticities of variables from the final model 2 presented in Table 32, are illustrated in Table 46. Elasticities presented in Table 45 are discussed below.

Table 45: Elasticities for Final Model 1 of Fairness of EZ Pass Discounts

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
ezown	EZ Pass Ownership	Binary	0.3959	-0.1770
ezdis	Aware of EZ Pass Discounts	Binary	0.1362	-0.0586
fmale	Female	Binary	-0.2454	0.1197
asian	Asian	Binary	0.0671	-0.0289
hilat	Hispanic/Latino	Binary	0.1677	-0.0542
nadlt	Number of Adults in Household	Number	0.1218	-0.3268
incik	Income	$1,000	-0.1318	0.3537
incfm	Income*Female	$1,000	0.1645	-0.4414
ezoad	EZ Pass Owner, aware of discounts	Binary	-0.1231	0.0066
ptime	Part Time Working Status	Binary	-0.0990	0.0489
labor	Labor Working Type	Binary	-0.1277	0.0653

Table 46: Elasticities for Final Model 2 of Fairness of EZ Pass Discounts

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
ezown	EZ Pass Ownership	Binary	0.4646	-0.2248
fmale	Female	Binary	-0.0629	0.0285
asian	Asian	Binary	0.0738	-0.0318
hilat	Hispanic/Latino	Binary	0.1696	-0.0635
nadlt	Number of Adults in Household	Number	0.1034	-0.2765
incfm	Income*Female	$1,000	0.1218	-0.3268
ezoad	EZ Pass Owner, aware of discounts	Binary	-0.1198	0.0646
ptime	Part Time Working Status	Binary	-0.0526	0.0251
labor	Labor Working Type	Binary	-0.1350	0.0705
inceo	Income*EZ Pass Ownership	$1,000	-0.1031	0.2757
incea	Income*Aware of EZP Discounts	$1,000	0.1072	-0.2867

The highest positive impact on the agreement on fairness of EZ pass discounts was for owner of EZ pass, whereas the highest negative impact was for the female respondents. For a typical respondent, the probability to agree with EZ pass discounts increased significantly for being EZ pass owner, being Hispanic, being aware of EZ pass discounts, and increase in number of adults in household. For a typical respondent, the probability to agree with EZ pass discounts decreased significantly for being female, increase in income, and being respondent of labor type of work. There was an increase in agreement due to income for a typical female respondent, whereas agreement decreased with income for a typical male respondent. Most of the variables in the model except being Asian and a part-time worker had a significant impact on the probability to agree with provision of discounts to EZ pass users.

The highest positive impact on the disagreement on fairness of EZ pass discounts was from income, whereas the highest negative impact was from number of adults in the household. The probability to disagree increased with increase in income for a typical male respondent and decreased with income for a typical female respondent, for being EZ pass owner, and with number of adults in household. The increase in disagreement due to other variables was small.

The elasticities of variables for the public opinion “Fairness of Discounts to Frequent Commuters” from the final model presented in Table 34, are illustrated in Table 47.

Table 47: Elasticities for Final Model of Fairness of Discounts to Frequent Commuters

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
ntpur	Number of Trips in a month	Number	0.1093	-0.1938
tpexp	Turnpike Experience	Years	0.0963	-0.1708
asian	Asian	Binary	0.1216	-0.0578
fmale	Female	Binary	0.0535	-0.0285
ageyr	Age	Years	-0.3457	0.6130
ntwoh	Not Working Outside Home Work Type	Binary	0.1434	-0.0660
clerk	Clerical Work Type	Binary	0.2142	-0.0946
ntric	Number of Trips in a month*Clerk	Number	-0.0221	0.0392

The highest positive impact on the agreement on fairness of discounts to frequent commuters was for doing clerical type of work, whereas the highest negative impact was due to age. For a typical respondent, the probability to agree with discounts for frequent commuters increased significantly with being clerk, not working outside home, being Asian, and increase in number of trips in a month. The impact from number of trips in a month for a clerk was less than respondents of other types of work. For a typical respondent, the probability to agree with discounts for frequent commuters decreased significantly with increase in age. Most of the variables in the model except being female, and turnpike experience had a significant impact on the probability to agree with provision of discounts to frequent commuters.

The highest positive impact on the disagreement on fairness of discounts to frequent commuters was from age, whereas the highest negative impact was from number of trips in a month. Increase in turnpike experience resulted in decrease of probability to disagree. The increase in disagreement due to other variables was small.

The elasticities of variables for the public opinion "Use of Revenues for Improvement of Public Transit" from the final model presented in Table 36, are illustrated in Table 48.

Table 48: Elasticities of Final Model for Use of Toll-Revenues to Improve Public Transit

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
gradw	Graduate Education	Binary	0.2176	-0.1583
rtttt	Recent Trip Total Travel Time	Minutes	-0.1122	0.1190
nchil	No. of Children in HH	Number	0.0565	-0.0599
tpexp	Experience of Turnpike	Years	0.2089	-0.2216
ageyr	Age	Years	-0.5357	0.5680
ptime	Part Time Working Status	Binary	0.1944	-0.1373
retdp	Retired	Binary	0.1900	-0.1362
techw	Technical Working Type	Binary	0.1157	-0.0905
labor	Labor Working Type	Binary	0.1699	-0.1219
ezown	EZ Pass Ownership	Binary	-0.1264	0.1110
ezdis	Aware of EZ Pass Discounts	Binary	-0.0764	0.0722
ezoad	EZ Pass Owner, aware of discounts	Binary	0.2022	-0.1645

The highest positive impact on the agreement on use of toll-revenues for improvement of public transit was for having graduate education, whereas the highest negative impact was due to age. For a typical respondent, the probability to agree with use of toll-revenues for improvement of public transit increased significantly with being a graduate, increase in turnpike experience, working status being part-time or retired, and type of work being labor or technical. For a typical respondent, the probability to agree with use of toll-revenues for improvement of public transit decreased significantly with increase in age, being owner of EZ pass owner, and increase in total travel time of recent trip. Either being owner of EZ pass or being aware of EZ pass discounts had a negative effect on agreement and having both had an overall effect of almost zero. Most of the variables in the model except number of children in household had a significant impact on the probability to agree with use of toll-revenues for improvement of public transit.

The highest positive impact on the disagreement on use of toll-revenues for improvement of public transit was from age, whereas the highest negative impact was from experience of turnpike. Increase in total travel time of recent trip resulted in increase of probability to disagree. Of the variables which increased probability to agree, being respondent of technical type of work had less effect on probability to disagree. All the other variables had similar effect on probability to disagree.

The elasticities of variables for the public opinion “Turnpike Tolls improved Traffic Condition” from the final model presented in Table 38, are illustrated in Table 49.

Table 49: Elasticities of Final Model of Improvement in Traffic Condition due to Turnpike Tolls

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
wfhfl	Work from Home Flexibility	Binary	0.1318	-0.1172
black	African American	Binary	0.0908	-0.0808
tpuse	Use of Turnpike Indicator	Binary	-0.1129	0.1353
gradw	Graduate Education	Binary	0.1672	-0.1377
incik	Income	$1,000	-0.2845	0.2849
agefm	Age*Female	Years	0.4368	-0.4373
clerk	Clerical Work Type	Binary	0.3055	-0.2210
mgmto	Management Working Type	Binary	0.2416	-0.2568
drvrp	Driver Work Type	Binary	0.4480	-0.2490
labor	Labor Working Type	Binary	0.1516	-0.1211
techw	Technical Work Type	Binary	0.3026	-0.2168
ftech	Female who does technical work	Binary	-0.2509	0.4369
fmgmt	Female who does management work	Binary	-0.2955	0.3734
fclrk	Female who does clerical work	Binary	-0.2291	0.3389

The highest positive impact on the agreement on improvement of traffic condition due to tolls was for respondent of driving type of work, whereas the highest negative impact was due to income. For a typical respondent, the probability to agree with impact of tolls on improvement of traffic condition increased significantly with being a driver, increase in age for female respondents, being a graduate, being able to work from home, and type of work being clerical or technical or professional or labor for male respondents. The type of work being clerical or technical or professional had an overall effect of almost zero for female respondents. For a typical respondent, the probability to agree with impact of tolls on improvement of traffic condition decreased significantly with increase in income, and having used turnpike. Most of the variables in the model except being African-American had a significant impact on the probability to agree with effect of tolls on improvement of traffic condition.

The highest positive impact on the disagreement on effect of tolls on improvement of traffic condition was from income, whereas the highest negative impact was from age for female respondents. All variables had similar effect on probability to disagree, except that type of work being clerical or technical or professional had an overall effect of increasing the probability to disagree for female respondents.

The elasticities of variables for the public opinion “Willingness to Pay for Faster Trip” from the final model presented in Table 40, are illustrated in Table 50.

Table 50: Elasticities of Final Model of Willingness to Pay for Faster Trip

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
incik	Income	$1,000	0.2247	-0.2099
fmale	Female	Binary	-0.2094	0.2423
wfhfl	Work from Home Flexibility	Binary	0.1931	-0.1773
ageyr	Age	Year	-1.0787	1.0080
fmfle	Female who could work from home	Binary	-0.1412	0.2031
techw	Technical Working Type	Binary	0.2542	-0.1996
mgmto	Management Working Type	Binary	0.1565	-0.1843
clerk	Clerical Work Type	Binary	0.2661	-0.2130
ftech	Female who does technical work	Binary	0.3751	-0.2346
ntrit	Number of Trips*Techw	Number	-0.0501	0.0468
ftexp	Turnpike Experience*Female	Years	0.1537	-0.1436

The highest positive impact on willingness to pay for faster trip was for a typical female respondent of technical type of work, whereas the highest negative impact was due to age. For a typical respondent, the probability to agree with payment for faster trip increased significantly with type of work being clerical or technical, increase in income, being able to work from home, and turnpike experience for female respondents. The type of work being technical had more overall effect (positive) for female respondents than male respondents. The work being flexible that allowed work from home had less overall effect (positive) for female respondents than male respondents. For a typical respondent, the probability to agree with willingness to pay for faster trip decreased significantly with increase in age, and being female. Most of the variables in the model except number of trips for a respondent whose type of work is technical had a significant impact on the probability to agree on payment for faster trip.

The highest positive impact on not willing to pay for faster trip was from age, whereas the highest negative impact was for female respondents of technical type of work. All variables had similar effect on probability to disagree, except that type of work being flexible to allow working from home had an overall effect of increasing the probability to disagree for female respondents.

The elasticities of variables for the public opinion "Willingness to Pay for Reliable Trip" from the final model presented in Table 42, are illustrated in Table 51.

Table 51: Elasticities of Final Model of Willingness to Pay for Reliable Trip

Variable	Description	Type/Scale	Elasticity for Agreement	Elasticity for Disagreement
ntpur	Number of Trips in a month	Number	-0.1167	0.0937
hilat	Hispanic/Latino	Binary	0.1175	-0.1359
incik	Income	$1,000	0.3456	-0.2775
clerk	Clerical Work Type	Binary	0.4560	-0.3257
mgmto	Management Work Type	Binary	0.1085	-0.1598
rtttt	Recent Trip Total Travel Time	Minutes	0.2803	-0.2251
ttclr	Travel Time*Clerk	Minutes	-0.0781	0.0627
ttbla	Travel Time of African American	Minutes	-0.0515	0.0413
incbl	Income of African American	$1,000	0.1212	-0.0973
inmgm	Income*Management	$1,000	-0.1727	0.1387
inclk	Income*Clerk	$1,000	-0.0994	0.0798
ingra	Income*Graduate	$1,000	0.0561	-0.0451

The highest positive impact on willingness to pay for reliable trip was for respondent of clerical type of work, whereas the highest negative impact was due to number of trips in a month. For a typical respondent, the probability to agree with payment for reliable trip increased significantly with type of work being clerical or management, increase in income, being Hispanic, and total travel time of recent trip. The probability to agree increased less with income whose type of work was clerical or professional, when compared to respondents of other work types. The probability to agree increased less with travel time for respondents whose type of work was clerical, when compared to respondents of other work types. The probability to agree increased more with income and less with total travel time of recent trip for African-American respondents, when compared to respondents of other races. The probability to agree increased less with income for respondents of clerical type of work. For a typical respondent, the probability to agree with willingness to pay for reliable trip decreased significantly with number of trips in a month. All variables in the model had a significant impact on the probability to agree on payment for reliable trip.

The highest positive impact on not willing to pay for reliable trip was from income for respondents of management type of work, whereas the highest negative impact was for respondents of clerical type of work. All variables had similar effect on probability to disagree.

4.3.2 Public Opinion on Travel Experience

There are three issues that relate to the respondents' travel experience, for which the opinion was asked from the respondents. The issues about travel experience are fairness of time of day pricing, use of toll-revenues for public transit, and impact of tolls on improvement of traffic condition. The sensitivity of agreement for these issues with respect to variables are compared, and presented in Table 52.

Age had a different effect on the respondents' opinion about different travel experience related issues. While age had a significant positive impact on the agreement of time of day pricing and impact of tolls on traffic condition for female respondents alone, it had a negative impact on use of toll-revenues for improvement of public transit. There was more impact on agreement for tolls impacting traffic condition than agreement with the time of day pricing. Gender had effect only on fairness of time of day pricing and it was negative. Being a graduate had positive effect on travel experience. However such effect of being a graduate was there for only female respondents about time of day pricing. While turnpike experience had a significant negative impact on the agreement of time of day pricing, turnpike experience had a positive impact on the use of toll-revenues for improvement of public transit. Race and income had an effect only on agreement for impact of tolls on traffic condition. Being African-American had a positive impact and income had a significant negative impact. Flexibility to work from home had a positive effect on impact of tolls on traffic condition and fairness of time of day pricing, of which the effect was higher for impact of tolls on traffic condition.

Table 52: Sensitivity Analysis for Opinion on Travel Experience

Variable	Time of Day Pricing	Revenues for Transit	Tolls improved Traffic condition
Age	+ +*	- - -	+ + +*
Female	- -		
Graduate	+ +*	+ +	+ +
Turnpike Experience	- - - # - -*	+ +	
Number of Children in HH	+ +	+	
African-American			+
Income			- -
Flexibility to work from home	+		+ +

Note: # indicates male sample; * indicates female sample

4.3.3 Public Opinion on Discounts

There are two issues that relate to perceived fairness about provision of discounts, for which the opinion was asked from the respondents. The questions obtained opinion of respondents on providing discounts to EZ pass users, and frequent commuters. The sensitivity of agreement for these issues with respect to variables are compared, and presented in Table 53.

Age had a significant negative impact on the fairness of providing discounts to frequent commuters. Gender had effect on fairness of providing discounts and the effect was significantly negative for provision of discounts to EZ pass users, and positive for provision of discounts to frequent commuters. Education had no effect on fairness of discounts. While turnpike experience and number of trips in a month had a positive impact only on the agreement of discounts to frequent commuters, owning EZ pass and being aware of EZ pass discounts and number of adults in household had a positive impact only on discounts to EZ pass users. Race and income had an impact on agreement for both the discounts. Being Asian had a positive impact on agreement for both the discounts, where the impact was more for discounts to EZ pass users. Income had significant negative impact on agreement for provision of discounts to frequent commuters. Income had significant negative impact on agreement for provision of discounts to EZ pass users for male respondents and impact was positive for female respondents.

Table 53: Sensitivity Analysis of Fairness of Discounts

Variable	Discounts to EZ Pass Users	Discounts to Frequent Commuters
Age		- -
Female	- -	+
Turnpike Experience		+
Number of Trips in a month		+ +
Asian	+ +	+
Income	- - # + *	- -
EZ Pass Owner	+ + +	
Aware of EZ Pass Discounts	+ +	
Number of Adults in HH	+ +	

Note: # indicates male sample; * indicates female sample

4.3.4 Public Opinion on Willingness to Pay

There are two issues that relate to willingness to pay, for which the opinion was asked from the respondents. The questions obtained opinion of respondents on their willingness to pay for a faster trip, and a reliable trip. The sensitivity of agreement for these issues with respect to variables are compared, and presented in Table 54.

Age had a significant negative impact on willingness to pay for faster trip. Gender had effect on willingness to pay for a faster trip and the effect was significantly negative. Turnpike experience had a positive impact on their willingness to pay for either a faster or a reliable trip and the effect was there for female respondents only for faster trip. Income had a positive impact on the willingness to pay for both the trips. The effect of income varied with race and type of work. Race had an effect only on willingness to pay of reliable trip and being Hispanic had a positive impact. Income had significant negative impact on agreement for provision of discounts to frequent commuters. Flexibility to work from home had a positive effect on willingness to pay for faster trip, of which the effect was higher for male respondents. While owning EZ pass had a significant positive impact on willingness to pay for a faster trip, recent trip's total travel time had a significant negative impact on willingness to pay for a reliable trip. Impact of travel time varied with race and type of work.

Table 54: Sensitivity of Public Opinion on Willingness to Pay

Variable	Willingness to Pay for Faster Trip	Willingness to Pay for Reliable Trip
Age	- - - -	
Female	- -	
Turnpike Experience	+ + #	+
Number of Trips in a month	- ^	- -
Income	+ + +	+ + +*
EZ Pass Owner	+ + +	
Flexible to Work from home	+ + m + #	
Recent Trip's Travel Time		+ +*
Hispanic		+ +

Note: * Varied with type of work and for African-American Respondents;
# indicates female sample; ^ for techical type of work respondents
m indicates male sample;

A sensitive analysis of the public opinion of the respondents with respect to gender, age, race, education level, employment status, E-Z pass ownership and income level is presented in this section. The next chapter presents the concluding remarks of public opinions.

5. Conclusion

The acceptability of time of day pricing initiative implemented in September 2000, for the New Jersey Turnpike Case was investigated in this paper. For this investigation, public opinion of the respondents has been studied to understand the factors or attributes of respondents that affect their opinion. The investigation was done in three parts. In first, the public opinions were analyzed against the demographic information, recent trip characteristics, and EZ pass related information. In the next, ordinal logit models were estimated for public opinions. In the final one, final ordinal logit models were analyzed for the sensitivity of the public opinion with respect to variables in the model. This paper presented the perceptions of respondents on issues related to travel experience, fairness of discounts and willingness to pay for a better trip.

A comprehensive analysis of the socio-economic information of the respondents suggested that a middle-aged full-time working white male with education of at least a four-year college degree, current user of turnpike and owner of E-Z Pass was the typical respondent of the survey. Analysis of information related to households of the respondents indicated that a typical household was of small size, with income above $80000, and has the same number of cars as number of licensed drivers in household.

Time of day pricing was considered unfair by the respondents of labor type of work, whereas respondents in either professional or clerical type of work found it fair. Turnpike experience resulted in reluctance to accept time of day pricing for male respondents, whereas the effect was of the opposite for female respondents. From elasticities, it can be observed that the probability of agreeing with time of day pricing increased significantly with increase in the number of children in a household, increase in age for females, and being a female graduate, whereas the probability of disagreeing with time of day pricing increased significantly with increase in turnpike experience and being female.

Discounts to EZ pass users were considered unfair by the respondents of labor type of work, whereas Asian and Hispanic respondents had more agreement for EZ Pass discounts. Income resulted in reluctance to accept EZ pass discounts for male respondents, whereas the effect was of opposite nature for female respondents. The sensitivity analysis of the opinion showed that the probability to agree with EZ pass discounts increased significantly for being EZ pass owner and being aware of EZ pass discounts, while the probability to disagree with EZ pass discounts increased significantly for being female.

Discounts for frequent commuters were considered unfair by older respondents, whereas respondents of clerical type of work had more agreement for such discounts. The sensitivity analysis of the perceived fairness indicated that the probability to agree with discounts for frequent commuters increased significantly with not working outside home, being Asian, and increase in number of trips in a month, whereas the probability to disagree increased significantly with increase in age.

Use of revenues for public transit improvement was considered unfair by owners of EZ pass, whereas respondents of labor and technical type of work found it fair. From elasticities, it can be observed that the probability to agree with use of toll-revenues for improvement of public transit increased significantly with being a graduate, and increase in turnpike experience, while the probability to disagree increased significantly with increase in age.

Respondents with graduate education found that implementation of tolls resulted in better traffic condition, whereas turnpike users did not agree with the same. From elasticities, it can be observed that the probability to agree with improvement of traffic condition due to tolls increased significantly for respondents who worked as drivers, while the probability to disagree increased significantly with increase in income.

With more income, respondents were willing to pay for a faster trip, whereas female respondents were not willing to pay for a faster trip. Analyzing the sensitivity of this opinion, the probability to agree with payment for a faster trip increased significantly with type of work being clerical or technical, and being able to work from home, while the probability to disagree increased with increase in age.

With more income, respondents were willing to pay for a reliable trip and respondents of clerical or professional type of work were also willing to pay for a reliable trip. Analyzing the sensitivity of this opinion, the probability to agree with payment for a reliable trip increased significantly with type of work, being a Hispanic, and increase in total travel time of recent trip, while the probability to disagree increased with increase in number of trips in a month.

REFERENCES

[1] Texas Transportation Institute, "2012 Urban mobility report," Oct. 2012. [Online]. Available: http://mobility.tamu.edu/ums/report/, Accessed on Nov. 19, 2014.

[2] T. Gärling and G. Schuitema, "Travel demand management targeting reduced private car use: Effectiveness, public acceptability and political feasibility," *J. of Social Issues*, vol. 63, no. 1, pp. 139-153, Mar. 2007.

[3] P. Jones, "Urban road pricing: Public acceptability and barriers to implementation," *Road Pricing, Traffic Congestion and the Environment, Issue of Efficiency and Social Feasibility*, K J. Button & E T. Verhoef, Eds. Northampton, MA, USA: Edward Elgar Publishing, 1998, pp. 263-284.

[4] B. Hårsman, "Urban road pricing acceptance," in *Proc. IMPRINT-EUROPE Seminar*, Brussels, Belgium, November 2001. [Online]. Available: http://www.movinginalivableregion.ca/wp-content/uploads/2013/06/urban_road_pricing_acceptance.pdf. Accessed on Nov. 19, 2014.

[5] M. Gaunt, T. Rye, and S. Allen, "Public acceptability of road user charging: The case of Edinburgh and the 2005 referendum," *Transport Rev.*, vol. 27 no. 1, pp. 85-102, Jan. 2007. [Online]. Available: http://www.geos.ed.ac.uk/homes/sallen/gaunt_et_al_2007.pdf, Accessed on Nov. 19, 2014.

[6] B. Schaller, "New York city's congestion pricing experience and implications for road pricing acceptance in the united states," *Transport Policy*, vol. 17, no. 4, pp. 266-273, Aug. 2010. [Online]. Available: http://www.nyc.gov/html/dot/downloads/pdf/schaller_paper_2010trb.pdf, Accessed on Nov. 19, 2014.

[7] P. Jones, "Gaining public support for road pricing through a package approach," *Traffic Engineering & Control*, vol. 32, no. 4, pp. 194-196, Apr. 1991.

[8] P. Jones, "Road pricing: The public viewpoint," in *Road Pricing: Theory, Empirical Assessment and Policy*, B. Johansson & L.G. Mattsson, Eds. Netherlands: Springer, 1995, pp. 159-179.

[9] B. Schlag and J. Schade, "Public acceptability of traffic demand management in Europe," *Traffic Engineering & Control*, vol. 41, no. 8, pp. 314-318, Sept. 2000. [Online]. Available: http://vplno1.vkw.tu-dresden.de/psycho/download/transprice.pdf, Accessed on Nov. 19, 2014.

[10] B. Schlag and U. Teubel, "Public acceptability of transport pricing," *IATSS Res.*, vol. 21, no. 2, pp. 134-142, 1997. [Online]. Available: http://vplno1.vkw.tu-dresden.de/psycho/projekte/afford/download/IATSSRP.pdf, Accessed on Nov. 19, 2014.

[11] T. D. Hau, "Electronic road pricing: Developments in Hong Kong 1983-1989," *J. of Transport Econ. and Policy,* vol. 24, no. 2, pp. 203-214, May 1990. [Online]. Available: http://www.econ.hku.hk/~timhau/electronic_road_pricing.pdf, Accessed on Nov. 19, 2014.

[12] G. Giuliano, "Equity and fairness considerations of congestion pricing," Transportation Res. Board Special Rep. 242, pp 250-279, June 1994.

[13] D. Banister, "Equity and acceptability questions in internalising the social costs of transport," *Internalising the Social Costs of Transport,* OECD, Paris, France, 1994. [Online]. Available: http://www.internationaltransportforum.org/IntOrg/ecmt/taxes/pdf/94socCosts7e.pdf, Accessed on Nov. 19, 2014.

[14] W. Harrington, A. J. Krupnick, and A. Alberini, "Overcoming public aversion to congestion pricing," *Transportation Res. Part A: Policy and Practice,* vol. 35, no. 2, pp. 87-105, Feb. 2001.

[15] C. Jakobsson, S. Fujii, and T. Gärling, "Determinants of private car users' acceptance of road pricing," *Transport Policy,* vol. 7, no. 2, pp. 153-158, Apr. 2000.

[16] S. Fujii, T. Gärling, C. Jakobsson, and R.-C. Jou, "A cross-country study of fairness and infringement on freedom as determinants of car owners' acceptance of road pricing," *Transportation,* vol. 31, no. 3, pp. 285-295, Aug. 2004.

[17] T. F. Golob, "Joint models of attitudes and behavior in evaluation of the San Diego I-15 congestion pricing project," *Transportation Res. Part A: Policy and Practice,* vol. 35, no. 6, pp. 495-514, July 2001.

[18] J. M. Viegas, "Making urban road pricing acceptable and effective: searching for quality and equity in urban mobility," *Transport Policy,* vol. 8, no. 4, pp. 289-294, Oct. 2001.

[19] J. Odeck and S. Bråthen, "Toll financing in Norway: The success, the failures and perspectives for the future," *Transport Policy,* vol. 9, no. 3, pp. 253-260, July 2002.

[20] J. Schade and B. Schlag, "Acceptability of urban transport pricing strategies," *Transportation Res. Part F: Traffic Psychology and Behaviour,* vol. 6, no. 1, pp. 45-61, Mar. 2003.

[21] S. Jaensirisak, M. Wardman, and A. May, "Explaining variations in public acceptability of road pricing schemes," *J. of Transport Econ. and Policy,* vol. 39, no. 2, pp. 127-153, May 2005.

[22] J. Eliasson, "Lessons from the Stockholm congestion charging trial," *Transport Policy,* vol. 15, no. 6, pp. 395-404, Nov. 2008.

[23] G. Schuitema, L. Steg, and S. Forward, "Explaining differences in acceptability before and acceptance after the implementation of a congestion charge in Stockholm," *Transportation Res. Part A: Policy and Practice,* vol. 44, no. 2, Feb. 2010.

[24] B. Hårsman and J. M. Quigley, "Political and public acceptability of congestion pricing: Ideology and self-interest," *J. of Policy Analysis and Manage.*, vol. 29, no. 4, pp. 854-874, Aug. 2010.

[25] A. Rentziou, C. Milioti, K. Gkritza, and M. G. Karlaftis,, "Urban road pricing: Modeling public acceptance," *J. of Urban Planning and Develop.*, vol. 137, no. 1, pp. 56-64, Mar. 2011.

[26] K. Ozbay *et al*., “Evaluation study of new jersey turnpike authority's time of day pricing initiative,” No. FHWA-NJ-2005-012. New Jersey Dept. of Transportation, Division of Res. and Technol., 2005. [Online]. Available: http://policy.rutgers.edu/vtc/reports/REPORTS/Value Pricing Evaluation_FHWA-NJ-2005-012.pdf, Accessed on Nov. 19, 2014.

[27] New Jersey Turnpike Authority, "1999 Annual Report," 1999. [Online]. Available: http://www.njleg.state.nj.us/OPI/Reports_to_the_Legislature/turnpike_authority_1999ar.pdf, Accessed on Nov. 19, 2014.

[28] New Jersey Turnpike Authority, "2012 Annual Report," 2012. [Online]. Available: http://www.state.nj.us/turnpike/documents/2012-NJTA-Annual-Report.pdf, Accessed on Nov. 19, 2014.

[29] New Jersey Turnpike Authority, "2000 Annual Report," 2000. [Online]. Available: http://hdl.handle.net/10929/19778, Accessed on Nov. 19, 2014.

[30] K. Ozbay O. Yanmaz-Tuzel, and J. Holguín-Veras, "Evaluation of combined traffic impacts of time-of-day pricing program and e-zpass usage on new jersey turnpike," *Transportation Res. Record,* vol. 1960, no. 1, pp. 40-47, Jan. 2006.

[31] R. C. Martin Jr. “Map of the New Jersey turnpike eastern spur (i-95 eastern route) map by MapQuest,” 2001. [Online]. Available: http://www.raymondcmartinjr.com/njfreeways/NJI-95ENJTuEasternSpurMap.html, Accessed on Nov. 19, 2014.

[32] R. D. McKelvey and W. Zavoina, "A statistical model for the analysis of ordinal level dependent variables," *J. of Math. Sociology,* vol. 4, no. 1, pp. 103-120, 1975. [Online]. Available: http://www.aae.wisc.edu/aae637/articles/mckelvey_zavina_j_math_soc_1975.pdf, Accessed on Nov. 19, 2014

[33] S. Beggs, S. Cardell, and J. Hausman, "Assessing the potential demand for electric cars," *J. of Econometrics,* vol. 17, no. 2, pp. 1-19, Sept. 1981.

[34] C. F. Baum, "Ordered logit and probit models," in *An Introduction to Modern Econometrics Using Stata*, 1st ed. College Station, TX, USA: Stata Press, 2006, pp. 256-259.

[35] W. H. Greene, "Ordered data," in *Econometric Analysis*, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2003, pp. 736-739.