UNDERSTANDING THE EFFECTS OF SENIOR CITIZEN FREE TRANSIT PROGRAM ON THE TRAVEL BEHAVIOR OF THE ELDERLY IN KADIKOY, ISTANBUL

by

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ABSTRACT

UNDERSTANDING THE EFFECTS OF SENIOR CITIZEN FREE TRANSIT PROGRAM ON THE TRAVEL BEHAVIOR OF THE ELDERLY IN KADIKOY, ISTANBUL

The increase in the elderly population around the world obliges governments to develop new policies on the transport of the elderly. To this end, free or reduced transport programs have begun to be implemented in some world countries and in Turkey to encourage elderly people to use public transport and to provide them with a more active life. In order to understand whether these programs are adequate, surveys were conducted taking into consideration the effects of using the free transportation program and the demographic characteristics of over 55 year olds living in Kadıköy district of Istanbul. The survey examines participants' travel behaviors and considerations of accessibility to public transport. The results of the analysis show that there are significant differences in the travel behavior of individuals under age 65 and above, and that the applied free transport program is insufficient to encourage individuals using their own vehicles to use public transport. On the other hand, it is understood that the free transportation program has a positive effect on the quality of life by increasing the mobility of elderly individuals.

ÖZET

ÜCRETSİZ ULAŞIM PROGRAMININ İSTANBUL, KADIKÖY'DEKİ YAŞLILARIN SEYAHAT DAVRANIŞLARI ÜZERİNDEKİ ETKİSİNİN ANLAŞILMASI

Dünya genelindeki yaşlı nüfusun artışı, hükümetlerin yaşlıların ulaşımları ile ilgili yeni politikalar geliştirmesini zorunlu kılmaktadır. Bu amaçla, bazı dünya ülkeleri ve Türkiye'de yaşlıları toplu ulaşım araçlarını kullanmaya teşvik etmek ve onlara daha aktif bir hayat sağlamak amacıyla ücretsiz ya da indirimli ulaşım programları uygulanmaya başlanmıştır. Uygulanan bu programların yeterli olup olmadığını anlamak amacıyla İstanbul'un Kadıköy ilçesinde yaşayan 55 yaş üstü bireylere, ücretsiz ulaşım programından faydalanma ve demografik özelliklerin etkilerini göz önüne alarak anketler yapılmıştır. Anket, katılımcıların seyahat davranışlarını ve toplu ulaşım araçlarına erişilebilirlik konusundaki düşüncelerini irdelemektedir. Analiz sonuçları, 65 yaş altı ve üstü bireylerin seyahat davranışlarında önemli farklılıklar olduğunu ve uygulanan ücretsiz ulaşım programının kendi aracını kullanan bireyleri toplu ulaşım araçlarına teşvik etmek konusunda yetersiz kaldığını göstermektedir. Buna karşın, ücretsiz ulaşım programı yaşlı bireylerin hareketliliğini arttırarak yaşam kalitelerine olumlu etki sağladığı anlaşılmaktadır.

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B	Beta value
D	Desirable maximum error
F	Anova Coefficient
N	Population
N	Total number of observations.
n	Total number of values.
n	Total number of samples in a population.
n_0	Sample size
n_1	Total number of values in first set
n_2	Total number of values in second set.
p	Percentage picking a response
p	Total number of populations
S	Standard deviation of the samples
S_1	Standard deviation of first set of values
S_2	Standard deviation of second set of values
X	Values given
Xi, Yi	Actual observations for i= 1, n observation
$\bar{x}$	Mean
$\bar{x}_1$	Mean of first set of values
$\bar{x}_2$	Mean of second set of values
Z_α	Confidence interval for chosen λ
$\hat{\beta}, \hat{\alpha}$	The estimates of the coefficients
λ	Confidence level

LIST OF ACRONYMS/ABBREVIATIONS

AM	Ante Meridiam
ANOVA	Analysis of Variance
ARCCA	Age-Restricted Community Connectivity Assessment
BRT	Bus rapid transit
DETR	Department of the Environment, Transport and the Regions
OECD	Organisation for Economic Cooperation and Development
IETT	Istanbul Public Transport Authority
MSE	Mean sum of squares due to error
MST	Mean sum of squares due to treatment
SSE	Sum of squares due to error
SST	Sum of squares due to treatment
N.A.	Not Available
NPTS	Nationwide Personal Transportation Study
PT	Public Transport
PTAL	Public Transport Accessibility Levels
RP	Revealed Preference
Sc.	School
Sig.	Significance Level
SP	Stated Preference
Std. Error	Standart Error
TURKSTAT	Turkish Statistical Institute
UK	United Kingdom
VIF	Variance inflation factor

1. INTRODUCTION

1.1. Problem Statement

Thanks to technological developments in the field of health, human life has begun to prolong. Statistics research shows that the elderly population in the world is increasing day by day. According to World Bank data (2015) in Table 1.1., the percentage of population over 65 years old is shown by different types of classification.

Table 1.1. Share of Population aged 65 and over in the World.

	Year					
Countries	**1980**	**1990**	**2000**	**2005**	**2010**	**2015**
World	5.84	6.09	6.84	7.28	7.63	8.27
OECD Members	10.78	11.57	12.96	13.73	14.67	16.25
European Union	13.29	13.76	15.67	16.71	17.54	19.19
High Income	11.41	12.32	13.81	14.61	15.53	17.23
Upper Middle Income	5.01	5.50	6.68	7.42	7.93	8.88
Lower Middle Income	3.91	4.01	4.49	4.74	4.94	5.23
Low Income	3.01	3.09	3.16	3.21	3.32	3.38
Turkey	4.70	4.54	5.99	6.55	7.03	7.54
China	4.49	5.34	6.65	7.49	8.25	9.55
United States	11.36	12.52	12.32	12.32	13.01	14.79
Russian Federation	10.29	10.30	12.44	13.82	13.09	13.37
Korean Republic	3.86	4.98	7.34	9.19	11.09	13.13
United Kingdom	14.95	15.73	15.83	15.99	16.18	17.76
Germany	15.68	14.87	16.20	18.82	20.60	21.24
France	13.92	14.02	16.10	16.63	17.02	19.12
Spain	11.04	13.35	16.64	16.63	17.16	18.79
Italy	13.31	14.81	18.08	19.47	20.44	22.41

Along with that, this trend has led to different problems related to transportation. According to Turkstat (2015), almost 4 million vehicles are in transit in Istanbul every day and the number of traffic accidents resulting in death increases day by day. Twenty percent of those who lost their lives in traffic accidents are over 65 years old citizens in Turkey. Due to the fact that individuals with age-related limitations use their own vehicles in traffic, such negativities are experienced. Rupprecht Consult states the factors that limit the elderly as follows.

Table 1.2. Age-Related Personal Constraints.

Physical Constraints	**Deceleration of**
Loss of mobility of limbs	Movements
Loss of physical power	Senses
Lower endurance and increasing fatigue	Cognition
Higher stress sensibility	Reaction
Reduced functionality of inner organs/chronic illnesses	Decisions
Sensory Constraints	
Visual impairments	
Hearing problems	
Cognitive and Psychological Constraints	
Loss of ability to coordinate movements	
Reduced and selective cognitive processes	
Reduced multitasking abilities, loss of flexibility	
Lower concentrativeness	
Higher stress sensibility	
Fears	

Unfortunately, another problem caused by age-related personal constrains is traffic congestion. The fact that it is not as fast as decision-making and responsive is causing the existing traffic problems to increase further.

Besides all of them, the decrease in the quality of life of the elderly individuals who started to passivate in the sense of socialization is another problem that should not be ignored. Because the elderly like everyone need to act actively and socialize in society.

In response to all these problems, local governments are also seeking various solutions. There are generally two purposes for these solutions; encouraging older people to use public transport in order to reduce the number of vehicles used in traffic, and providing them with a more active life in order to take on more active roles in society.

The free public transport program for the elderly, which have been implemented in many cities in recent years, is one of the most important solutions. However, this solution alone is not enough to convince senior citizens to use public transport. Accessibility to public transportation

vehicles, ease of landing-to-vehicles, comfortable, fast and safe travel issues constitute the main issues that decision-making mechanisms seek for solutions.

1.2. Objectives of the Study

Despite the existence of several research topics in transportation field, there has been limited research conducted free transportation policy for seniors. Given the demographic trend of Turkey's aging population, systematic research on this topic can make an important influence on future policies concerning mobility for the elderly. In this context, the goal of this research is to explore the public transportation travel behavior of seniors towards free transportation programs using the case study for Kadıköy, Istanbul. In particular, three research questions were examined:

- How is travel behavior of senior citizens?
- How has travel behavior of seniors changed after free transit program?
- How has preference of transportation modes been affected by accessibility factors?

1.3. Contribution to Knowledge and Practice

Policy makers and planners need to first analyze the citizens' travel behavior and the problems they face in order to improve quality and provide solutions to problems. Although there are important world-wide studies on travel behavior, each city can exhibit different travel behaviors. And unfortunately, studies on travel behavior especially for the elderly in Istanbul are insufficient. In Istanbul, where traffic is a very big problem, the contributions of the researches related to transportation to cities and citizens are very high. Analyzing the factors that prevent older people from choosing public transport by understanding their travel behavior will ensure that existing transport policies are corrected or new transport policies are prepared. The feasibility of the studies made for other cities is not possible due to the geopolitical and demographic characteristics of Istanbul being different from other cities. Therefore, the contribution of this work to Istanbul will be great.

1.4. Thesis Outline

This study consists of five main sections.

- The first chapter contains general information on the study.
- The second chapter discusses past studies on older people's travel behaviors, past studies on accessibility, and examples of transport policies targeting senior citizens.
- The third chapter gives information on the questionnaire and applied methods that make up the skeleton of the work.
- In the fourth chapter, analysis results and interpretations, factor-variable relations and modeling are explained.
- In the last chapter, there is a brief presentation of the results and suggestions.

2. LITERATURE REVIEW

2.1. Previous Studies about Travel Behaviors

The issue of travel behavior is a matter of research not only in transportation but also in fields such as medicine, sociology and psychology. The travel behavior of the elderly has become more eye-catching because of the growing number of the elderly worldwide. In addition to that, the increase in the number of drivers also makes it more important to examine the travel behaviors of the elderly in terms of transportation area.

According to many researches in the literature, researchers include the results related to the use of personal vehicles in their studies. Rosenbloom (2001) mentions that the driver population grows enormously while the population in the US and Europe is on the rise. The daily traffic statistics results of over 65-year-old citizens living in America are shown on the Table 2.1. According to this table, which reflects between 1983 and 1995, travels made with personal vehicles have increased significantly.

Table 2.1. Daily Travel Statistics for Older Americans (65+), 1983-1995.

Travel Characteristics	**Year**			
	1983	**1990 (adjusted)**	**1995**	**% change 1983–1995**
Vehicle trips per driver	1.66	2.27	2.94	77.1
Vehicle miles traveled per driver	9.8	14.83	19.56	98
Average vehicle trip length	5.92	6.61	6.69	13
Average time spent driving (in minutes)	N.A.	30.83	42.89	39.1
Person trips per person	1.82	2.49	3.43	88.5
Person-miles per person	12.21	19.85	25.24	106.7
Average person trip length	6.7	8.12	7.46	11.3

The study by Böcker *et al*. (2016), examines the differences between travel behaviors of the elderly and non-elderly people living in Rotterdam. While 49 percent of non-elderly citizens travel by car, 39.2 percent of the elderly prefer to drive. Another implication is that 22.4 percent of the elderly are not car owners, while 18.3 percent of the elderly do not have their own car.

Newbold's (2005) survey of older Canadian citizens comparing their travel behavior with young people shows that the vast majority of both young and elderly individuals prefer to use their own vehicles while traveling. Currie and Delbosc (2010) claim that the tendency of elderly individuals to use individual vehicles is on an increasing trend. None the less, according to the spatial analysis, it is stated that the trend of using public transportation vehicles for the elderly living in the city center is increased. Table 2.2. used in the study of Alsnih and Hensher (2003) shows that the proportion of people over 55 years old in terms of the number of personal cars and the household size.

Table 2.2. Car Ownership and Household Size Statistics for Seniors in Adelaide, 1999.

	Car Ownership and Household Size			
Age group	**No vehicles, household size=1**	**One vehicle, household size=1**	**One vehicle, household size=2**	**Two vehicles, household size=2**
55–59	1	11.3	20.1	34.5
60–64	2.9	11.6	33.6	28.5
65–69	4.9	14.8	40.9	22.9
70–74	8.5	20.6	43.1	15.5
75–79	8.6	23.5	45.6	8.3
80–84	22.5	21.4	37.6	6.4
85+	43.4	18.9	16.9	3.8

Previous studies focus on travel frequencies in addition to comparing personal vehicle usage and public transport usage. According to Rosenbloom's (2001) published table, which reflects between 1983 and 1995, a huge increase has also been observed in the distance traveled. In the study of Newbold (2005), who supports Rosenbloom's (2001) study, while the number of daily trips in 1986 was 2.7, it increased to 3.3 in 1998. Again, according to the same article, it is seen that the travel time of citizens over 65 years is shorter than that of young people. Similarly, in a survey on the use of public transport by old people living in Melbourne, people over the age of 60 are traveling 30 percent less and 16 percent lower than those under 60 years of age (Currie and Delbosc, 2010). In another study, Song *et al*. (2014) analyzed travel behaviors of travelers older than 65 years living in Korea and found that the average travel time of the elderly population was 31 minutes. Noh and Joh (2011) analyzes the results of the questionnaire survey of the elderly travel behavior in Korea in 2002 and 2006. The study focuses on changes

in travel behavior and spatial characteristics of trip destinations. According to the results, the number of people traveling increased between 2002-2006. Another implication is that the travel distance has increased significantly while traveling times remain the same. Contrary to all these past work, Böcker *et al*. (2016) has come to a different conclusion about vehicle use. According to the results of the study of Böcker *et al*. (2016), the elderly people have lower travel frequencies and they prefer to walk instead of driving. Furthermore, the average journeys of the elderly were found 7.8 km, while 9.8 km of non-elderly individuals. This situation is considered to be effective in walking preference. According to the results of the study, the elderly regards walking more attractive. While 29.4 percent of the elderly prefer to walk, only 19.4 percent of non-elderly people prefer to walk.

Another important issue in the previous studies of the elderly travel behaviors is the mode choice. The article of Rosenbloom (2001) draws attention to the increase in the use of personal vehicles by the Table 2.3. showing the change between the years 1984 and 1994 of the preference of individual cars, buses and railways for seniors living in some leading European countries.

Table 2.3. Percentage of Trips by Mode, 1984-1994.

Countries	**Transportation Mode**					
	Cars and taxis		**Buses and coaches**		**Rail**	
	Years					
	1984	**1994**	**1984**	**1994**	**1984**	**1994**
Belgium	81.2	88.3	11.1	5.2	7.8	6.5
Denmark	75.5	80.4	16.1	12.9	8.4	6.7
Finland	76.2	81.8	17.2	13.2	6.6	5
France	83	86.6	6.8	5.6	10.2	7.8
Germany	76.7	84.6	13.4	8.1	9.9	7.3
Great Britain	84.1	88.9	9.9	6.7	6	4.5
Netherlands	85.7	83.8	7.6	7.9	6.7	8.2
Norway	84.9	85	9.5	9.6	5.6	5.5
Portugal	78.5	81.1	13.1	13.5	8.5	5.6
Spain	71	79.1	18.4	14.7	10.5	6.2

Table 2.4. synthesizes some of the perceptions of those aged over 75 years in the United States (Coughlin, 2001). The literature suggests that the dissatisfaction with conventional (fixed

route) public and community transport is similar in many western countries (Alsnih and Hensher, 2003).

Table 2.4. Range of Perceptions of Selected Alternatives to Driving.

Alternative	Positive attributes	Negative attributes
Ride with friends/family	‘‘Socialise and mobility together’’	‘‘Imposing on people’’
	‘‘Almost like doing it yourself’’	‘‘Cannot always have it (ride) when you want it’’
Bus	‘‘Do not have to bother anyone’’	‘‘Bad element on bus’’
	‘‘Gets you around traffic’’	‘‘Waiting’’
Light rail	‘‘Quick, on time’’	‘‘Do not necessarily go where you need to go’’
	‘‘Comfortable in all weather’’	‘‘Too far to walk’’
Walking	‘‘Fresh air’’	‘‘You can get there, but you cannot get back’’
	‘‘Good for you’’	‘‘Bad weather’’
Taxi	‘‘Good for an emergency’’	‘‘Too expensive’’
	‘‘Reliable’’	‘‘Cannot always get one’’
Demand response (senior vans, paratransit)	‘‘Door to door’’	‘‘Late picking you up’’
	‘‘Cheap’’	‘‘Do not know of any’’

The study of Alsnih and Hensher (2003), demonstrates the importance of understanding the elderly movement needs. Table 2.5. shows car, bus and train trip rates for each person in Sydney, respectively. Car trip rates increased (as expected) in the period from 1991 to 2000, whereas bus trips for the three age groups decreased. Train trip rates, for the 65–75 age group showed a slight increase in the period between 1991 and 2000, however, the corresponding trip rates for the other age groups decreased.

Table 2.5. Sydney Person Trip Rates by Selected Mode by Age Group.

	Age Group		
Trip Rates	**18–64**	**65–75**	**75+**
2000 Car trip rates	3.241	1.94	1.237
1991 Car trip rates	3.172	1.780	0.999
2000 Bus trip rates	0.16	0.228	0.244
1991 Bus trip rates	0.191	0.255	0.262
2000 Train trip rates	0.205	0.136	0.073
1991 Train trip rates	0.215	0.105	0.123

According to study of Currie and Delbosc (2010), citizens aged 60 and over use 36 percent fewer trains, 14 percent fewer trams and 33 percent more buses than under 60 years of age. Despite all these efforts, the study of Noh and Joh (2011) has achieved different results. It is stated that the use of subway between the ages of 65-75 is increased. According to the article, it is the reason for this change to make transfers between public transport in Seoul free of charge. Another study supporting Noh and Joh (2011) is the study of Song *et al*. (2014). Contrary to expectations, it turns out that seniors have a longer journey through the metro than the bus. Interestingly, it was determined that free card holders did not transfer more as expected. Furthermore, the elderly did not opt for metro transport and metro transit because they were exhausting. In addition to all these, Böcker *et al*. (2016) claims that an important factor in the selection of transportation for the elderly is the air condition. Bad weather conditions also reduce the elderly's travel frequencies.

What the residents do for their trips is an important parameter when making travel behavior measurements. Noh and Joh's (2011) study result is that old people are becoming more active in shopping, personal affairs and out-of-work activities. Moreover, citizens aged 65 to 69 were among the most affected by travel developments among their travel behaviors. It turned out that the activity area of the aged between 65 and 69 years has expanded considerably. Naess (2006) conducted a study analyzing the relationship between residential location and travel behavior. Through a qualitative interviews and analysis of work in Copenhagen Metropolitan area, it became clear that it was easy to reach trip destinations in city centers. While residents in urban areas prefer to spend more time in restaurants, theaters and cafés, residents outside the city prefer to resort to coastal, forest and day-to-day business. This showed that those living in

the city center and those living outside the city reached different kinds of activities. In Mackett's (2015) article, there is a table (2.6.) of the purpose of public transit usage. According to the results, the elderly mostly use transportation modes for shopping and leisure time. Those whose age range is 50-59 frequently use transportation modes for commuting purpose. It has become clear that education (as expected) is the place where transportation modes are least used.

Table 2.6. Average number of trips each year per head by age and purpose in Great Britain 2012.

Trip purpose	**Age Group**			
	All ages	**Age 50–59**	**Age 60–69**	**Age 70+**
Commuting	146	227	94	10
Business	31	68	28	1
Education	64	1	1	–
Escort education	52	28	16	8
Shopping	189	234	293	283
Other escort	87	81	72	38
Personal business	94	110	136	131
Leisure/social	248	240	288	221
Other including just walk	43	61	61	41
All purposes	954	1050	987	733

According to Böcker *et al*. (2016), sociodemographic results indicate that age and gender have no significant impact on travel frequencies. However, it was found that old women prefer to walk and ride bicycles more than men, and older men prefer to use the vehicle more than women. Despite that, Schwanen and Páez's (2010) research on mobility of the elderly population indicates that vehicle use and travel distances are increasing, and that this is especially true for women. It is also mentioned that the developments in transportation technologies will affect the accessibility positively in the course of the process.

One of the most specific studies on the free transport policy for the elderly belongs to Coronini-Cronberg (2012). Since 2006 in the UK, people aged 60 years and over are free to use buses after 9:30 AM on weekdays, and all day on weekends and public holidays. The percentage of those who use buses increased from 56.8 per cent in 2005 to 74.7 per cent in 2008. It was observed that the percentage of those who participated in the survey was higher among those who are over 70 years old, women, living in rented houses and living in crowded areas. One of the conclusions is that the rate of bus use among the elderly and the rate of walking three times a week increased.

Apart from all these travel behavior studies, some researchers have emphasized the importance of the right perception of the elderly concept. Alsnih and Hensher (2003) emphasizes that the elderly should not be regarded as a homogeneous group and that 'young' elderly and 'elderly' elderly people have different characteristics in terms of travel behavior. Alsnih and Hensher (2003) refers to those between the ages of 65 and 75 as 'young' elderly and those aged 75 and over as 'elderly' elderly. Cao *et al.* (2010) says that the elderly is not a homogenous group, as Alsnih and Hensher (2003) says. However, they do the classification differently than Alsnih and Hensher (2003). They point out that the traditional neighborhoods and the people who love traveling have different travel behaviors.

As a result, researchers share a common opinion that encouraging older people to public transport and providing them with comfortable transportation opportunities should be included in government policies. The article of Rosenbloom (2001) stating that transport-related policies should focus on environment, safety and mobility underscores the necessity of encouraging the elderly to public transport and adding that the accidents caused $ 150 million annual loss and that most of these accidents are caused by the old drivers. Another important conclusion is that the mass transportation incentive should not only be successful with its payment policies, but also the necessary sensitivity to comfort and accessibility issues (Noh and Joh, 2011).

2.2. Previous Studies about Accessibility

Sun and Lin (2015) describe accessibility as a parameter used to measure the level of service of public transport systems. They also add that the definition of accessibility is still unclear. For this purpose, the paper of Sun and Lin (2015) focuses on defining public transportation accessibility, based on the characteristics of urban public transit operation and travel, as well as previous research on urban road accessibility. In this article, accessibility is divided into locational and regional. The total travel time of travelling between the two points using transit is the locational accessibility of public transit. The parameters affecting the locational accessibility are as follows; walking time, journey time, waiting time and penalty time. Accordingly, regional accessibility of transit is defined as the number of people that can arrive by transit at all the destinations within the region in the maximum tolerable time in terms of the total population and number of stops within the region.

Similarly, according to Verseckienė *et al*. (2016), accessibility in public transport is defined as the quality of transit. In their research using the PTAL (Public Transport Accessibility Levels) method, it was found that the city centers were convenient for access to public transport, and it was found that there were significant problems with accessibility in areas outside the city.

In another study by Bok and Kwon (2016), the quality of service provided to passengers is emphasized. In particular, the study of European cities and cities in north America gives important information on the relationship between service quality and the use of public transport.

Study of Beiler *et al*. (2015) emphasizes that the way to improve the quality of life of old people living in America is to make them more mobile. Moreover, the research includes analysis of two different regions where ARCCA (Age-Restricted Community Connectivity Assessment) is applied. Urban area was found to have high connectivity for transit and pedestrian access for almost all age-restricted communities. The results for rural area showed that there are short-term opportunities for transit connection as well as varying levels of pedestrian accessibility. These

results indicate that ARCCA is applicable to real-world networks as it supports planning principles of urbanized areas providing more walkable and transit oriented connections.

Cheng and Chen's (2015) research in Taiwan on accessibility, mobility and connectivity on public transport has significant implications. The elderly represent a growing share of Taiwan's population, such that local authorities should provide adequate incentives to transportation service operation agencies, such as tax reductions or subsidies, to improve their public transportation services for these residents, including comfortable seating on buses, protection from inclement or hot weather, improved signage, and lighting at bus stops.

'A Review of International Best Practice in Accessible Public Transportation for Persons with Disabilities' provides information on different challenges and solutions for accessibility. Under the UK regulations, it was underlined that bus stops should be positioned so that passengers cannot walk more than 400 meters. The same report also highlights that low-floor buses provide significant facilities for the access of passengers. The report also opens up a separate paragraph for the impact of ramps on accessibility. According to European guidelines, the preferred slope should be 5%, and the acceptable maximum slope should be 8%. In addition, it is recommended that ramp lengths never exceed 132 meters. For ladders used for transportation to public transport, it is said that the steps should be made 150 mm high and 300 mm deep (Wisma *et al*., 2010).

Mercado *et al*. (2010) talks about the points that affect service quality such as accessibility, comfort, safety for the elderly in transportation. It is stated that urban planning should not only be considered as a health-related function, but also that transportation should be examined very well. It is underlined that the elderly want to have more active access. It also states that mobility environment and institutional and legislative reforms policies are very important for the aging of the elderly, and that older people can have a more active life.

Broome *et al*.'s (2010) study, which focuses on buses from public transport, emphasizes the importance of reducing obstacles to bus access and facilitating bus travel. The article suggests that creating the elderly friendly bus system would be beneficial to overcome obstacles,

emphasizing the need for buses to have closer and closer access, the need for bus drivers to be more responsive and helpful, and the need to increase bus numbers.

A case study in London by Ferrari *et al*. (2014) reveals that travels are heavily influenced when stations, stops and vehicles are not fully accessible. It is thought that if accessibility is ensured, boarding of vehicles will be faster and this situation will benefit other passengers as well. In addition to platforms that make it easier for vehicles to get on board, there is also talked about the benefits of providing free transfers between modes of transport.

2.3. Free Public Transport Implementations and Accessibility Policies in the World

Today, free mass transit programs are available in many parts of the world. Canada is one of the leading countries that have started and continued this practice. Senior ride for free transportation programs occurred in the 1980s in Edmonton, Alberta (George, 2000). In 2010, Ottawa, Ontario and Moncton, New Brunswick implemented ride for free transit programs on Wednesdays (OC Transpo, 2014). In 2011, Halifax, Nova Scotia attempted a pilot project for three months, but it was deemed unfeasible (Lightstone, 2011). In the following year, Oakville, Ontario introduced their ride for free program on Mondays for seniors (Oakville Beaver, 2012). More recently, Laval, Quebec introduced a senior ride for free program at any time and any day starting in 2014 (Canada Newswire, 2014). Not only Canada but also European countries are passionate about free public transport.

The governments of England, Scotland and Wales provide free buses for citizens over the age of 60 in order to increase public participation. This practice started in England on June 1, 2001, and started on 1 April 2002 in Wales. In Scotland, the practice, which was launched on September 30, 2002, is implemented after 09:30 on weekdays and all day on weekends. Free bus usage for seniors has been validated in all British cities since 2008. The main aim of the program, which is estimated to be 1.1 billion pounds per annum, is to increase bus usage (Butcher, 2012).

According to the polls, 30 per cent of the elderly in Bremen travel frequently, while 70 per cent rarely travel. In Bob-Ticket application in Bremen, old people pay the cheapest fare of their travels during the day. This practice aims to benefit the elderly more often by means of public transport and to lead a more active life (VBN, 2016).

Rhine and Ruhr Public Transport Authority (Germany) offers monthly ticket application for seniors over 60 years old. This ticket provides not only transportation but also sports, culture, education and health services (Rheinbahn, 2016).

In Lille, France, 400 ‘friendly agents’ are working to help seniors on public transport and increase their accessibility. These workers, who have difficulties in finding a job, are also able to access professional assistance quickly in case of possible accidents.

Benefits;

• Improved safety and security
• Additional services: Information, escort passengers who need assistance (e.g. carrying luggage, showing the right way to the platform)
• Decreased fraud rates – generates revenues
• Less vandalism – saves money and improves image
• Better monitoring of quality: Staff can identify messy or broken down infrastructure; passengers are more likely to report directly to staff than via hotlines
• Public transport gets a friendly face – positive image and customer retention
• Less discrimination of other passengers (e.g. youths, immigrants) than in other schemes
• Moderating impact instead of menacing appearance (Trendsetter Europe, 2003)

Bad experiences such as falls and accidents can cause the elderly to abandon their habit of using public transport. Trainings are held in Salzburg, Austria, to teach older people how to protect themselves from such situations and to encourage them to use public transport. In the course of training, information is given about how to get to the vehicles and how they should be placed in the vehicle, and this information is put into practice with a trip. In parallel, drivers are trained on safe driving. The Salzburg municipality, which considers that complaints and

hearings from passengers will increase the use of public transport, receives feedbacks and makes improvements accordingly (ZGB, 2016).

In a similar but different application, Germany's Munich city, in its so-called "Stadtviertelkonzept Nahmobilität" (Urban Mobility Scheme), resolves the citizens' problems by meeting them and observing the places that are causing the problem (Muenchen, 2012).

While Birmingham (UK) was one of the cities that granted seniors concessions for public transport, it was noticed that the impact of this program was not much in the city. The reason for this situation is the inability to provide sufficient information and especially language difficulties of foreign nationals. For this purpose, a city-based committee helps with both mobility and other transport issues. This is done in the native language of the people (Birmingham Municipality, 2014).

In Gothenburg (Sweden) many public transport vehicles have been improved to be accessible. However, this development is not enough to prevent the difficulties encountered by older people during the transfer. The support team, established to enable the elderly to travel freely, serves not only in transfers but also in carrying their suitcases and bags (Kola Goteborg, 2013).

A new generation of bus interchanger stations, implemented in Manchester and West Bromwich (UK), provide convenience for seniors and disabled people. These stations, which also include small shops and toilets, provide seniors a comfortable and weather-friendly environment while waiting for vehicles (GMPTE, 2014).

In Turkey, the 'Free or Reduced Travel Cards Regulation' was published in the official gazette on March 4, 2014, and entered into the joy. According to this directive, citizens in the 60-65 age group are entitled to a 50% discount in all cities, while citizens aged 65 and over are entitled to free travel (Resmi Gazete, 2014). Having the most populated old population of Turkey, Istanbul is the first city that comes to mind when this regulation is implemented. In the non-timetable program, travels are carried out with smart transportation cards, which passengers

apply to the application centers. Free transportation cards can be used in all local public transportation vehicles except express lines.

Figure 2.1. Free Transportation Card for Citizens over 65 Years Living in Istanbul (IETT).

3. METHODOLOGY

The main aim of free public transport policies for the elderly is to reduce the number of vehicles in the traffic and possible dangerous situations. The other important goal, however, is to enable individuals to maintain a more active social life. Therefore, it is important to consider the habits of old people's use of public transport and the reasons for keeping them away from using public transport. This study, which is prepared for this purpose, analyzes the travel habits of the elderly, the effect of free card application on travel habits and the accessibility effect of public transportation mode selection.

3.1. Design of the Survey

The most commonly used types of questionnaires are Revealed Preference (RP) and Stated Preference (SP) surveys. "Traditionally, analysis of preference and behavior were based on the Revealed Preference (RP) method, in which the observation was made on the existing transportation system (actual market)" (Sivakumar *et al*., 2006). SP surveys refer to asking consumers about their preferences, choices, frequencies of use, and so on, while revealed RPs refer to actual choices (Louviere and Street, 2000).

The questionnaire was designed to understand the preferences of passengers on travel choice and the influence of the accessibility factor on mode preferences. Survey questions were formed with four main sections. In the first part, questions were asked about travel behaviors of individuals using their own vehicles or public transport. The aim here is to make a general comparison about the preferences of passengers over the age of 55 who are benefiting from and not benefiting from public transportation. In the second part, beneficiaries of free public transport are being asked about past travel behaviors, while those not included in this practice are being asked about their predictions of future travel behaviors. The answers from this section help analyzing how free public transport policies have an impact on the preferences of passengers. The third part is designed to investigate the effect of the accessibility factor on

transport mode choices. In the last part, questions about the demographic characteristics of the respondents are directed.

The first part of the questionnaire is divided into different parts within itself. Citizens using their own vehicles also answer questions about the use of public transport, while non-citizens are solely responsible for questions concerning the use of public transport. In addition to this, there is a separate section for individuals' preferences for using public transportation on the weekend. The main purpose of the questions in the first part is to examine the influence of habits of individuals on ridership. In the first question, citizens are asked whether they benefit from free public transport. In the second question, the driver's license status and in the third question, the individual's own vehicle status is questioned. Other questions are selected according to the answer of these questions.

Table 3.1. First Part of the Survey.

Question		**Answer**	
1	Do you benefit from the free/discounted public transportation program?	Yes	No
		1	2
2	Do you have a driver's license?	Yes	No
		1	2
3	Do you have your own vehicle?	Yes	No
		1	2

The questions directed to those who own their vehicle were collected in question number four. These questions are; the frequency of vehicle use, the purpose of driving the vehicle, the preferred time slot in the direction of leaving home, the preferred time slot in the direction of returning home, and the region in which transportation was most carried out.

The fifth question, which consists of eight different questions in-house, is the type of question that all participants must answer, examine the public transport habits of the people and aim to find its effect on the ridership. In this section, the most common types of public transportation vehicles, the factors affecting the choice of public transportation vehicles, the frequency of use of public transportation vehicles, the purposes of public transportation usage, the time periods in which public transportation vehicles are used in the direction of going home and returning home, the factors that affect it, and the area in which public transport is most used.

Table 3.2. Questions that Measure Public Transport Usage Preferences.

Question		**Answers**				
5.1	Which one do you use the most from public transport?	Bus	Minibus	Rail systems: Metro, Marmaray, Tram	BRT (Bus Rapid Transit)	Steamboat
		1	2	3	4	5
5.2	List the factors in your selection of public transport by their importance.	Home-stop distance	Landing-boarding convenience	Speed	Comfort	Security
		1	2	3	4	5
5.3	What is your frequency of using public transport?	Once a month	Once every 2 weeks	Once a week	2-4 times a week	Every day of the week (5 times)
		1	2	3	4	5
5.4	For what purpose do you use public transport most?	Business	Sightseeing	Hospital	Shopping	Other: daily work
		1	2	3	4	5
5.5	At what time of the day do you travel with public transport in the direction of leaving the house?	06:00-10:00	10:00-13:00	13:00-16:00	16:00-20:00	20:00-00:00
		1	2	3	4	5
5.6	At what time of the day do you travel with public transport in the direction of returning home?	06:00-10:00	10:00-13:00	13:00-16:00	16:00-20:00	20:00-00:00
		1	2	3	4	5
5.7	List the factors in your selection about travel time.	Comfortable travel	Business hours	Quick access		
		1	2	3		
5.8	Which districts do you travel the most with public transport?					

The sixth question of the first section is to ask participants whether or not they use public transport on weekends. Those who answered yes to this question answered the seventh question, while those who say no go to other questions. Responses from this section are designed to examine the relationship between weekday and weekend travel behaviors. The seventh question is itself divided into six questions. These are respectively; the day or days on which the weekend of public transport is used, the purpose of using public transport, the mode to be preferred most, the period of time when public transport is used for departure and return home, and where the trips are carried out.

The second section examines past transportation habits for ages sixty-five and over, and future predictions for under sixty-five. This section, which is asked as the number eight question, consists of seven different questions. These questions are; The choice of public transportation vehicles, the frequency of use of public transportation vehicles, the use of public transportation vehicles at the weekend, the purpose of using public transportation vehicles, the time of departure from home and the direction of returning home and which zones are used the most by public transport

Section three questions are designed to examine the relationship between accessibility and mode selection. The first question concerns the transfer from metro stations to other modes of transport. The following question is aimed to determine the opinion of passengers about the use of elevators in subway stations. The ongoing question examines the effect of location of subway stations on the subway choice. BRT-related questions analyze the accessibility-preference relationship of transits and stops. In the same way, two questions were addressed to the participants in order to learn the accessibility of the ferryboats and the influence of the transfer options on the selection of this transport mode. In the last question in this section, it is tried to learn the effect of landing-boarding problems caused by crowded vehicles on the mode selection.

The final questions are asked about the demographic characteristics (gender, age, job status, level of education, and monthly income). Age and monthly income questions are directed towards numerical answers and thus net results are targeted to be collected.

Table 3.3. Questions that Examine the Impact of the Accessibility Factor on the Choice of Public Transportation Type.

Question		Answer		
9	Access to other public transport from metro stops, I find exhausting.	I agree	I am undecided	I do not agree
		1	2	3
10	I cannot use elevators comfortably in metro transportation.	I agree	I am undecided	I do not agree
		1	2	3
11	The fact that the metro stations are very in-depth are obstructing the choice of metro.	I agree	I am undecided	I do not agree
		1	2	3
12	Access to other public transport from BRT stops, I find exhausting.	I agree	I am undecided	I do not agree
		1	2	3
13	The long distance of access to BRT prevents it from being preferred.	I agree	I am undecided	I do not agree
		1	2	3
14	The long distance of access to Steamboat prevents it from being preferred.	I agree	I am undecided	I do not agree
		1	2	3
15	Access to other public transport from Steamboats, I find exhausting.	I agree	I am undecided	I do not agree
		1	2	3
16	Landing and boarding difficulties caused by crowded vehicles prevent me for choosing public transportation vehicles.	I agree	I am undecided	I do not agree
		1	2	3

3.2. Sampling Procedure

Free transportation program in Istanbul is implemented for the people over the age of 65. Additionally, bargain-priced transportation program covers the people between the age of 60 and 65. After people are included such policies, travel behavior can change. At the same time, due to the free transportation, accessibility can play a significant role on decision of transportation mode. In this study, accessibility conditions in transportation modes and travel behavior changes of people after obtaining the free or bargain-priced transportation right are investigated. Istanbul has various public transport modes such as bus, BRT, subway and ferry. In order to present impartial and correct results, selected district should be located on the whole

transportation modes. Therefore, Kadıköy is the optimal choice with the population of 145,000 (Turkstat, 2015). Due to the fact that it is necessary to represent the entire population, stratified sampling is utilized. The population is divided into homogeneous with stratified sampling, mutually exclusive groups called strata, and then independent samples are selected from each stratum. In our study, stratification variable is age. Hence, surveys are conducted to the people over the age of 55. This selection provides us to analyze future estimation of people between the age of 55 and 60 and comparing them with the people over the age of 60. That is, the method consists of two group in terms of age factor. In addition to these, stratified sampling provides us two crucial advantages. Sampling strategy becomes more efficient than other methods and research can be protected against biased samples. In order to improve the statistical efficiency of survey, the samples are selected from the locations where are close to various public transport modes. Therefore, homogeneity factor can be provided.

3.2.1. Survey Area

Located at the intersection point of Asia and Europe, Istanbul has 39 counties. In the city which has different modes in terms of transportation, new alternative transportation systems are introduced every day and solutions are sought to reduce the traffic. Istanbul, which is the city with the highest population density of Turkey, has a daily number of 12,881,300 passengers transported by public transport. While the share of highways is 77.30 percent in daily transportation, the share of railed systems is 17.85 percent and the share of sea transportation is 4.86 percent. (IETT, 2015) Unfortunately, transportation modes do not have the same accessibility for each district. Therefore, in order to make the deductions in our work more robust, it is necessary to select a district that contains all the transportation modes. The districts with all types of transportation are only Kadıköy in Anatolian side and Fatih district in European side. However, the fact that BRT connection of Fatih district is located far from the district boundaries and that the marine transportation is close to the business areas rather than the living areas of the people can prevent reliable results from being obtained. Kadıköy is preferred because it is a district with equal accessibility of citizens to all types of transportation. In addition, Kadıköy is the district where the over 55 years old citizen lives most intensively in Istanbul. Apart from this characteristic, Kadıköy is a district which does not have a high

difference with the average income level of Istanbul. In terms of gender, another demographic feature, Kadıköy is a county where the numbers of men and women are close to each other. All these features make Kadıköy the ideal district for transportation surveys.

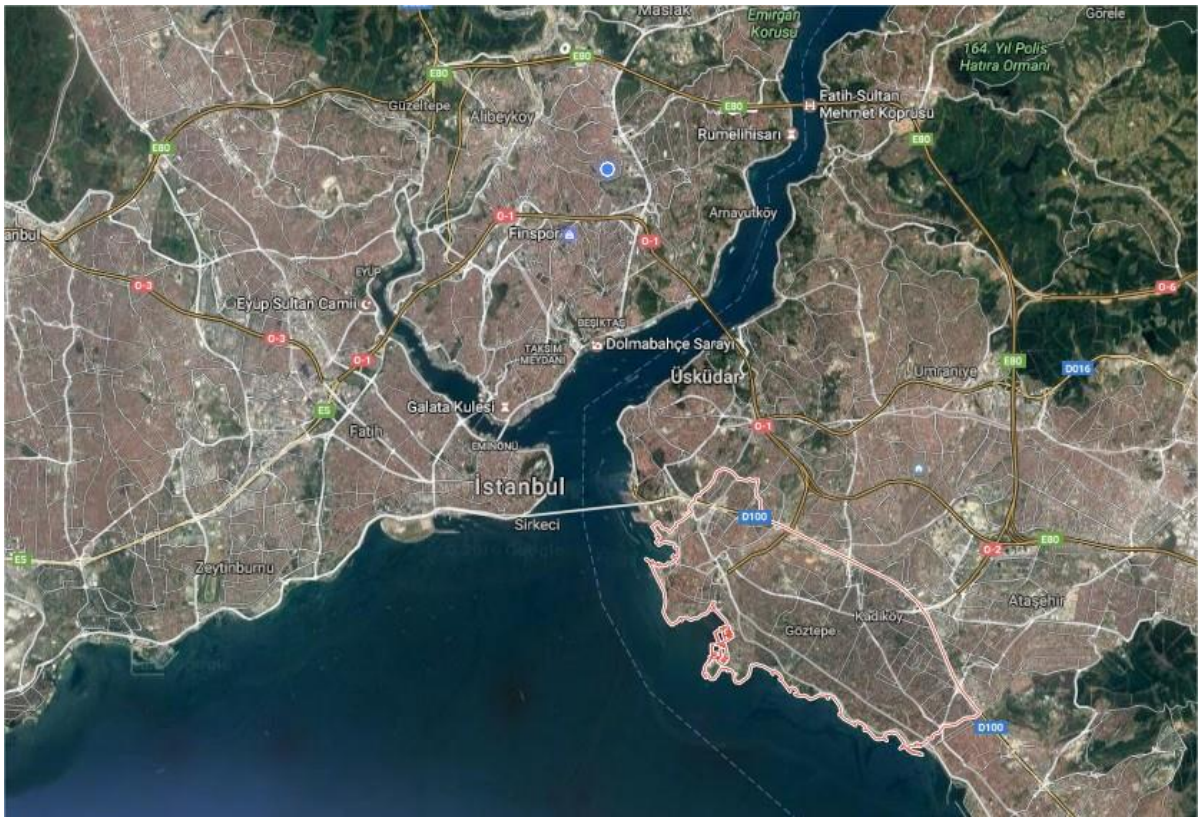

Figure 3.1. Borders of Kadıköy.

When the questionnaires are being made, it is tried to choose the regions that are close to the public transportation modes. The coastal part of Kadıköy was the area chosen for the survey because of its proximity to metro, bus and ferry scaffoldings. Söğütlüçeşme region was selected because it is the starting point of BRT line and it is a region where many minibuses and bus lines pass. In addition to all these regions, Bağdat Avenue is also selected for the survey in terms of representing inner parts of Kadıköy and having an island connection.

Figure 3.2. Survey Area.

3.2.2. Sample Size

According to Turkstat (2015), 61,445 people between 55 and 65 years old and 83,674 people over 65 years lives in Kadıköy.

Table 3.4. Target Population.

	Population	
District	**55-65**	**Over 65**
Kadıköy	61,445	83,674
Istanbul	1,134,462	912,042

Formulation in order to calculate Sample Size is given below (Stopher and Meyburg, 1979):

$$n_0 = \left(\frac{{Z_\alpha}^2}{D^2}\right) p(1-p) \tag{3.1}$$

n_0= sample size

λ= confidence level (0.90 for our study)

D= desirable maximum error for p (0.05 for our study)

p= percentage picking a response (0.30 for our study) (145.119/482.571=0.30)

Z_α= confidence interval for chosen λ (1.65 for λ=0.90)

$$n_0 = \left(\frac{1{,}65^2}{0.05^2}\right) 0.30(1-0.30) \tag{3.2}$$

$$n_0 = 228.69 \tag{3.3}$$

Final required sample size is given below:

$$n = \left(\frac{n_0}{1+(\frac{n_0}{N})}\right) \tag{3.4}$$

N: population (145,119 for seniors in Kadıköy)

$$n = \left(\frac{228.69}{1+(\frac{228.69}{145,119})} \right) = 228.330 \qquad (3.5)$$

In order to collect more accurate result, selected sample size for our study is 230. Furthermore, sample size should be divided properly for stratified sampling.

Table 3.5. Calculations for Stratified Sampling.

Age Group	**Number of People in Strata**	**Number of People in Sample**
55-65	61,445	(230/145,119)*61,445=97
65+	83,674	(230/145,119)*83,674=133

3.2.3. Data Collection

In order to collect data, Interviewer-assisted method is used. However, this method is divided into two categories; personal interviews and telephone interviews. In this study, the audience is seniors and this situation causes some disadvantages. For instance, if the elderly try to answer survey questions on their own, they cannot understand what the question asks them exactly. In this case, answers will not be confidential. In addition to reliability, response rate is a crucial factor for surveying. Due to the lack of confidence of the elderly, completing the survey with seniors can be difficult. For this reason, response rate can be low. Furthermore, another important problem in surveys is time consuming. If the questionnaire is made by the way of telephone or self-enumeration methods, surveys with aged people take a long time. In the face of these disadvantages in conducting a poll with seniors, personal interview is the best choice in all sampling methods. By means of the face to face communication method, respondents can understand questions easily and personal interview increase response rate. Hence, personal interview enables us to collect more reliable results and quality of research increases.

3.3. Modeling Methods

In our study, travel behavior is analyzed from different angles. The first goal is to reveal the differences and similarities by analyzing the travel behavior of those who benefit from and do not benefit from discounted or free travel. Another goal, however, is to analyze the similarities and differences in travel behavior between individuals using their own vehicles and using public transport. Thirdly, it is aimed to determine similarities and differences between passengers' weekend and weekday travel behaviors. In the fourth part, it is aimed to compare the past habits of the individuals benefiting from free-discount transportation with the travel behaviors of those who do not benefit. In addition to this, the opposite is aimed (those who do not benefit from free-discount transportation are predicting future travel habits and the comparison of travel habits of those who already enjoy free transportation). Another and last objective is to examine the relevance of accessibility questions by grouping options such as demographic characteristics, use of public transport, frequency, time zone chosen for daytime transportation, and modes of transport. When all these studies are done; t-test, Anova and Multiple regression are used.

T-test is the most commonly used method in hypothesis testing. The t-test is used to compare the mean of the two groups and it is decided whether the difference is coincidental or not statistically significant. There are three types of t-test. These are one-sample t-test, independent samples t-test, and paired-samples t-test. The preferred t-tests in our study are independent samples t-test. In research, it is often necessary to make comparisons between groups obtained from different mainstream. Such analyzes are done by independent samples t-test. For example; the independent samples t-test is used to analyze the relationship between the use of public transport at the weekend of passengers who benefit from and do not benefit from the free transport program.

For t-test, calculations are made with following formulas (Walpole *et al.*, 2012):

$$t = \frac{\bar{x}1 - \bar{x}2}{\sqrt{\frac{{s_1}^2}{n1} + \frac{{s_2}^2}{n2}}} \tag{3.6}$$

Where,

$\bar{x}_1$ = Mean of first set of values

$\bar{x}_2$ = Mean of second set of values

S_1 = Standard deviation of first set of values

S_2 = Standard deviation of second set of values

n_1 = Total number of values in first set

n_2 = Total number of values in second set.

$$S = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \tag{3.7}$$

Where,

x = Values given

$\bar{x}$ = Mean

n = Total number of values.

By t-test it is possible to examine only the differences between the two groups. However, in many cases, it is often necessary to compare two or more groups. This is where the t-test is inadequate in situations where more than one group needs to compare one another with another. One-way analysis of variance is the most commonly used type of analysis in such cases. ANOVA is used to analyze whether or not the mean of group variables on a dependent variable significantly differed. For example; 'Is education level an important variable on the purpose of using public transport?' The answer to the question can be taken by ANOVA. If the education level had been divided into two groups, that is to say if it was two variants, the t-test could be used. In other words, t-test can be used when examining the effect of gender (male, female) on the intended use of public transport. When constructing an ANOVA table, it is also necessary to know the concepts of dependence and factor. In the previous example, the dependent variable is the intention to use public transport and the factor is education. There are two important criteria when creating an ANOVA table. The data should be normally distributed and homogeneous. However, even if the data are not homogeneous, an ANOVA table can be created by selecting from the options available for non-homogeneous data in Post-Hoc part.

For Anova, calculations are made with following formulas (Walpole *et al.*, 2012):

$$F = \frac{MST}{MSE} \tag{3.8}$$

where,

F = Anova Coefficient

MST = Mean sum of squares due to treatment

MSE = Mean sum of squares due to error.

$$MST = \frac{SST}{p-1} \tag{3.9}$$

$$SST = \sum n(x - \bar{x})^2 \tag{3.10}$$

where,

SST= Sum of squares due to treatment

p = Total number of populations

n = Total number of samples in a population.

$$MSE = \frac{SSE}{N-p} \tag{3.11}$$

$$SSE = \sum(n-1)S^2 \tag{3.12}$$

where,

SSE = Sum of squares due to error

S = Standard deviation of the samples

N = Total number of observations.

In all these analysis methods, the relations between variables are examined. In the multiple regression analysis, the coefficients of relations between a dependent variable and several independent variables are found. For example; 'How much is the choice of public transport mode

affected by using the free transportation program?' The answer to the question is found by Multiple Regression.

For Multiple Regression, calculations are made with following formulas (Walpole *et al.*, 2012):

$$\hat{\beta} = \frac{n\sum XiYi - (\sum Xi)(\sum Yi)}{n\sum Xi^2 - (\sum Xi)^2} \quad (3.13)$$

$$\hat{\alpha} = \bar{Y} - \beta\bar{X} \quad (3.14)$$

Where;

Xi, Yi: Actual observations for i= 1, n observations

$\hat{\beta}, \hat{\alpha}$: The estimates of the coefficients

4. ANALYSIS AND RESULTS

290 surveys were conducted, of which 230 were considered appropriate. 134 of the questionnaires belong to those who use the free transportation program, and 96 belong to those who do not use this program.

Table 4.1. Distribution of Free Transportation Program Utilization.

Validty	Frequency	Percent
Yes	134	58.3
No	96	41.7
Total	230	100.0

Participants' driver status, own vehicle status, and weekend travel frequency and percentages are shown in the Table 4. 2.. According to the results, 61.9 percent of citizens over 65 years of age have a license, but only 20.1 percent own their vehicle. 67.7 percent of the citizens aged between 55-65 have a driver's license and 37.5 percent have their own vehicle. According to this, over age 65 people prefer public transportation instead of using their own vehicles. In addition, 76 percent of individuals aged between 55 and 65 and 53 percent of individuals aged 65 or older do not travel on weekends.

Table 4.2. Distribution of Responses to General Questions in the Survey.

General Questions		Frequency			Percent		
		Between 55-65 years	**Over 65 years**	**Total**	**Between 55-65 years**	**Over 65 years**	**Total**
Driving License	**Yes**	65	83	148	67.7	61.9	64.3
	No	31	51	82	32.3	38.1	35.7
Own Car	**Yes**	36	27	63	37.5	20.1	27.4
	No	60	107	167	62.5	79.9	72.6
Weekend Trip	**Yes**	23	63	86	24	47	37.4
	No	73	71	144	76	53	62.6

The distribution of answers to demographic questions is given in Table 4.3.. The proportion of employees is 65.6 per cent in the 55-65 age group and 6.7 per cent in the over 65 age group. The reason for this change can be thought of as the retirement age being 65 years old. In addition, in terms of education level, the highest rate in both groups belongs to high school graduates. This situation is parallel to the data of the Turkish Statistical Institute. The income level of individuals aged between 55 and 65 is more than 4000 TL. The same situation is observed for income distribution over the age of 65 years. The income level is equally distributed over the age of 65, but it is concentrated over 4000 TL for those under 65 years of age. This may be because the number of employees is high between the ages of 55 and 65 and the working conditions are different.

Table 4.3. Frequencies of Demographic Variables.

Demographic Variables		**Frequency**			**Percent**		
		Between 55-65 years	**Over 65**	**Total**	**Between 55-65 years**	**Over 65**	**Total**
Sex	**Woman**	50	40	90	52.1	29.9	39.1
	Man	46	94	140	47.9	70.1	60.9
Age	**55-65**	96	0	96	100	0	41.7
	65+	0	134	134	0	100	58.3
Work	**Yes**	63	9	72	65.6	6.7	31.3
	No	33	125	158	34.4	93.3	68.7
Education	**Elementary**	25	55	80	26	41	34.8
	High Sc.	40	52	92	41.7	38.8	40
	Faculty	31	27	58	32.3	20.1	25.2
Income	**0-2000**	5	33	38	5	24.6	17
	2000-3000	17	31	48	18	23.1	21
	3000-4000	22	34	56	23	25.4	24
	4000+	52	36	88	54	26.9	38

Monthly income information was taken numerically from the participants. That's why the number of categories is higher. The following chart (Figure 4.1.) is prepared to examine more detailed results in order to better understand the income distribution.

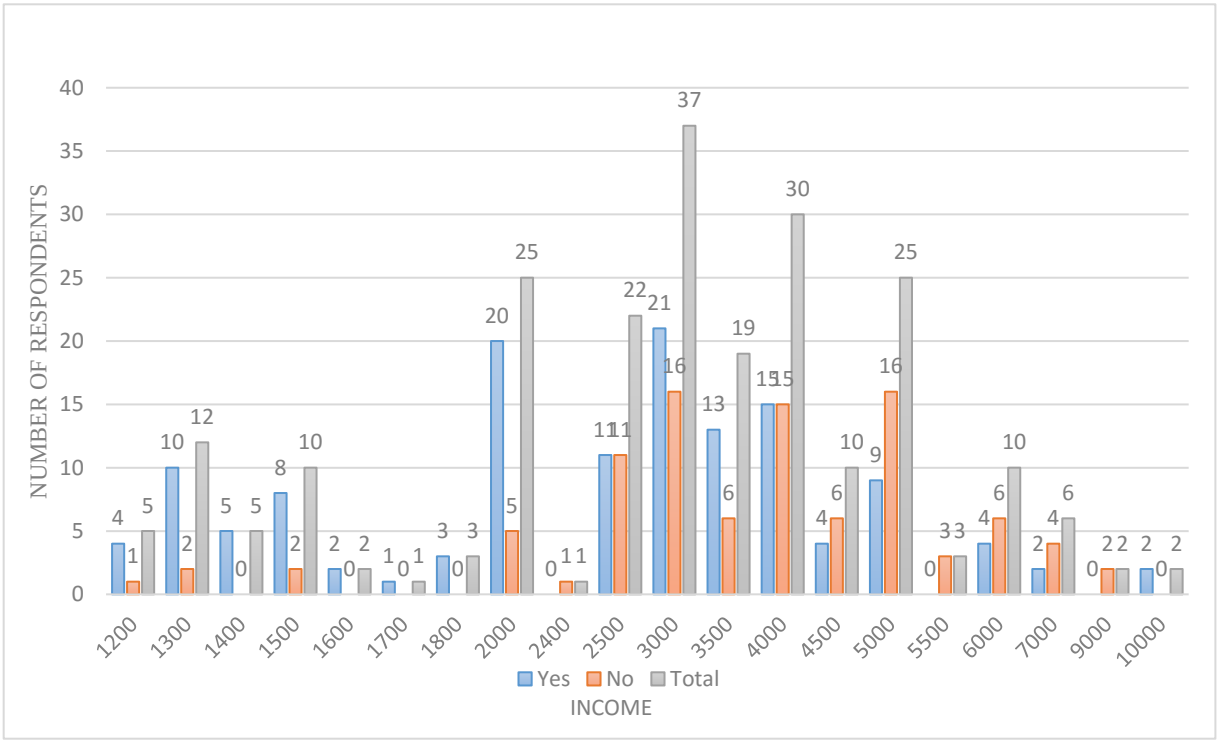

Figure 4.1. Income Distribution.

The Figure 4.2. shows a comparison of the mode preferences of those who benefit from and do not benefit from the free transport program. According to the results, those who use the free transportation program prefer to use buses, followed by rail systems and ferry trips. The least preferred is a minibus. This may be because the minibuses are excluded from the free transportation program. On the other hand, it is seen that those who do not benefit from the free transportation program have a normal distribution in transportation type selection. Unlike individuals over 65 years of age, the most preferred type of transportation for individuals in this group is railed systems. This is followed by minibus, bus, BRT and ferries respectively. Here, it can be interpreted that paying for all vehicle models does not separate the choice of minibus

from other transport vehicles. Moreover, the fact that the number of employees is high in this group can also be considered as influencing this situation.

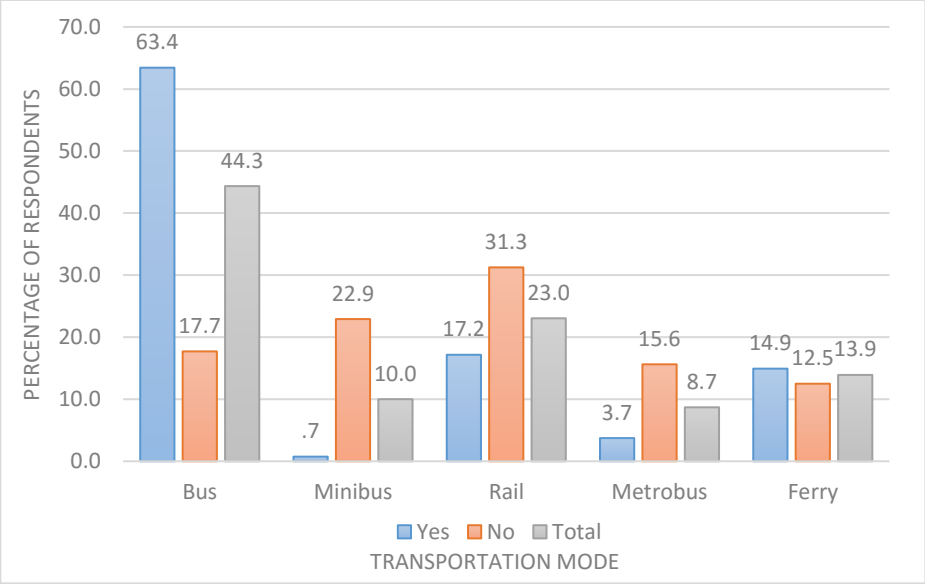

Figure 4.2. Distribution of Public Transport Mode Choice.

Figure 4.3. gives the distribution of the most important factors in the selection of public transport among the groups. According to these results, while the individuals over 65 years indicated that the home stop distance is effective in selecting public transportation types, the other group shows that speed factor plays an important role in transportation type selection. This may be due to differences in the number of employees in the groups and time constraints depending on the work situation.

Another analysis result relates to the frequency of use of public transport. According to these results, the vast majority of those who use the free transportation program use the public transport 2-4 times a week, while the vast majority of those who do not benefit from the free transportation program use it every day. While a small proportion of individuals over the age of 65 indicated that they use public transport every day, a small proportion of individuals between the ages of 55 and 65 stated that they use public transportation once every two weeks.

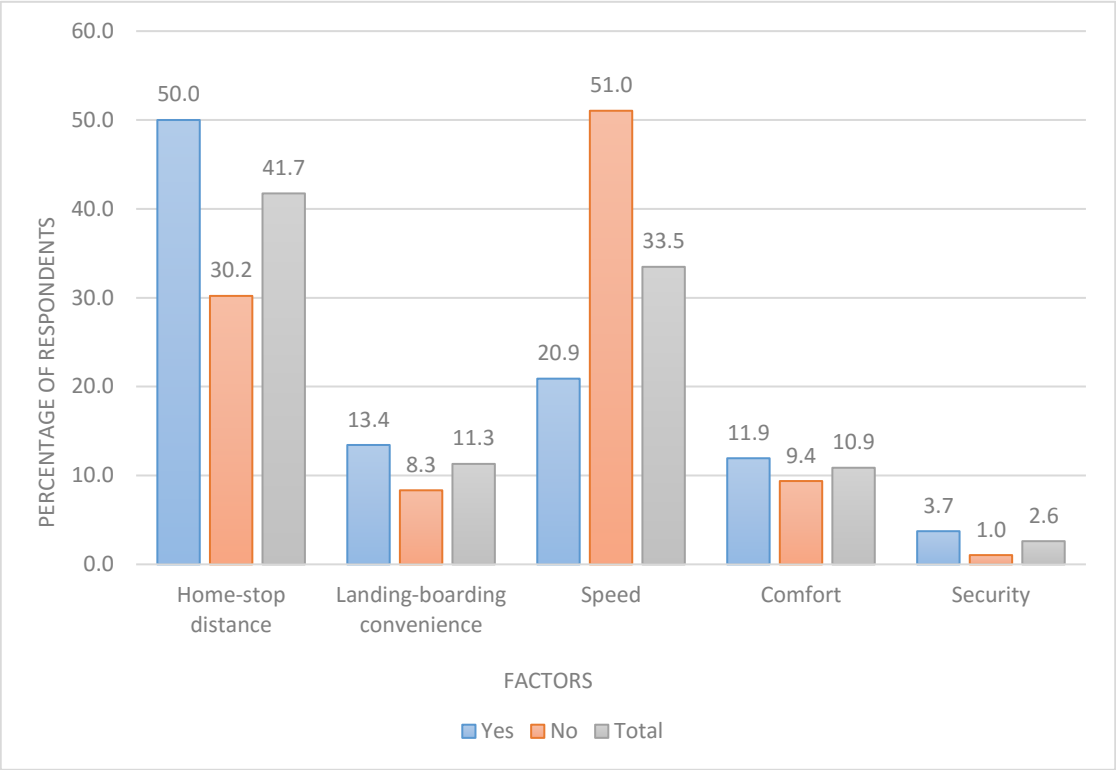

Figure 4.3. Distribution of Factors in the Selection of Public Transport Mode.

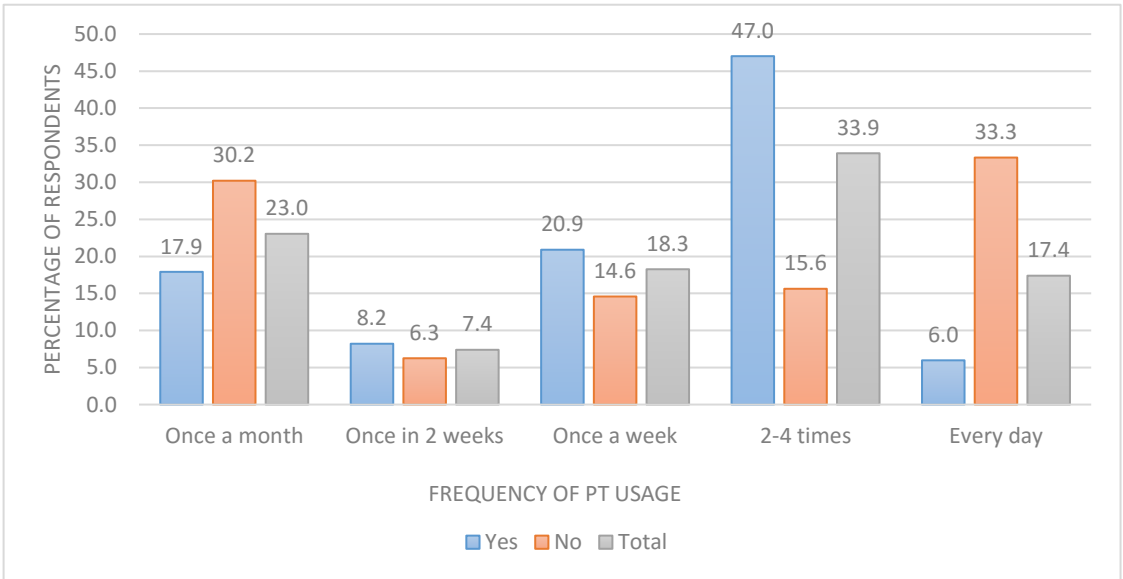

Figure 4.4. Distribution of Frequency of Public Transport Usage.

In the Figure 4.5., individuals' public transport purposes are shown. While the vast majority of individuals over the age of 65 indicated that they use public transport for leisure purposes, the individuals in the other group indicate that they use public transport for business the most. While individuals over the age of 65 use public transportation for work at least, individuals under 65 indicate that they use it for the hospital at least. In the survey period, it was the point most frequently mentioned by the participants that individuals used their own vehicles, taxi or relatives' vehicles in urgent situations such as hospitals.

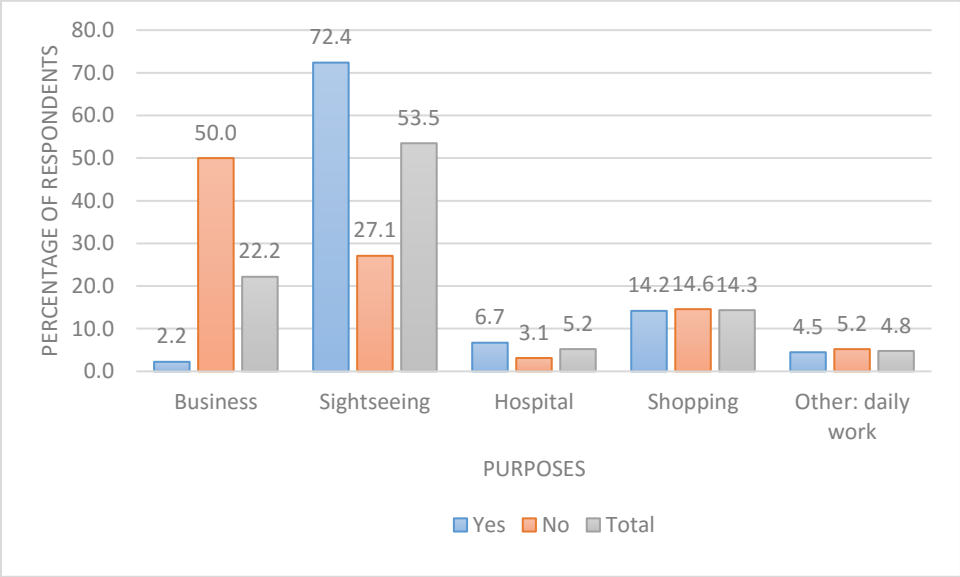

Figure 4.5. Distribution of Purposes of Public Transport Usage.

The choice of time slots for passengers to leave the house also shows differences between the two groups. While 82.1 percent of individuals over 65 years old say that they leave home from 10:00 to 13:00, half of the under 65s indicate that they leave the home between 06:00 and 10:00.

The most frequently used time period for participants to return home is 16:00 to 20:00 for the total and under 65 years, and 13:00 to 16:00 for those over 65 years. However, a significant number of citizens over the age of 65 are returning home from 16:00 to 20:00. The number of

passengers in the vehicle is also high during this time when traffic is the busiest. These results also reflect this situation.

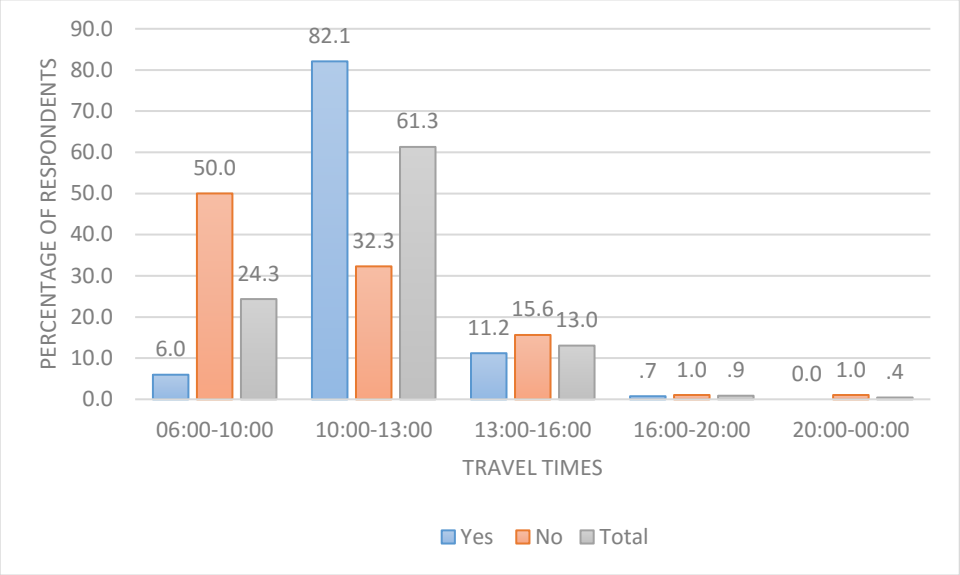

Figure 4.6. Distribution of Time Slots for Departure from Home.

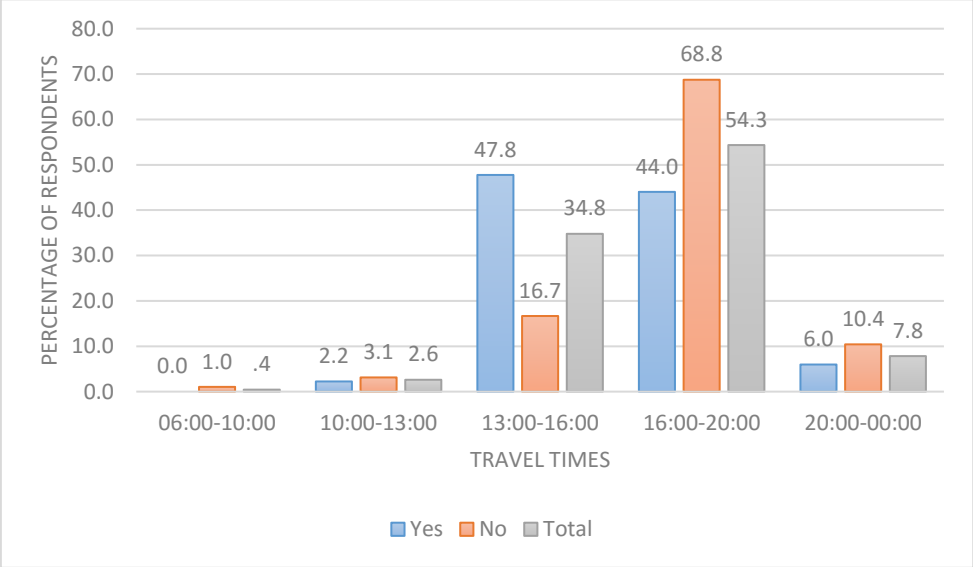

Figure 4.7. Distribution of Time Slots for Arriving Home.

The following Figure 4.8. compares the factors of preference of transportation hours, while under 65 people indicate that business hours affect their hourly choices, followed by rapid transportation and convenient travel respectively. For individuals over 65 years old, the most important factor is the comfortable travel, followed by rapid transportation and the least effective factor is shown as working hours. These results are also consistent with previous results. As individuals between the ages of 55 and 65 work in general, they may have chosen their working hours as the most important factor. Participants over the age of 65 may have indicated that the option of working hours has the least impact on them, as the vast majority are retiring.

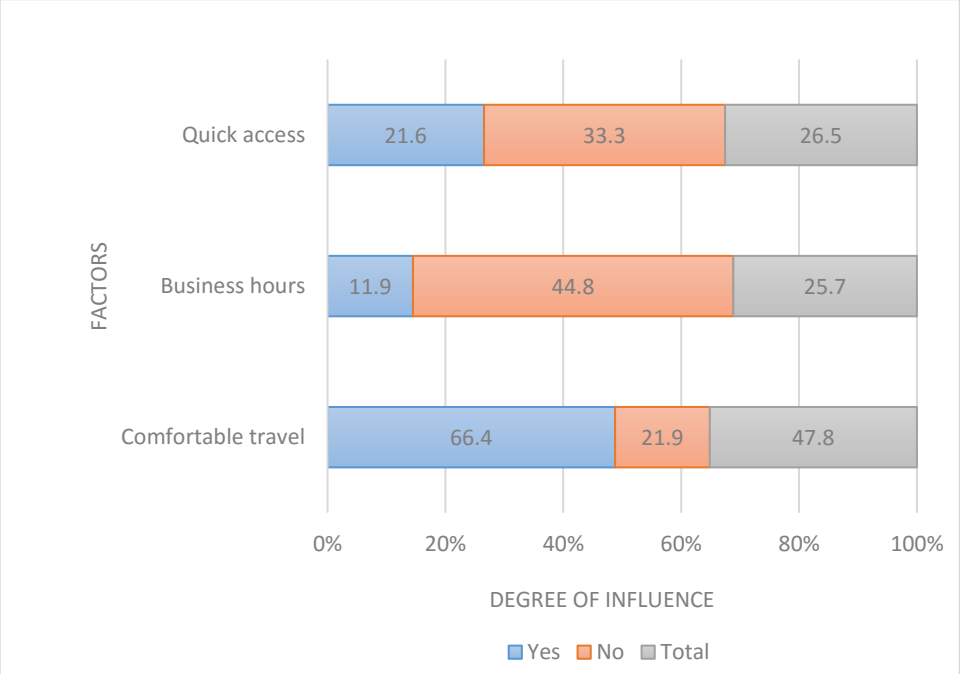

Figure 4.8. The Factors That Effected Selection of Transportation Hours.

The Figure 4.9. shows the distribution of the regions where participants perform their trips. While individuals aged 65 and over most traveled in Kadıköy, individuals under the age of 65 are mostly moving to the European side. The remarkable result is that the over 65-year-olds have a higher travel intensity to the nearby cities. In total, the number of people traveling in and

around Kadıköy is equal. These regions are followed by Usküdar, Umraniye and Maltepe respectively.

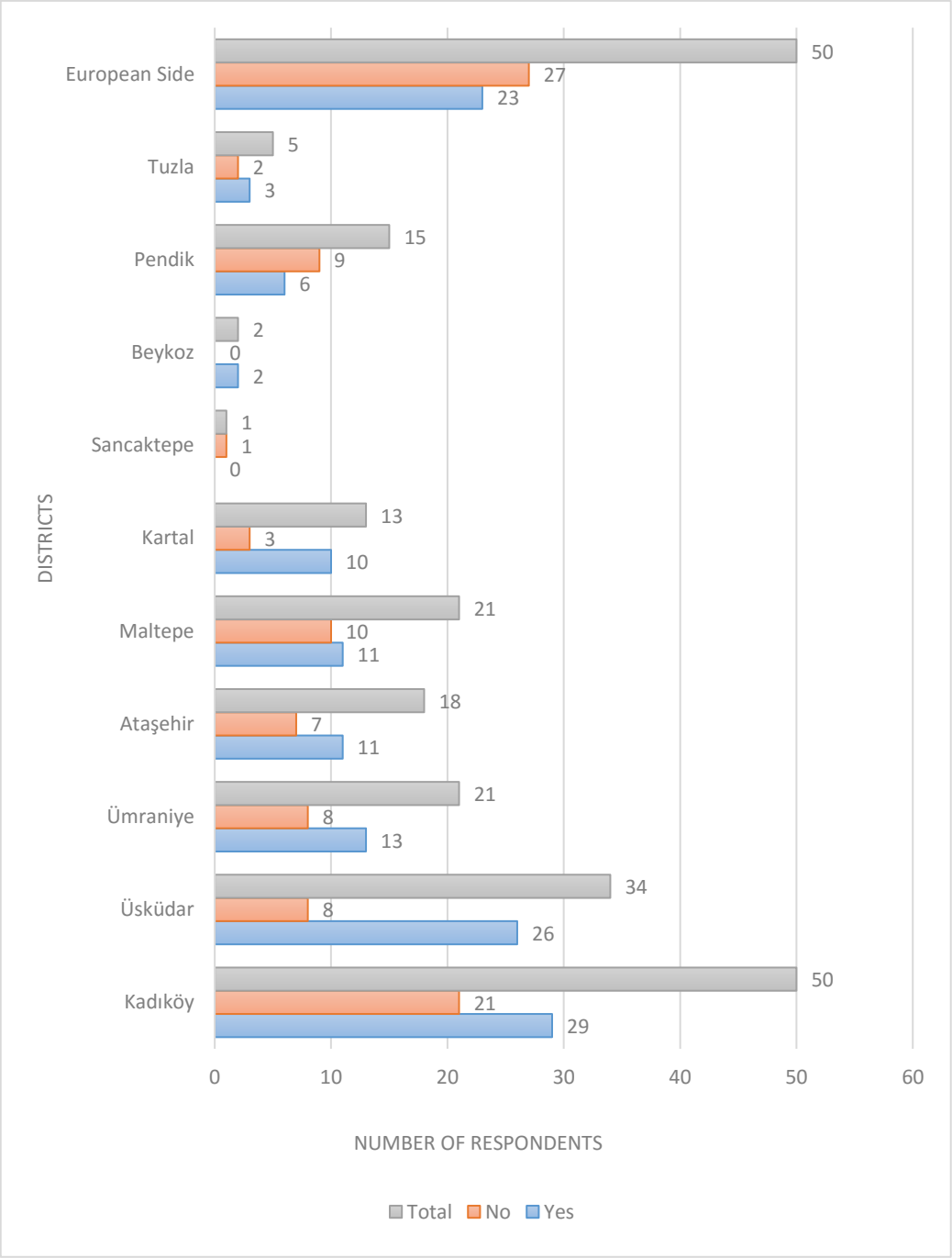

Figure 4.9. The Distribution of the Travelled Regions.

In our survey, another section outside public transportation was prepared to analyze the travel behavior of individuals using their own vehicles. The distributions of the individuals using their own vehicle are shown in the Figure 4. 10.. According to this graph, 62.9 percent of individuals under 65 years of age use their own vehicles on weekdays, while 33.3 percent of individuals over 65 years use their own vehicles 2-4 times a week. Another remarkable point is that the travel frequency of the participants' own vehicles is high. This includes differences when compared to the frequency of public transport use.

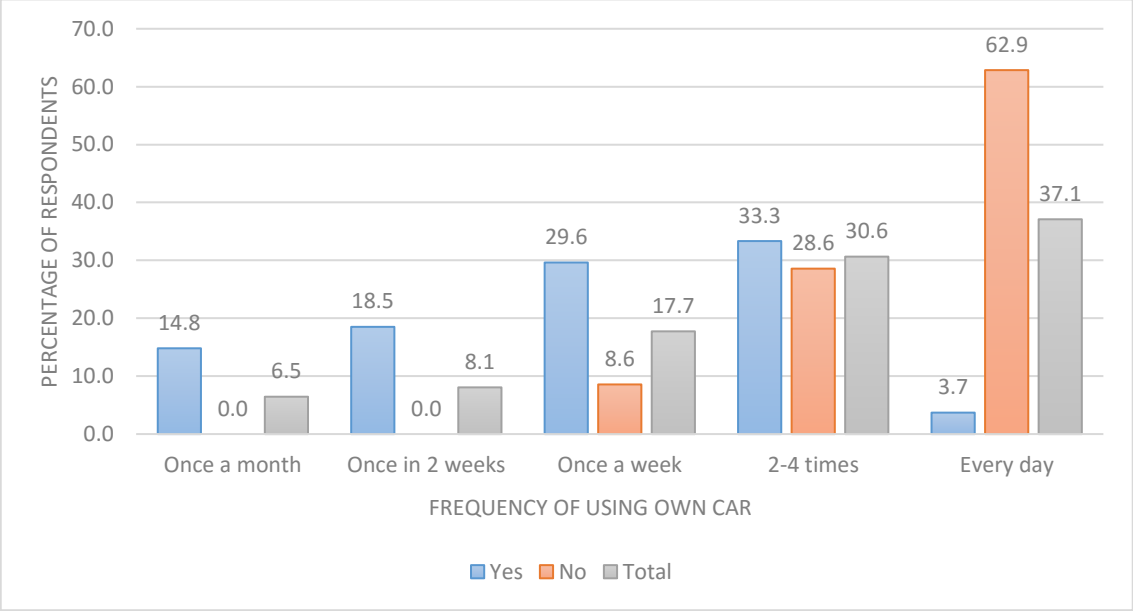

Figure 4.10. The Distribution of the Using Own Car.

The vast majority of individuals under the age of 65 who use their own vehicle indicate that they are traveling for work, while individuals over the age of 65 use their own vehicles for sightseeing purposes. Secondly, over 65-year-olds are bombarded with their own cars to go to the hospital the most. This explains less hospital response in the results of the previous chart. When individuals feel tired and sick, they do their jobs through their own cars or with the help of family members.

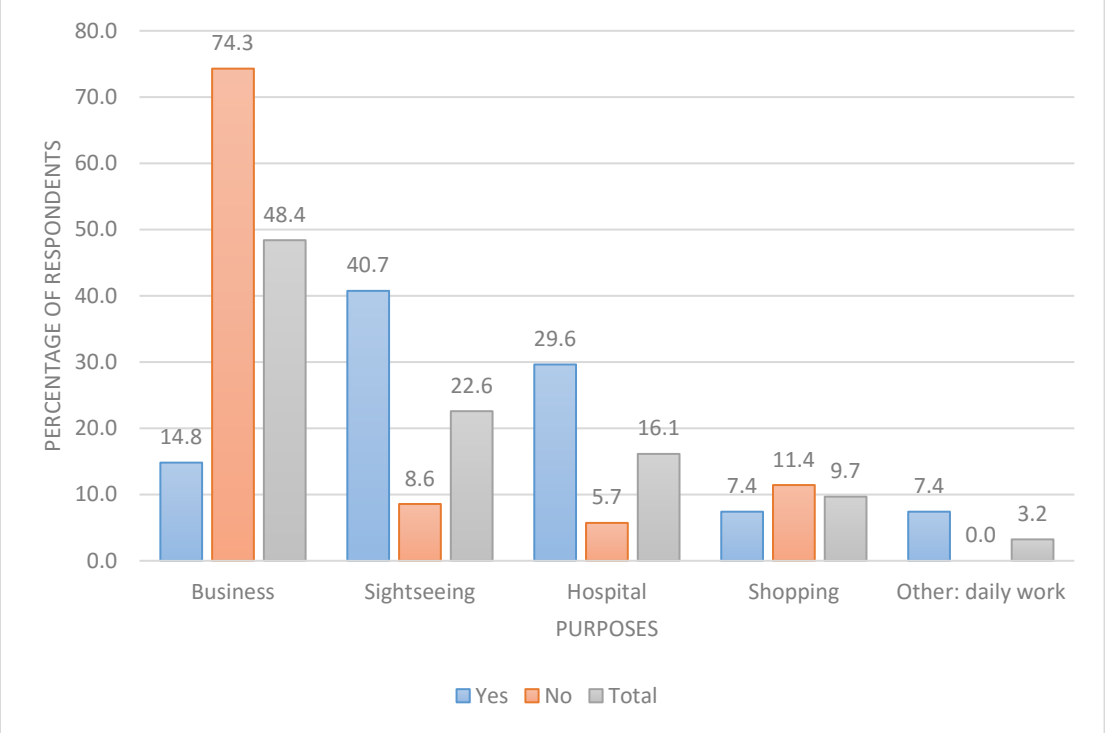

Figure 4.11. The Distribution of the Purpose of Using Own Car.

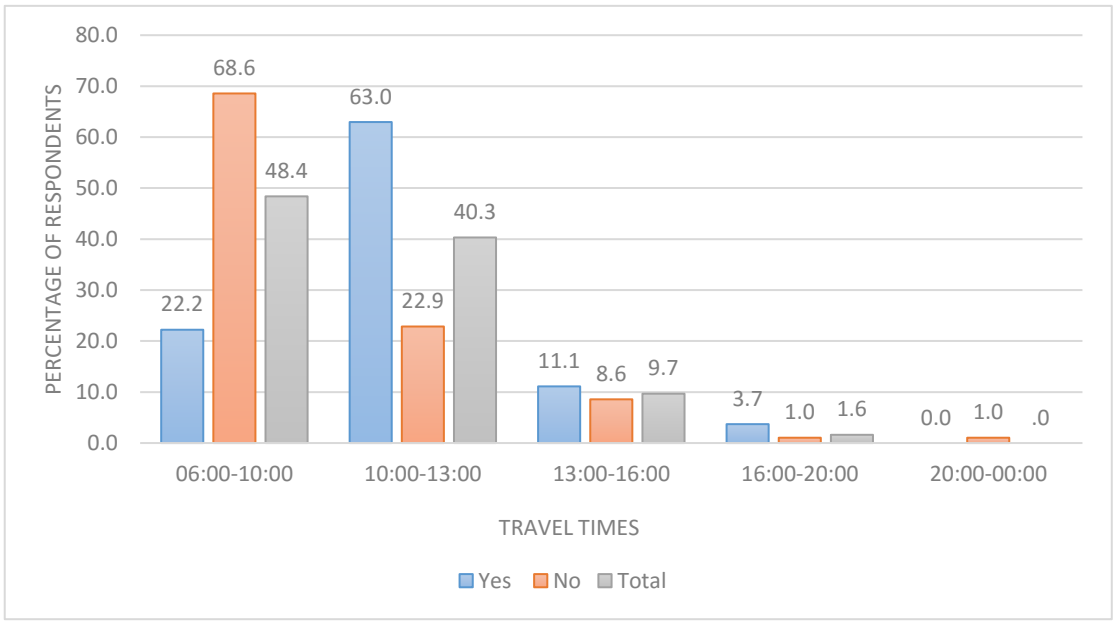

Figure 4.12. Distribution of Time Slots for Departure from Home by Personal Vehicle.

Distribution of departure times of individuals using their own vehicles is shown in the graphic. According to this chart, under the age of 65, when the morning traffic is the busiest, the individuals use their own vehicle. While those over 65 years of age prefer the time period of 10:00-13:00, where traffic is often less. Here again, it is possible to mention the effect of working hours, considering that the vast majority of individuals who use their own vehicles use their own vehicles for business purposes. In another graph (Figure 4.13.), the time interval for returning home is shown for those who use their own vehicle. According to the results obtained here, both groups carry out their own journeys at times when traffic is intense.

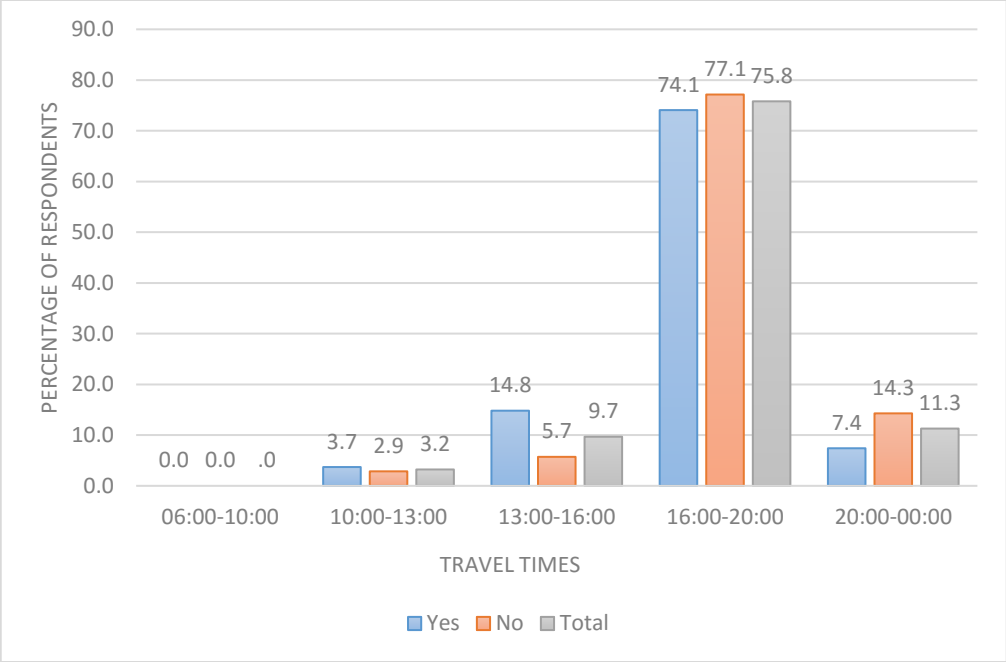

Figure 4.13. Distribution of Time Slots for Arriving Home by Personal Vehicle.

The Table 4.4. shows the results of the analysis for the use of public transportation vehicles at the weekend. According to the results, both groups travel mostly on Sundays, and the majority of the two groups use public transport for sightseeing. Individuals older than 65 years prefer to travel by bus, while individuals under 65 prefer buses, minibuses and ferry models at equal rates. Both groups leave home from 10:00 to 13:00 hours, while both groups return home between 16:00 and 20:00. The two groups are mostly visiting the Asian neighborhoods.

Table 4.4. Frequencies of Travel Behavior at Weekend.

		Frequencies		
Variables		**65+**	**55-65**	**Total**
Travel Days	**Saturday**	28.6	34.8	30.2
	Sunday	57.1	56.5	57.0
	Both	14.3	8.7	12.8
Purpose	**Sightseeing**	74.6	65.2	72.1
	Shopping	25.4	34.8	27.9
Mode	**Bus**	68.3	26.1	57.0
	Minibus	4.8	26.1	10.5
	Rail systems	6.3	13.0	8.1
	BRT	0.0	8.7	2.3
	Ferry	20.6	26.1	22.1
Travel Times for Leaving Home	**06:00-10:00**	1.6	4.3	2.3
	10:00-13:00	73.0	78.3	74.4
	13:00-16:00	23.8	17.4	22.1
	16:00-20:00	1.6	0.0	1.2
	20:00-00:00	0.0	0.0	0.0
Travel Times for Arriving Home	**06:00-10:00**	0.0	0.0	0.0
	10:00-13:00	0.0	0.0	0.0
	13:00-16:00	28.6	34.8	30.2
	16:00-20:00	65.1	60.9	64.0
	20:00-00:00	6.3	4.3	5.8
District	**Asian Side**	79.0	65.2	75.3
	European Side	21.0	34.8	24.7

Utilizing the free public transport program explains two different situations. Since these two conditions are independent of each other, it is appropriate to compare them with the independent samples t-test. The results of the t-test analysis are shown below (Table 4.5.). If the significance value is greater than 0.1 (because the confidence interval is selected as 90%), it is understood that the variable is homogeneous. So, the first line of sig (2-tailed) is interpreted.

According to the results, the significance value of Time Slot Selection Factors-2 is 0.345, which is greater than 0.1, and this variable is homogenous. That's why the first line is checked. The significance value in the first line is 0.929, which is greater than 0.1, so taking advantage of the free transport program has no significant effect on the second factor in travel time selection. However, contrary to this situation, the significance values for all other public transport travel behaviors are lower than 0.1. Because they are not homogeneous, the second significance value is looked up in sig. (2-tailed).

According to the results, the use of free transportation program has a significant effect on variables such as ‘Public Transport Type’, ‘Factors in the Selection of Public Transport-1’, ‘Factors in the Selection of Public Transport-2’, ‘Factors in the Selection of Public Transport-3’, ‘Factors in the Selection of Public Transport-4’, ‘Purpose of Using Public Transport’, ‘Time Slot for Departure from Home’, ‘Time Slot for Arriving Home’, ‘Time Slot Selection Factors-1’, ‘Time Slot Selection Factors-3’ and ‘Public Transport Districts’.

The Table 4.6. in which the gender factor's effect on travel behaviors is examined by independent samples t-test shows that all items are homogeneous except for 'Factors in the Selection of Public Transport-4', 'Purpose of Using Public Transport' and 'Time Slot Selection Factors-2'. The gender factor has an influence only on 'Factors in the Selection of Public Transport-4' from nonhomogeneous variables. When the homogeneous factors are examined, only the effect of the gender factor on 'Time Slot for Arriving Home'.

The following Table 4.7. is created as a result of analyzing the effect of employment status on public transport usage by independent samples t-test. According to this table, except for 'Time Slot Selection Factors-2', the other items are not distributed homogeneously. Thus, in the significance (2-tailed) section, the second part of the value is looked up. All items except the variables 'Factors in the Selection of Public Transport-4', 'Factors in the Selection of Public Transport-5' and 'Time Slot Selection Factors-2' are significantly affected by the work situation factor.

Table 4.5. Independent Samples T-Test for Free Transport Program Usage Factor.

Variables		Levene's Test		t-test
		F	Sig.	Sig. (2-tailed)
Public Transport Type	Equal variances assumed	11.576	.001	.000
	Equal variances not assumed			.000
Factors in the Selection of Public Transport-1	Equal variances assumed	3.676	.056	.019
	Equal variances not assumed			.016
Factors in the Selection of Public Transport-2	Equal variances assumed	6.112	.014	.000
	Equal variances not assumed			.000
Factors in the Selection of Public Transport-3	Equal variances assumed	15.017	.000	.008
	Equal variances not assumed			.010
Factors in the Selection of Public Transport-4	Equal variances assumed	5.156	.024	.006
	Equal variances not assumed			.007
Factors in the Selection of Public Transport-5	Equal variances assumed	16.648	.000	.976
	Equal variances not assumed			.977
Frequency of Using Public Transport	Equal variances assumed	26.280	.000	.971
	Equal variances not assumed			.972
Purpose of Using Public Transport	Equal variances assumed	7.523	.007	.001
	Equal variances not assumed			.002
Time Slot for Departure from Home	Equal variances assumed	73.383	.000	.000
	Equal variances not assumed			.000
Time Slot for Arriving Home	Equal variances assumed	5.880	.016	.001
	Equal variances not assumed			.001
Time Slot Selection Factors-1	Equal variances assumed	7.017	.009	.000
	Equal variances not assumed			.000
Time Slot Selection Factors-2	Equal variances assumed	.897	.345	.929
	Equal variances not assumed			.929
Time Slot Selection Factors-3	Equal variances assumed	13.181	.000	.000
	Equal variances not assumed			.000
Public Transport Districts	Equal variances assumed	6.759	.010	.033
	Equal variances not assumed			.036

Table 4.6. Independent Samples T-Test for Sex Factor.

Variables		Levene's Test		t-test Equality of Means
		F	**Sig.**	**Sig. (2-tailed)**
Public Transport Type	Equal variances assumed	.593	.442	.168
	Equal variances not assumed			.166
Factors in the Selection of Public Transport-1	Equal variances assumed	.099	.753	.504
	Equal variances not assumed			.500
Factors in the Selection of Public Transport-2	Equal variances assumed	1.337	.249	.284
	Equal variances not assumed			.288
Factors in the Selection of Public Transport-3	Equal variances assumed	.454	.501	.489
	Equal variances not assumed			.492
Factors in the Selection of Public Transport-4	Equal variances assumed	3.357	.068	.054
	Equal variances not assumed			.061
Factors in the Selection of Public Transport-5	Equal variances assumed	.632	.427	.832
	Equal variances not assumed			.833
Frequency of Using Public Transport	Equal variances assumed	1.782	.183	.112
	Equal variances not assumed			.108
Purpose of Using Public Transport	Equal variances assumed	6.458	.012	.098
	Equal variances not assumed			.102
Time Slot for Departure from Home	Equal variances assumed	2.184	.141	.909
	Equal variances not assumed			.912
Time Slot for Arriving Home	Equal variances assumed	.212	.646	.049
	Equal variances not assumed			.047
Time Slot Selection Factors-1	Equal variances assumed	.029	.864	.139
	Equal variances not assumed			.143
Time Slot Selection Factors-2	Equal variances assumed	8.429	.004	.197
	Equal variances not assumed			.212
Time Slot Selection Factors-3	Equal variances assumed	2.046	.154	.798
	Equal variances not assumed			.794
Public Transport Districts	Equal variances assumed	1.612	.206	.877
	Equal variances not assumed			.879

Table 4.7. Independent Samples T-Test for Business Factor.

Variables		Levene's Test		t-test
		F	Sig.	Sig. (2-tailed)
Public Transport Type	Equal variances assumed	13.710	.000	.000
	Equal variances not assumed			.000
Factors in the Selection of Public Transport-1	Equal variances assumed	10.502	.001	.012
	Equal variances not assumed			.006
Factors in the Selection of Public Transport-2	Equal variances assumed	4.111	.044	.000
	Equal variances not assumed			.000
Factors in the Selection of Public Transport-3	Equal variances assumed	16.356	.000	.002
	Equal variances not assumed			.004
Factors in the Selection of Public Transport-4	Equal variances assumed	7.103	.008	.189
	Equal variances not assumed			.213
Factors in the Selection of Public Transport-5	Equal variances assumed	9.765	.002	.322
	Equal variances not assumed			.343
Frequency of Using Public Transport	Equal variances assumed	48.536	.000	.160
	Equal variances not assumed			.223
Purpose of Using Public Transport	Equal variances assumed	2.936	.088	.000
	Equal variances not assumed			.000
Time Slot for Departure from Home	Equal variances assumed	32.130	.000	.000
	Equal variances not assumed			.000
Time Slot for Arriving Home	Equal variances assumed	49.762	.000	.000
	Equal variances not assumed			.000
Time Slot Selection Factors-1	Equal variances assumed	29.842	.000	.000
	Equal variances not assumed			.000
Time Slot Selection Factors-2	Equal variances assumed	.010	.922	.271
	Equal variances not assumed			.270
Time Slot Selection Factors-3	Equal variances assumed	6.212	.013	.000
	Equal variances not assumed			.000
Public Transport Districts	Equal variances assumed	4.253	.040	.001
	Equal variances not assumed			.001

The t-test cannot be applied on the level of education because the educational status is a multiple-choice variable. Therefore, analysis with Anova is necessary. If the significance values are less than 0.1 according to the following ANOVA table, then public transport characteristics differ according to education level. The answers to the 'Factors in the Public Transport-1',

'Factors in the Selection of Public Transport-2', 'Factors in the Selection of Public Transport-5' 'Public Transport Districts' options vary according to the level of education of the individuals.

Table 4.8. Anova Table for the Factor ‘Education Level’.

Variables	F	Sig.
Public Transport Type	11.927	.000
Factors in the Selection of Public Transport-1	6.663	.002
Factors in the Selection of Public Transport-2	4.265	.015
Factors in the Selection of Public Transport-3	.986	.375
Factors in the Selection of Public Transport-4	1.092	.337
Factors in the Selection of Public Transport-5	2.841	.060
Frequency of Using Public Transport	4.022	.019
Purpose of Using Public Transport	1.967	.142
Time Slot for Departure from Home	.299	.742
Time Slot for Arriving Home	.434	.648
Time Slot Selection Factors-1	1.224	.296
Time Slot Selection Factors-2	.970	.381
Time Slot Selection Factors-3	1.936	.147
Public Transport Districts	7.559	.001

Table 4.9. Test of Homogeneity of Variances.

Test of Homogeneity of Variances	
Variables	Sig.
Public Transport Type	.010
Factors in the Selection of Public Transport-1	.716
Factors in the Selection of Public Transport-2	.049
Factors in the Selection of Public Transport-5	.065
Frequency of Using Public Transport	.000
Public Transport Districts	.000

Homogeneous and inhomogeneous substances should be identified to determine which type of test is to be used for Post-Hoc analysis. The 'Test of Homogeneity of Variances' tabulation is used to determine the distinction between homogeneous and inhomogeneous variables. According to Table 4.9., only 'Factors in the Selection of Public Transport-1' is homogenous and other variables are not homogeneous. As a result of multiple comparisons, the choice of public transportation type differs between elementary school graduates-high school graduates and elementary school graduates-faculty graduates. 'Factors in the Selection of Public Transport-1' shows differences between faculty graduates-high school graduates and faculty graduates-elementary school graduates. Preferences of 'Factors in the Selection of Public Transport-2' are different between elementary school graduates and high school graduates and elementary school graduates and faculty graduates. Preferences of 'Factors in the Selection of Public Transport-5' differ only between faculties and elementary school graduates. 'Frequency of Using Public Transport' preferences differ between elementary school graduates and high school graduates and elementary school graduates and faculty graduates. Finally, 'Public Transport Districts' preferences differ between elementary school graduates-high school graduates and elementary school graduates-faculty graduates.

Independent samples t-test is used to analyze the effect of free transport program usage on travel behaviors of car ownership. According to the table, all variables except 'Frequency of Personal Vehicle Usage' are homogenous. The use of free transportation program significantly influences the variables of 'Homogeneous Purpose of Personal Vehicle Usage' and 'Time Slot for Deep Home from Personal Vehicle'. The same is true for the nonhomogeneous 'Frequency of Personal Vehicle Usage' variant. That is to say, the free transportation program affects the variables 'Purpose of Personal Vehicle Usage', 'Time Slot for Departure from Home with Personal Vehicle' and 'Frequency of Personal Vehicle Usage'. The use of the free transport program does not have a significant effect on the 'Time Slot for Arriving Home with Personal Vehicle' and 'Districts with Personal Vehicle' options.

The following Table 4.12. analyzes the public transportation habits at the weekend with the same analysis method. From the table it is seen that variables except for 'Public Transit Usage at Weekend' and 'Public Transport Districts at Weekend' are homogeneous. According to

the results, only 'Public Transit Usage at Weekend' and 'Public Transport Type at Weekend' are affected by the use of free transportation program.

Table 4.10. Multiple Comparisons.

Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	90% Confidence Interval	
							Lower Bound	Upper Bound
Public Transport Type	**Games-Howell**	**elementary**	high school	-.65326*	.20311	.004	-1.0729	-.2336
			faculty	-1.15776*	.24248	.000	-1.6610	-.6546
		high school	elementary	.65326*	.20311	.004	.2336	1.0729
			faculty	-.50450	.25321	.119	-1.0293	.0203
		Faculty	elementary	1.15776*	.24248	.000	.6546	1.6610
			high school	.50450	.25321	.119	-.0203	1.0293
Factors in the Selection of Public Transport-1	**Tukey HSD**	**elementary**	high school	-.23641	.17545	.370	-.5983	.1255
			faculty	-.71767*	.19793	.001	-1.1259	-.3094
		high school	elementary	.23641	.17545	.370	-.1255	.5983
			faculty	-.48126*	.19243	.035	-.8782	-.0843
		Faculty	elementary	.71767*	.19793	.001	.3094	1.1259
			high school	.48126*	.19243	.035	.0843	.8782
Factors in the Selection of Public Transport-2	**Games-Howell**	**elementary**	high school	-.47554*	.17165	.017	-.8302	-.1209
			faculty	-.43319*	.19513	.072	-.8376	-.0288
		high school	elementary	.47554*	.17165	.017	.1209	.8302
			faculty	.04235	.19587	.975	-.3635	.4482
		Faculty	elementary	.43319*	.19513	.072	.0288	.8376
			high school	-.04235	.19587	.975	-.4482	.3635
Factors in the Selection of Public Transport-5	**Games-Howell**	**elementary**	high school	.27065	.21144	.408	-.1662	.7075
			faculty	.58362*	.24567	.050	.0742	1.0930
		high school	elementary	-.27065	.21144	.408	-.7075	.1662
			faculty	.31297	.24933	.423	-.2037	.8297
		Faculty	elementary	-.58362*	.24567	.050	-1.0930	-.0742
			high school	-.31297	.24933	.423	-.8297	.2037
Frequency of Using Public Transport	**Games-Howell**	**elementary**	high school	.42228*	.19751	.085	.0142	.8304
			faculty	.65991*	.25555	.030	.1293	1.1906
		high school	elementary	-.42228*	.19751	.085	-.8304	-.0142
			faculty	.23763	.26124	.635	-.3044	.7797
		Faculty	elementary	-.65991*	.25555	.030	-1.1906	-.1293
			high school	-.23763	.26124	.635	-.7797	.3044
Public Transport Districts	**Games-Howell**	**elementary**	high school	-1.80652*	.69602	.028	-3.2449	-.3681
			faculty	-3.20345*	.83441	.001	-4.9364	-1.4705
		high school	elementary	1.80652*	.69602	.028	.3681	3.2449
			faculty	-1.39693	.89827	.269	-3.2586	.4647
		Faculty	elementary	3.20345*	.83441	.001	1.4705	4.9364
			high school	1.39693	.89827	.269	-.4647	3.2586

Table 4.11. Independent Samples T-Test for Travel Behaviors of Car Ownership.

		Levene's Test		t-test
		F	Sig.	Sig. (2-tailed)
Frequency of Personal Vehicle Usage	Equal variances assumed	7.272	.009	.000
	Equal variances not assumed			.000
Purpose of Personal Vehicle Usage	Equal variances assumed	.165	.686	.001
	Equal variances not assumed			.001
Time Slot for Departure from Home with Personal Vehicle	Equal variances assumed	1.119	.294	.002
	Equal variances not assumed			.002
Time Slot for Arriving Home with Personal Vehicle	Equal variances assumed	.845	.362	.241
	Equal variances not assumed			.245
Districts with Personal Vehicle	Equal variances assumed	.819	.369	.241
	Equal variances not assumed			.236

Table 4.12. Independent Samples T-Test for Travel Behaviors at Weekends.

		Levene's Test		t-test
		F	Sig.	Sig. (2-tailed)
Public Transit Usage at Weekend	Equal variances assumed	46.978	.000	.000
	Equal variances not assumed			.000
Public Transport Usage Days at Weekend	Equal variances assumed	.065	.799	.450
	Equal variances not assumed			.443
Purpose of Using Public Transport at Weekend	Equal variances assumed	2.344	.130	.396
	Equal variances not assumed			.422
Public Transport Type at Weekend	Equal variances assumed	.009	.927	.039
	Equal variances not assumed			.040
Time Slot for Departure from Home at Weekend	Equal variances assumed	2.121	.149	.308
	Equal variances not assumed			.288
Time Slot for Arriving Home at Weekend	Equal variances assumed	.278	.599	.544
	Equal variances not assumed			.549
Public Transport Districts at Weekend	Equal variances assumed	5.072	.027	.223
	Equal variances not assumed			.277

The Accessibility section of the questionnaire consists of eight variables. Each variable consists of three different options. The Descriptive Statistics table shows the Mean and Standard Deviation values of all participants, participants over 65 years and participants aged 55-65 years. According to these results, individuals aged 65 and over are suffering from metro and BRT access except ferryboats. On the other hand, passengers under the age of 65 had neither a

positive nor negative opinion on the metro and BRT access difficulties, and they stated that they did not have any problems about access to the ferry.

Table 4.13. Descriptive Statistics for Accessibility.

Answers	Total		Over 65 years		Between 55 and 65 years			
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Min.	Max.
Access to other public transport from metro stops, I find exhausting.	1.5348	.75698	1.2761	.62998	1.8958	.77431	1	3
I cannot use elevators comfortably in metro transportation.	1.6043	.78467	1.3284	.68029	1.9896	.76081	1	3
The fact that the metro stations are very in-depth are obstructing the choice of metro.	1.7217	.83114	1.5149	.76321	2.0104	.83973	1	3
Access to other public transport from BRT stops, I find exhausting.	1.5304	.72776	1.2910	.57288	1.8646	.78967	1	3
The long distance of access to BRT prevents it from being preferred.	1.7478	.79676	1.4851	.72273	2.1146	.75212	1	3
The long distance of access to Steamboat prevents it from being preferred.	2.5522	.67025	2.4776	.71205	2.6563	.59521	1	3
Access to other public transport from Steamboats, I find exhausting.	2.6435	.62259	2.5896	.66279	2.7188	.55636	1	3
Landing and boarding difficulties caused by crowded vehicles prevent me for choosing P.T.	1.4348	.62872	1.2910	.57288	1.6354	.65083	1	3

Independent samples t-test is used for the analysis of the accessibility variables. The results of the analysis of the effect of the free transport program status parameter on accessibility are shown in the following tables. According to the results, 'I cannot use elevators comfortably in metro transportation', 'The fact that the metro stations are very in-depth are obstructing the choice of metro' and 'The long distance of access to BRT prevents it from being preferred' are homogeneous and other variables are not homogeneous. Depending on this subtraction, all other

options are affected by the use of the free transport program except for the variable 'Access to other public transport from Steamboats, I find exhausting'.

Table 4.14. Independent Samples T-Test for Accessibility Variables.

Variable		Levene's Test		t-test
		F	Sig.	Sig. (2-tailed)
Access to other public transport from metro stops, I find exhausting.	Equal variances assumed	9.616	.002	.000
	Equal variances not assumed			.000
I cannot use elevators comfortably in metro transportation.	Equal variances assumed	.879	.349	.000
	Equal variances not assumed			.000
The fact that the metro stations are very in-depth are obstructing the choice of metro.	Equal variances assumed	.356	.551	.000
	Equal variances not assumed			.000
Access to other public transport from Metrobüs stops, I find exhausting.	Equal variances assumed	18.302	.000	.000
	Equal variances not assumed			.000
The long distance of access to Metrobüs prevents it from being preferred.	Equal variances assumed	.165	.685	.000
	Equal variances not assumed			.000
The long distance of access to Steamboat prevents it from being preferred.	Equal variances assumed	9.947	.002	.046
	Equal variances not assumed			.040
Access to other public transport from Steamboats, I find exhausting.	Equal variances assumed	7.918	.005	.121
	Equal variances not assumed			.111
Landing and boarding difficulties caused by crowded vehicles prevent me for choosing public transportation vehicles.	Equal variances assumed	9.494	.002	.000
	Equal variances not assumed			.000

Table 4.15. Descriptive Statistics of Past, Current and Future Estimation of Travel Behaviors.

Using the Free Transportation Program		Mean	Std. Deviation	Std. Error Mean
Over 65 Years	Public Transport Type (Past)	2.2331	1.42960	.12396
	Public Transport Type (Current)	2.0451	1.51690	.13153
	Frequency of Using Public Transport (Past)	3.8195	1.51174	.13108
	Frequency of Using Public Transport (Current)	3.1429	1.22563	.10628
	Weekend Public Transport Use (Past)	1.6791	.46857	.04048
	Weekend Public Transport Use (Current)	1.5299	.50098	.04328
	Purpose of Using Public Transport (Past)	1.8507	1.30071	.11236
	Purpose of Using Public Transport (Current)	2.4627	.92303	.07974
	Public Transport Time Slot for Departure from Home (Past)	1.4701	.67934	.05869
	Public Transport Time Slot for Departure from Home (Current)	2.0672	.44549	.03848
	Public Transport Time Slot for Arriving Home (Past)	3.5373	.64490	.05571
	Public Transport Time Slot for Arriving Home (Current)	3.8134	.53688	.04638
	Public Transit Districts (Past)	5.3358	4.75085	.41041
	Public Transit Districts (Current)	5.5522	4.73599	.40913
Between the age of 55 and 65	Type of Public Transport (Future)	2.3333	1.83341	.18712
	Type of Public Transport (Current)	2.8229	1.25652	.12824
	Frequency of Using Public Transport (Future)	3.0313	.99951	.10201
	Frequency of Using Public Transport (Current)	3.1563	1.66277	.16971
	Weekend Public Transit Use (Future)	1.5521	.49989	.05102
	Weekend Public Transit Use (Current)	1.7604	.42907	.04379
	Purpose of Using Public Transport (Future)	2.3333	.82929	.08464
	Purpose of Using Public Transport (Current)	1.9792	1.26474	.12908
	Public Transit Time Slot for Departure from Home (Future)	2.1354	.60905	.06216
	Public Transit Time Slot for Departure from Home (Current)	1.7083	.84501	.08624
	Public Transit Time Slot for Arriving Home (Future)	3.3542	.59788	.06102
	Public Transit Time Slot for Arriving Home (Current)	3.8438	.68561	.06998
	Public Transit Districts (Future)	5.7813	5.50254	.56160
	Public Transit Districts (Current)	6.7604	5.22896	.53368

The first part of the Table 4.15. shows the analysis of the current and past travel behavior of the beneficiaries of the free transport program with descriptive statistics. The second part provides an analysis of the current travel behavior and future forecasts of those who do not benefit from the free transportation program.

Before presenting the results of multiple regression, Table 4.16. was created below. Because all variable names are long in all generated models, these symbols are used in variables.

Table 4.16. The Symbols for Variables.

Variables Used in Equations	Representing Letter
Public Transport Type (Current)	X_1
Frequency of Using Public Transport (Current)	X_2
Purpose of Using Public Transport (Current)	X_3
Public Transport Time Slot for Departure from Home (Current)	X_4
Public Transport Time Slot for Arriving Home (Current)	X_5
Public Transit Districts (Current)	X_6

Important summary information and Anova results of the different models generated by multiple regressions are shown on the Table 4. 17.. R Square shows how much the model can explain the variable. The Durbin Watson value should be between 1.5 and 2.5. The significance value in Anova should also be less than 0.1. In the light of these limitations, 'Public Transit Districts (Future)' is excluded from the model because it is out of the range of Durbin Watson. Since the Significance value is 0.109, 'Public Transport Time Slot for Departure from Home' (Past) is excluded from modeling. The other variables are modeled.

Table 4.17. Summary of Variables in Multiple Regression.

Model Summary			**Anova**	
Dependent Variable	**R Square**	**Durbin-Watson**	**F**	**Sig.**
Type of Public Transport (Future)	.398	1.508	4.166	0.000
Frequency of Using Public Transport (Future)	.422	1.921	10.844	0.000
Purpose of Using Public Transport (Future)	.233	2.026	4.511	0.000
Public Transit Time Slot for Departure from Home (Future)	.216	2.302	4.091	0.001
Public Transit Time Slot for Arriving Home (Future)	.153	1.833	2.677	0.020
Public Transit Districts (Future)	.347	1.250	7.874	0.000
Public Transport Type (Past)	.200	2.118	5.280	0.000
Frequency of Using Public Transport (Past)	.368	2.275	12.326	0.000
Purpose of Using Public Transport (Past)	.130	2.034	3.150	0.007
Public Transport Time Slot for Departure from Home (Past)	.077	1.815	1.778	0.109
Public Transport Time Slot for Arriving Home (Past)	.188	2.083	4.905	0.000
Public Transit Districts (Past)	.240	2.112	6.695	0.000

Table 4.18. Coefficients for Type of Public Transport (Future).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	-1.510	1.154		
X_1	.588	.196	.430	2.324
X_2	-.016	.124	.620	1.613
X_3	.330	.180	.504	1.982
X_4	.028	.275	.487	2.055
X_5	.323	.284	.692	1.445
X_6	.043	.049	.401	2.496

$$Y_1 = -1.510 + 0.588X_1 - 0.016X_2 + 0.330X_3 + 0.028X_4 + 0.323X_5 + 0.043X_6 \quad (4.1)$$

Y_1= Type of Public Transport (Future)

Table 4.19. Coefficients for Frequency of Using Public Transport (Future).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	2.001	.574		
X_1	-.210	.098	.430	2.324
X_2	.387	.062	.620	1.613
X_3	-.159	.090	.504	1.982
X_4	.500	.137	.487	2.055
X_5	-.085	.141	.692	1.445
X_6	.028	.024	.401	2.496

$$Y_1 = 2.001 - 0.210X_1 - 0.387X_2 - 0.159X_3 + 0.500X_4 - 0.085X_5 + 0.028X_6 \quad (4.2)$$

Y_1= Frequency of Using Public Transport (Future)

Table 4.20. Coefficients for Purpose of Public Transport (Future).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	3.509	.549		
X_1	.027	.093	.430	2.324
X_2	.010	.059	.620	1.613
X_3	.153	.086	.504	1.982
X_4	.056	.131	.487	2.055
X_5	-.428	.135	.692	1.445
X_6	-.005	.023	.401	2.496

$$Y_1 = 3.509 + 0.27X_1 + 0.010X_2 + 0.153X_3 + 0.056X_4 - 0.428X_5 - 0.005X_6 \quad (4.3)$$

Y_1= Purpose of Public Transport (Future)

Table 4.21. Coefficients for Public Transit Time Slot for Departure from Home (Future).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	.556	.408		
X_1	-.028	.069	.430	2.324
X_2	.085	.044	.620	1.613
X_3	.099	.064	.504	1.982
X_4	.206	.097	.487	2.055
X_5	.168	.100	.692	1.445
X_6	.029	.017	.401	2.496

$$Y_1 = 0.556 - 0.28X_1 + 0.085X_2 + 0.99X_3 + 0.206X_4 + 0.168X_5 + 0.029X_6 \quad (4.4)$$

Y_1= Public Transit Time Slot for Departure from Home (Future)

Table 4.22. Coefficients for Public Transit Time Slot for Arriving Home (Future)

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	2.059	.416		
X_1	.051	.071	.430	2.324
X_2	-.053	.045	.620	1.613
X_3	.065	.065	.504	1.982
X_4	-.005	.099	.487	2.055
X_5	.345	.102	.692	1.445
X_6	-.019	.018	.401	2.496

$$Y_1 = 2.059 + 0.51X_1 - 0.53X_2 + 0.65X_3 - 0.05X_4 + 0.345X_5 - 0.019X_6 \quad (4.5)$$

Y_1= Public Transit Time Slot for Arriving Home (Future)

Table 4.23. Coefficients for Public Transport Type (Past).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	1.411	.907		
X_1	.195	.114	.422	2.367
X_2	-.117	.108	.730	1.370
X_3	.184	.135	.820	1.220
X_4	-.269	.275	.850	1.177
X_5	.158	.195	.811	1.233
X_6	.062	.035	.467	2.141

$$Y_1 = 1.411 + 0.195X_1 - 0.117X_2 + 0.184X_3 - 0.269X_4 + 0.158X_5 + 0.062X_6 \quad (4.6)$$

Y_1= Public Transport Type (Past)

Table 4.24. Coefficients for Frequency of Using Public Transport (Past).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	1.115	.864		
X_1	.133	.109	.422	2.367
X_2	.652	.103	.730	1.370
X_3	-.158	.129	.820	1.220
X_4	.335	.262	.850	1.177
X_5	.152	.185	.811	1.233
X_6	-.091	.033	.467	2.141

$$Y_1 = 1.115 + 0.133X_1 + 0.652X_2 - 0.158X_3 + 0.335X_4 + 0.152X_5 - 0.091X_6 \quad (4.7)$$

Y_1= Frequency of Using Public Transport (Past)

Table 4.25. Coefficients for Purpose of Using Public Transport (Past).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	3.372	.864		
X_1	-.079	.109	.422	2.367
X_2	-.261	.103	.730	1.370
X_3	.130	.129	.820	1.220
X_4	.009	.262	.850	1.177
X_5	-.310	.185	.811	1.233
X_6	.042	.033	.467	2.141

$$Y_1 = 3.372 - 0.079X_1 - 0.261X_2 + 0.130X_3 + 0.009X_4 - 0.310X_5 + 0.042X_6 \quad (4.8)$$

Y_1= Purpose of Using Public Transport (Past)

Table 4.26. Coefficients for Public Transport Time Slot for Arriving Home (Past).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	2.772	.344		
X_1	-.026	.043	.422	2.367
X_2	.090	.041	.730	1.370
X_3	-.079	.051	.820	1.220
X_4	.205	.105	.850	1.177
X_5	.166	.074	.811	1.233
X_6	-.001	.013	.467	2.141

$$Y_1 = 2.772 - 0.026X_1 + 0.090X_2 - 0.079X_3 + 0.205X_4 + 0.166X_5 - 0.001X_6 \quad (4.9)$$

Y_1= Public Transport Time Slot for Arriving Home (Past)

Table 4.27. Coefficients for Public Transit Districts (Past).

Model	Unstandardized Coefficients		Collinearity Statistics	
	B	Std. Error	Tolerance	VIF
(Constant)	5.283	2.940		
X_1	-.321	.371	.422	2.367
X_2	-.252	.351	.730	1.370
X_3	.611	.438	.820	1.220
X_4	-1.232	.892	.850	1.177
X_5	-.011	.631	.811	1.233
X_6	.526	.113	.467	2.141

$$Y_1 = 5.283 - 0.321X_1 - 0.252X_2 + 0.611X_3 - 1.232X_4 - 0.011X_5 + 0.526X_6 \quad (4.10)$$

Y_1= Public Transit Districts (Past)

5. CONCLUSIONS AND RECOMMENDATIONS

The Free Transportation Program grants citizens over 65 years the right to use public transport for free in all cities of Turkey. Such policies have the aim of encouraging the elderly to use public transportation or to make them live a more active life. However, the application of these policies without limitations has raised questions about whether the program's purpose has been achieved. For this purpose, surveys were conducted in Kadiköy for those aged 55 and over. These surveys measure travel behaviors related to public transportation and personal vehicles. Moreover, participants' thoughts on accessibility are included. In the last part of the study, past behavioral patterns of individuals over the age of 65 and future predictions of individuals under the age of 65 are modeled.

The results of the study show that there are great differences in the travel behaviors of the beneficiaries and non-beneficiaries of the free transport program. Participants over the age of 65 prefer buses that are easier to access as they use public transport for more sightseeing purposes. Despite the convenience of access to the minibus, it is not preferred because it is not covered by the free transportation program. Metro is not preferred because it is difficult to access the stops. Due to the fact that under-65-year-olds are composed mostly of employees, they use public transportation modes for business purpose, so speed seems to be the most important factor in public transportation preferences. Therefore, under the age of 65, individuals prefer transportation types that are not affected by traffic such as the metro. It is understood that under 65 years old individuals use public transportation every day, while over 65 years old people use 2-4 times a week. This is the positive impact of the free transport program on mobility. Another important outcome is that in the case of emergency such as a hospital, the vehicles of family members or taxis are used instead of public transport. Individuals under the age of 65 are traveling at peak hours in the morning and evening due to working hours. Individuals over 65 years of age are traveling at times when morning traffic is less, before and during peak hours of evening traffic. Individuals older than 65 years indicate that they prefer travel time according to the comfortable travel factor, while individuals under 65 indicate that they are making this

choice due to working hours. Individuals older than 65 years travel mostly between short distances, while individuals under 65 travel longer distances.

Personal vehicle use is more common in individuals under 65 years of age. According to the results of analysis on personal vehicle use, individuals aged 65 and over use 2-4 times a week, while individuals under 65 years of age use their own vehicles daily. These results are also in line with public transportation travel behaviors. Just as in the case of public transport travel behavior, citizens under age 65 use personal cars for business purposes, while citizens over age 65 use personal cars for travel. Participants below the age of 65 indicate that the time of departure is the peak of the traffic, while participants over the age of 65 indicate that they prefer the times when the traffic is calm. However, in both groups, more than 70 percent of the participants are returning home at peak hours. This is an indication of the negative effect of seniors using their own vehicles on traffic.

At weekends, almost half of all individuals over the age of 65 are using public transport. A few of the under-65s indicate that they travel by public transport. The fact that the proportion of employees who are under 65 years old is high and that they spend time with their families on the weekend play an important role here. While the individuals in both groups indicated that they were traveling on Sundays, in other parameters, the two group members showed similar travel behavior tendencies.

As a result of the t-test analysis, it was found that the travel behavior parameters were greatly influenced by the free transportation program and business condition; It is possible to say that gender has no significant effect on the parameters. Anova tests conducted to examine the effect of education level reveal that primary school graduates show different travel behaviors than high school and faculty graduates. The t-test analysis results to understand the effect of the free transportation program on the individuals using their own car show that the free transportation program does not have any significant influence on the individuals using their own car. As a result, the free transportation program does not appear to be an effective way to encourage public transport. Likewise, weekend travel behaviors are not significantly affected by the free transport program.

In terms of accessibility, the following results are obtained. While individuals over the age of 65 indicated that they had difficulty accessing all modes of transport except ferry, individuals under the age of 65 were unstable about accessibility to transportation modes except ferryboats. Both groups expressed satisfaction with accessibility to the ferry. That is, individuals who benefit from and do not benefit from the free transportation program have different opinions on accessibility. This can be correlated with progressive age-related health and inactivity problems.

In addition to all these studies, current and past travel behaviors of individuals over 65 years old and current and future travel behaviors of individuals under 65 years are expressed by multiple regression and separate models for each parameter are shown.

In conclusion, this study is designed to understand the travel behaviors of the elderly and to analyze the impact of the free transportation program. In the light of the results, it is understood that the spread of transportation networks and the increase of the accessibility of public transport modes will be more effective than the free transportation program. A positive effect of the free transportation program on the mobility of the elderly is irrefutable. However, if time constraints are imposed, in-vehicle densities at peak hours can be avoided and other citizens can travel more comfortably. Considering that the work situation leads individuals to use their own vehicles, it may seem beneficial for employers to encourage employees over a certain age to provide flexibility in working hours, or to increase staff service opportunities.

REFERENCES

Alsnih, Rahaf, and David A. Hensher, 2003, "The mobility and accessibility expectations of seniors in an aging population.", *Transportation Research Part A: Policy and Practice*, pp. 903-916.

Beaver, O., *Many benefits to free transit day for seniors*, 2012. http://ezproxy.lib.ryerson.ca/login?url=http://search.proquest.com/docview/1221934760?accountid=13631, accessed at November 2016.

Beiler, Michelle Oswald, Ben Seketa, and William Swiatek, 2015, "Investigating Transit and Pedestrian Accessibility for Age-Restricted Communities Using Spatial Analysis." *International Journal of Sustainable Transportation*, Vol. 10, pp. 881-893.

Birmingham Municipality, *Cooperation with Local Communities in Birmingham*, 2014, http://www.birmingham.gov.uk, accessed at July 2016.

Bok, Jinjoo, and Youngsang Kwon, 2016, "Comparable Measures of Accessibility to Public Transport Using the General Transit Feed Specification", *Sustainability*, p. 224.

Böcker, Lars, Patrick Amen, and Marco Helbich, 2016, "Elderly travel frequencies and transport mode choices in Greater Rotterdam, the Netherlands", *Transportation*, pp. 1-22.

Broome, Kieran, *et al*., 2010, "Priorities for an age-friendly bus system", *Canadian Journal on Aging/La Revue canadienne du vieillissement*, pp. 435-444.

Butcher, L., *Buses: concessionary fares. House of Commons*, 2011, http://www. parliament. uk/briefing-papers/SN01499, accessed at October 2016.

Canada NewsWire, *Free public transit for seniors in Laval - the STL launches horizon 65 +*, 2014, http://search.proquest.com, accessed at July 2016.

Cao, Xinyu, Patricia L. Mokhtarian, and Susan L. Handy, 2010, "Neighborhood design and the accessibility of the elderly: An empirical analysis in Northern California", *International Journal of Sustainable Transportation*, pp. 347-371.

Cheng, Yung-Hsiang, and Ssu-Yun Chen, 2015, "Perceived accessibility, mobility, and connectivity of public transportation systems", *Transportation Research Part A: Policy and Practice*, pp. 386-403.

Coronini-Cronberg, Sophie, *et al*., 2012, "The impact of a free older persons' bus pass on active travel and regular walking in England", *American journal of public health*, pp. 2141-2148.

Coughlin, J., 2001, "Transportation and Older Persons: Perceptions and Preferences", *A Report on Focus Groups, Centre for Transportation Studies and Age Lab, AARP*, Washington D.C.

Currie, Graham, and Alexa Delbosc, 2010, "Exploring public transport usage trends in an ageing population", *Transportation*, pp.151-164.

Ferrari, Laura, *et al*., 2014, "Improving the accessibility of urban transportation networks for people with disabilities", *Transportation Research Part C: Emerging Technologies*, pp. 27-40.

Fiedler, Matthias., , "Older people and public transport", *Challenges and changes of an ageing society - Final report*, 2015, http://www.emta.com, accessed at September 2016.

George, V. E., "Transit socks it to seniors", *Edmonton Journal*, 2000, http://search.proquest.com/docview/252860244?accountid=13631, accessed at August 2016.

Kola Goteborg, Goteborg City, http://www.kolla.goteborg.se, 2013, accessed at September 2016.

IETT, Istanbul Electric Tramway and Tunnel Establishments, *İstanbul'da Toplu Ulaşım*, 2015, http://www.iett.istanbul/tr/main/pages/istanbulda-toplu-ulasim/95, accessed at November 2016.

Lightstone, M., 2011, "No free rides for Halifax seniors", *Herald News,* http://thechronicleherald.ca, accessed at October 2016.

Louviere, J.J. and D. Street, 2000, Stated-Preference Methods, in: D. A. Hensher and K. Button (Eds) Handbook in Transport I: *Transport Modelling*, Vol. 8, pp.131-144.

Mackett, Roger, 2015, "Improving accessibility for older people–investing in a valuable asset", *Journal of Transport & Health*, pp. 5-13.

Mercado, Ruben, Antonio Páez, and K. Bruce Newbold, 2010, "Transport policy and the provision of mobility options in an aging society: a case study of Ontario, Canada", *Journal of Transport Geography*, pp. 649-661.

Muenchen, Munich City, 2012, http://www.muenchen.de, accessed at August 2016.

Trendsetter Europe, *Friendly Agents*, 2003, http://www.trendsetter-europe.org/index.php?ID=867, accessed at August 2016.

Naess, Petter, 2006, "Accessibility, activity participation and location of activities: exploring the links between residential location and travel behaviour", *Urban studies*, 43.3 pp. 627-652.

Newbold, K. Bruce, *et al*., 2005, "Travel behavior within Canada's older population: a cohort analysis", *Journal of Transport Geography*, pp. 340-351.

Noh, S. Hak and C. Hyeon Joh, 2011, "Change in travel behavior of the elderly in Seoul Metropolitan Area", *Journal of the Korean Geographical Society*, pp. 781-796.

OC Transpo, *Senior Riders*, 2014, http://www.octranspo1.com, accessed at July 2016.

Rheinbahn, Rhine and Ruhr Public Transport Authority, 2016, http://www.rheinbahn.de, accessed at October 2016.

Rosenbloom, Sandra, 2001, "Sustainability and automobility among the elderly: An international assessment", *Transportation*, pp. 375-408.

ZGB, Salzburg municipality, 2016, http://www.zgb.at, accessed at October 2016.

Schwanen, Tim, and Antonio Páez, 2010, "The mobility of older people–an introduction", *Journal of Transport Geography*, pp. 591-595.

Sivakumar, T., T. Yabe, T. Okamura, F. Nakamura, 2006, "Survey Design to Grasp and Compare User's Attitudes on Bus Rapid Transit (BRT) in Developing Countries", *IATSS Research*, Vol. 30, No. 2.

Song, Ji-Young, Jin Ki Eom, and Sung Il Kim, 2014, "Evaluation of Elderly Mobility Based on Transit Card Data in Seoul", *PROMET-Traffic&Transportation*, pp. 281-290.

Stopher, P.R., A.H. Meyburg, 1979, *Survey Sampling and Multivariate Analysis for Social Scientists and Engineers*, Lexington, MA: Lexington Books.

Sun, Yang, and Hang Fei Lin, 2015, "GIS-Based Analysis of Public Transit Accessibility: Definition and Display", *15th COTA International Conference of Transportation Professionals*, 2015.

The World Bank, *Population ages 65 and above*, 2015, http://www.worldbank.org. accessed at October 2016.

GMPTE, Transport for Greater Manchester, 2014, http://www.gmpte.com, accessed at June 2016.

Resmi Gazete, Turkish Official Gazette, Republic of Turkey, 2014, http://www.resmigazete.gov.tr/main.aspx?home=http://www.resmigazete.gov.tr/eskiler/2014/03/20140304.htm&main=http://www.resmigazete.gov.tr/eskiler/2014/03/20140304.htm, accessed at October 2016.

Turkstat, *Aged based population of districts*, Turkish Statistical Institute, 2015, http://www.tuik.gov.tr, accessed at October 2016.

TurkStat, *Number of motor vehicle*, Turkish Statistical Institute, 2014, http://www.tuik.gov.tr/PreTablo.do?alt_id=1051, accessed at October 2016.

TurkStat, *Traffic Accident Statistics*, Turkish Statistical Institute, 2013, http://www.tuik.gov.tr/IcerikGetir.do?istab_id=70, accessed at October 2016.

VBN, Verkehrsverbund Bremen, *Bob Ticket*, 2016, https://www.vbn.de, accessed at June 2016.

Verseckienė, Alina, Vaidotas Meškauskas, and Nijolė Batarlienė, 2016, "Urban Public Transport Accessibility for People with Movement Disorders: The Case Study of Vilnius", *Procedia Engineering*, pp. 48-56.

Walpole, R., E. Raymond, H. Myers, S.L. Myers, K. Ye, *Probability and Statistics for Engineers and Scientists*, Boston, MA: Pearson, 2012.

Wisma, U. N., C. Block, and KP DAMANSARA, *A review of international best practice in accessible public transportation for persons with disabilities*, Kuala Lumpur: UNDP Malaysia, 2010.