



The Comparative Analysis of Urban Transport in Ankara By Gender and Age Groups

Ankara'da Kent İçi Yolculukların Cinsiyete ve Yaş Gruplarına Göre Karşılaştırmalı Analizi

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ABSTRACT

Today travel time by urban transport has varied as a result of developing urban facilities, land use pattern, development of transport infrastructure and alternative transport system options for communities. Different factors such as transportation mode, transportation distance, travel route as well as disability status, child ownership and working conditions play a role in the differentiation of individuals' travel time. However, age group, gender and the purposes of travel should be specified as some of the main factors among travel time differences that are investigated in this work in order to find out statistically meaningful differences. This study has argued the differences between the travel times of urban transport throughout Ankara on these three basic factors. According to household survey in Ankara, it has been applied to Welch's ANOVA to research whether the participants' purposes of travel influence the average of travel time or not. It has showed that there are statistically considerable differences in general and gender between the average of travel time depending on the purpose of travel. It has been applied to post-hoc tests for determining purposes causing these differences. The difference has been generally seen between travel times for the purpose of work, school and shopping. Individuals from different age groups have differences in travel time for school and shopping. The purposes of travel and travel times of young and middle-age group distinguish from each other. However, there are no considerable differences for child age group between the purposes of travel and travel times by gender.

Keywords: Gender; one-way analysis of variance; total travel time; travel pattern; urban transport; Welch's ANOVA.

ÖZ

Günümüzde kentiçi ulaşımında geçirilen yolculuk süresi, gelişen kentsel imkânlar, arazi kullanım deseni, ulaşım altyapısının gelişmişliği ve kentlilerce alternatif ulaşım sistemlerinin tercih edilmesiyle farklılık göstermektedir. Ulaşım türü, ulaşım mesafesi, ulaşım güzergahının yanı sıra, engellilik durumu, çocuk sahipliği ve iş koşulları da, ulaşımında geçirilen sürenin farklılaşmasında bir etkidir. Ancak bireylerin yolculuk süresinin farklılaşmasında en temel değişkenler, yaş grubu, cinsiyet ve yolculuk amacıdır. Bu çalışma kapsamında, Ankara genelinde gerçekleşen kent içi yolculukların yolculuk sürelerinde ortaya çıkan farklılıklar, bu üç temel değişken bazında değerlendirilmiştir. Ankara'da yapılan hanehalkı araştırmasına göre, katılımcıların yolculuk amaçlarına göre yolculuk süresi ortalamaları arasında fark olup olmadığı, Welch'in ANOVA testi ile araştırılmıştır. Genel ve cinsiyete göre, amaca bağlı yolculuk süresi ortalamaları arasında istatistiksel olarak anlamlı farklılıklar elde edilmiştir. Farklılığı yaratan amaçları belirlemek için post-hoc testlerinden faydalanılmıştır. Genellikle iş, okul ve alışveriş amaçlı yolculuk süreleri arasında farklılık gözlenmiştir. Farklı yaş gruplarına ait bireylerin, okul ve alışveriş amaçlı yolculuk sürelerinde farklılıklar bulunmuştur. Genç ve orta yaş grubunun yolculuk amaçları ve süreleri arasındaki farklılık çeşitlenirken, çocuk yaş grubundaki bireylerin cinsiyete bağlı yolculuk amaçları ve süreleri arasında anlamlı farklılığa rastlanmamıştır. Yapılan bu çalışma sonucunda, yaş grupları ve cinsiyete göre çeşitli öneriler geliştirilerek, kentsel ulaşım konusunda politika geliştirenlere ve kent içi ulaşımın sosyal bağlamına yönelik araştırma yapanlara yardımcı olacak sonuçlara ulaşılmıştır.

Anahtar sözcükler: Cinsiyet; tek yönlü varyans analizi; yolculuk süresi; yolculuk deseni; kent içi ulaşım; Welch'in ANOVA testi.

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Introduction

Today urban population growth and rising of welfare bring about the increase in automobile ownership. As a consequence of automobile use, the increase of long-distance travels in urban transport lead people to settle in different regions of the city. This demand causes the enlargement of urban area. Since 1960s, urban sprawl has been further growing and the sprawl emerging from spreading in metropolitan cities has been becoming a big problem more and more.^{1,2} Urban sprawl is seen as the spread of urban macroform which takes shape in line with transportation behaviors, like oil stain over periphery as a result of the increase in automobile ownership. Many metropolitan cities face with this situation. It causes many transportation-related problems including extending travel times, delays, rising emission levels, increase in environmental pollution and impair of urban communities' health.^{3,4}

Travel pattern is the outcome of thought system varying by physical and temporal combination. This travel pattern emerging from human activities is based on the access to destination in the shortest time possible without allowing any negative situation especially when it comes to vehicle traffic.⁵ However, the travels with the same departure time prevent each other and cause arrivals to take much longer time under the travel pattern aiming fast access of each individual. It is possible through analyzing daily travels and determining differences between travel times and purposes to prevent the travel time to last longer.

The main indicators of differences in travel pattern are suggested as time, income, age, education level, household size, responsibilities, employment opportunities, security, land use pattern and political, economic geography of mobility.^{6,7,8} While people do not travel any for different reasons, some people have to travel more than one and endure too long-distance or multi-purpose travels for their responsibilities. It has appeared during the literature review that there are differences between the travel patterns of women and men from different age groups.^{9,10} According to Cao and Mokhtarian, it is also seen that there are differences in travel pattern regarding having child, income statue, life cycle as well as differences in travels based on age and gender.¹¹ Due to the responsibility of looking after children, women prefer workplaces close to their homes despite low income job. They minimize their travel time for work and spare more time for non-occupational activities.^{12,13} According to the study of Law on transportation

behaviors and policies, travel time of women lasts shorter than travel time of men.⁸ As they care for housework and family members, women are forced to travel shorter and more frequently and therefore, the demand appear for more complex transportation chain.^{13,14} According to American Time Use Survey compared to men from same age group, young and working women aged 18 and older spare more time for household activities and family members.¹⁵ Thus, women shorten the commuting distance to work and this allows her to spare more time for home or shopping. According to Li and others, it takes 32.05 minutes on average for the work travels of men while it is measured as 29.58 minutes on average in women in Atlanta, USA.¹⁶ This result supports that women have occupational travel time shorter than men.

Ankara is politically and strategically important capital city owing to its location in the center of Turkey. As a bureaucratic center it attracts many business-trips from all corners of the country. As well as on the main axes of east-west and north-south main roads linking the country's main centers, and playing a "transitionary-city" role, in addition to being a secondary-capital city after mega-city İstanbul. Thanks to its central location, it has many transportation connections with many cities through highway, railway and airline transportation options. Urban transport depends on partially railway but mostly highway. Therefore, new roads and decreasing demand for public transportation trigger the spread of urban macroform. It has been tried to limit this spread via beltway through transportation decisions. However, oil stain-shaped expansion has prevented and the city has been getting more addicted to automobile. The routes which radially connects the city to beltway in east, west, north and south directions, has turned into the speed roads like highways. Therefore, they have continued to expand in a way that it supports automobile use on highways.

Ankara is the second largest metropolitan city owing to approximately 5,5 million populations¹⁷ in Turkey.¹⁸ The problems on transportation leave the advantages of being metropolitan city behind. The spread of urban macroform causes the demand for multi-travel in Ankara, which catches up with İstanbul regarding these problems. The deficiency of public transportation management and limited transfer options cause the travel time to last longer. For the purpose of relieving traffic and automobile-based transportation solutions lead to push public transportation aside and be incapable of developing alternative transportation types.

¹ Glaeser and Kahn, 2004.

² Couch et all, 2008.

³ Zhao, 2010.

⁴ Vos and Witlox, 2013.

⁵ Monat, 2018.

⁶ Uteng, 2012.

⁷ Kaufmann, 2017.

⁸ Law, 1999.

⁹ Helling, 2004.

¹⁰ Boumans and Harms, 2004.

¹¹ Cao and Mokhtarian, 2005.

¹² Chapple, 2001.

¹³ Gordon et all, 1989.

¹⁴ Lu and Pas, 1999.

¹⁵ BLS- Bureau of Labor Statistics, 2003.

¹⁶ Li et all, 2004.

¹⁷ In 2013, when this study was carried out, the population of Ankara was 5 million (TUIK, 2014).

¹⁸ TUIK, 2019.

This study analyzes the travel patterns and travel behaviors of individuals living in Ankara. It covers the assessments of long travel time, which is one of the most urgent problems in daily transportation. These assessments purpose to determine the considerable differences between the travel times varying by purpose of travel, age group and gender. They also intend to analyze the cases in which these differences come out and then put forward suggestions. The statistical methods and tests used in the study are mentioned in the methodology section. Findings obtained in this study are discussed by means of tables under the findings and research results section. Acquired conclusions are supported and evaluated through opinions and suggestions under the discussion and conclusion section.

Methodology

In this study aiming to determine travel pattern for urbanites, it applies to the household survey data which has been conducted under Ankara Metropolitan Area Transportation Master Plan in 2013. Social, demographic and economic information of households, their personal information, and detailed information about travel times and purpose of these travels in last 24 hours have been collected within the framework of household survey. This data has been stored in a large database and analyzed in different ways. Local travels in Ankara are discussed on the basis of main indicators under this study. In order to determine whether there are differences in the averages of travel time depending on age group, gender and purpose of travel or not, it is applied to independent T-test, one-way variance analysis (One-way ANOVA) and Welch's ANOVA. It is applied to one-way variance analysis (ANOVA) for determining whether there are statistically considerable differences between the averages of two or more independent groups for this studied situation or not. While carrying out ANOVA, it is necessary that ANOVA assumptions of the data be measured at dependent variable, range or rate level; and that independent variable be composed of two or more categorical groups. Dependent and independent variable categories need to have almost normal distribution and the homogeneity of their variance needs to be ensured.¹⁹ It is applied to Games-Howell test, one of the post-hoc tests, for determining the groups which vary in travel times.

According to Stopher transportation information of children aged 5 and below has not been registered because it is assumed that they travel daily with their parents.²⁰ Therefore, travel patterns of the individuals aged 6 and above, who are old enough to travel by their own, should be taken into account under this study. In this case, children between the age of 6-14, 15-24 young, 25-40 young-

middle age, 41-64 middle age and older people belongs to 65 and older age group have been determined as the age groups. It is generally suggested in household surveys carried out under the scope of transportation researches that it is necessary to address 10% in cities with under 100.000 population and 1-4% in cities with over 100.000 populations as the sample size.^{21,22,23} As a result of survey conducted among 46.057 households, travel information of 123.777 people has been collected with %3 sample rates and 95% confidence interval throughout the Ankara population.²⁴ When all travels of these people have been taken into account, total travel amount becomes 159.448. Due to the fact that intercity trips would affect considerable differences in travel times and mislead the measurement of average travel time, it has been removed from the data base. Differences between average travel times and their reasons are put forward in line with these assessments under findings and research results section.

Finding and Research Results

The demographic information of those who participated in the Ankara household survey and conducted the trip is given at Table 1. 51.76% of participants are men, and 48.24% are women. When examining total travel number, however, it is possible to see that 61.5% of these travels are performed by men, and 38.5% by women. The highest rate of travel belongs to the young-middle aged group by 31.5%. The middle-aged group has the second highest rate by 30.7% and then young by 20.8%. The lowest rate belongs to older people by %4.2.

According to last three transportation researches in Ankara, the average number of mobility per capita has also increased in parallel with the increase in car ownership. While it is 39 cars per one thousand people according to transportation survey by Ankara Urban Transport Study in 1985²⁵ and 84 cars per one thousand people according to Ankara household survey in 1992.²⁶ According to household survey by Ankara Transportation Master Plan, it is 184 cars per one thousand people.²⁴ The mobility per capita has continued to increase by 1.72 in 1985; 1.96 in 1992 and 2.09 in 2013 over the years.^{24,25,26}

According to household survey, it is seen in Figure 1 that travels peak especially between 07.00-09.00 a.m. in shorter period and increase between 3.00- 8.00 p.m. in longer period when examining hourly distribution of all travels in 2013.²⁴

Following examining the general transportation data and demographic data gathered from household surveys, summary information has been provided about travel

¹⁹ Yiğit, 2009.

²⁰ Stopher, 1996.

²¹ Cambridge Systematics, 1996.

²⁴ AUAP, 2014.

²² Dickey, 2017.

²⁵ ABB, 1985.

²³ Ortuzar and Willumsen, 1994.

²⁶ ABB, 1992.

Table 1. Demographic data on travelers

	N	%
Gender		
Woman	60,073	48.24
Man	64,457	51.76
Total travel number		
Woman	61,366	38.5
Man	98,082	61.5
Age range		
6-14	20,101	12.6
15-24	33,166	20.8
25-40	50,593	31.7
41-64	48,957	30.7
65 +	6,631	4.2
Education level		
Literate	156,881	98.4
Illiterate	2,567	1.6
Employment status		
Employed	75,956	47.6
Not employed but still in touch with her/his job	1,542	1.0
Unemployed	81,950	51.4
Sectoral distribution of employers		
Paid public	21,551	28.6
Paid private	37,163	49.3
Self employment	16,710	22.2
Income level		
1,000 TL and below	27,100	17.4
1,001-2,000 TL	61,834	39.6
2,001-4,999 TL	56,310	35.92
5,000-7,499 TL	8,141	5.2
7,500-9,999 TL	1,459	0.9
10,000 TL and above	1190	0.8

time, purpose of travel and age groups of participants. The purposes of travel are collected under the titles of home, work, work follow-up, school, friend visit, shopping, hospital-health center, social-sports-entertainment and others. According to Table 2 and Table 3 in this context,

- When examining the purposes of travel by men and women, both have the home-arrival travel rate of 48%, 26% of men and 13% of women execute work travels out of total travels. This difference in work travel rates shows that men contribute to labor more than women. It is seen that this rate is quite close to the employment rate of men and women determined by Turkey Statistical Institute.²⁷

- When examining all travels together, men and women have had average 36.26 and 33.81 minutes of travel time respectively. This shows that men have spent 3.45 min-

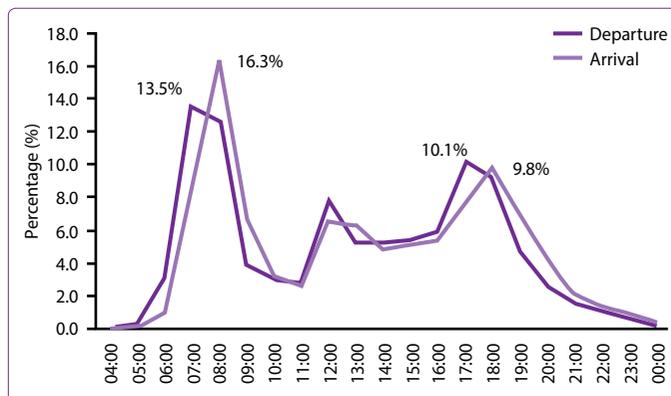


Figure 1. The hourly distribution of all travels in Ankara.²⁴

utes more than women in urban transport. On one hand, men spend extra 2.61 minutes for work travels, 2.84 for work follow-up, and 2.87 for hospital- health center. On the other hand, women spend extra 4.56 minutes for work travels, 4.09 for work follow-up, 6.21 minutes for hospital-health center.

- It is seen that men have had the rate of 10% for school travels, 3% for shopping, 3% for friend visit, 1% for hospital-health center travels; women have had the rate of 14% for school travels, 7% for shopping, 5% for friend visit, 3% for hospital-health center travels. When these results are taken into account, women travel and spare time more than men for school, hospital, friend visit and shopping.

- When considering the travel time of men and women by purpose of travel and age groups, child age group has the shortest home-arrival travel time with 20.26 minutes, young-middle age group has the longest travel time with 41.56 minutes among men. Among women, child age group has the shortest travel time with 20.44 minutes and young age group has the longest travel time with 39.48. Regardless of the departure point, travel behavior of child-aged individuals intends to minimize the arrival time.

- In work travels, child age group has the shortest travel time with 26.45 minutes and young age group has the longest travel time with 39.84 minutes among men. Among women child age group has the shortest travel time with 24.24 minutes and young age group has the longest travel time with 39.38. Among both men and women, young age group spends the longest time for business travels. This shows that they take the risk of time loss and endure longer travel times for joining business life.

- In business travels, the average travel time of young woman age group is 4 minutes more than the average travel time of all women age groups. This amount shows that young woman age group endures longer travel times and contributes to labor and employment more than their

²⁷ TUIK, 2014.

²⁴ AUAP, 2014.

Table 2. The travel time distribution in men by the purpose of travel and age groups

Age groups			The purpose of travel										
			Home	Work	School	Work follow-up	Shopping	Social sports, entertain	Hospital health center	Friend visit	Others	Total	
Travel time (minutes)													
Man	6-14	N	5200	87	4398	4	119	369	53	161	232	10623	
		Mean	20.26	26.45	17.26	30.00	29.13	27.30	33.17	31.39	25.61	19.77	
		SD	17.557	21.274	13.228	21.213	26.344	25.547	22.955	31.143	21.848	17.168	
		SAG	6.0%	.2%	30.5%	.3%	3.6%	5.9%	3.6%	5.5%	5.4%	5.9%	
15-24		N	9059	2595	4331	122	369	1415	88	448	696	19123	
		Mean	38.93	39.84	34.89	40.93	31.73	32.69	41.65	36.67	39.07	37.51	
		SD	28.099	26.887	24.014	26.483	21.425	25.619	25.510	28.886	26.488	26.801	
		SAG	20.0%	10.5%	60.6%	11.4%	12.1%	27.3%	7.4%	17.7%	24.8%	20.2%	
25-40		N	14920	12224	437	392	766	1180	247	555	673	31394	
		Mean	41.56	39.57	38.70	39.30	28.21	32.66	39.82	36.92	37.14	39.87	
		SD	28.763	26.098	29.652	28.680	20.226	25.226	28.420	29.806	25.997	27.535	
		SAG	35.3%	49.1%	6.8%	35.0%	22.4%	22.7%	19.9%	22.1%	22.8%	35.2%	
41-64		N	15435	10208	160	527	1510	1807	590	1075	1185	32497	
		Mean	39.58	37.97	28.23	39.03	30.24	30.82	39.50	37.99	36.26	37.91	
		SD	28.709	25.775	21.181	29.965	22.984	24.648	26.601	30.755	30.738	27.589	
		SAG	34.7%	39.3%	1.8%	46.8%	47.3%	32.8%	47.3%	44.0%	39.2%	34.6%	
65 +		N	2101	253	46	80	468	658	282	272	285	4445	
		Mean	33.42	36.00	18.41	36.21	30.13	29.12	38.09	36.43	29.96	32.74	
		SD	25.810	24.439	12.377	32.464	23.308	22.458	25.645	26.149	26.716	25.268	
		SAG	4.0%	.9%	.3%	6.6%	14.6%	11.3%	21.8%	10.7%	7.8%	4.1%	
Total		N	46715	25367	9372	1125	3232	5429	1260	2511	3071	98082	
		Mean	37.66	38.87	26.60	39.10	29.87	31.26	39.13	36.93	35.70	36.26	
		SD	28.191	26.042	21.857	29.298	22.380	24.885	26.547	29.792	28.054	27.039	
		SAG	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

*Standard Deviation: SD, % of Sum in Age Group: SAG.

fellows. This amount is 1.25 minutes for young man age group. It is possible to conclude that men participants in young man age group also prefers to take the risk of longer travel time and contribute to economy though not as much as young woman group.

- In school travels, young-aged individuals travel most. The travel time of young men and women are 34.89 and 36.24 minutes respectively. Considerable difference in this purpose of travel emerges in only young-middle age group. There are considerable differences in the cost of travel time spent by young-middle age group. The average travel time is 38.70 minutes for men and 25.10 minutes for women. Taking into consideration that the cost of time is 3.08 TL/hour in Ankara, this 13.6 minute difference shows that the cost of time loss of school travels in men is more than the ones in women. This appears in monthly income of men as an additional 15 TL endurance cost.

- Although the average travel time for hospital-health center in women is more than in men, the average travel

times of young, young-middle age and old men are more than in women. The average travel times of these age groups are 41.65, 39.82, 38.09 in men and 39.60, 39.77 and 36.99 respectively.

- Although women stand out in friend visits in terms of travel number, men travel 36.93 minutes within the average travel times of all age groups for this purpose compared to women travelling 34.83 minutes.

Summary information on travel time by the purpose of travel is given in Table 4. According to Table 4, it is seen that work, work follow-up, and hospital-health center travels take the longest time while school and shopping travels take the shortest time. This shows that participants both take the risk of time loss and afford the cost of long-distance travels by travelling for longer time when it concerns their private lives.

Before researching whether there are differences in travel times by the purpose of travel, it is researched under hypothesis of ANOVA test whether variances are ho-

Table 3. The travel time distribution in women by the purpose of travel and age groups

Age groups			The purpose of travel										
			Home	Work	School	Work follow-up	Shopping	Social sports, entertain	Hospital health center	Friend visit	Others	Total	
Travel time (minutes)													
Man	6-14	N	4629	59	3988	2	130	285	38	146	201	9478	
		Mean	20.44	24.24	17.61	60.00	30.34	29.25	34.50	30.93	26.82	20.04	
		SD	18.122	23.022	13.564	21.213	27.659	25.040	35.798	25.412	22.075	17.495	
		SAG	9.2%	.5%	31.5%	1.0%	3.2%	6.8%	1.7%	4.2%	6.4%	9.2%	
	15-24	N	6666	1083	3679	56	521	804	158	377	699	14043	
		Mean	39.48	39.38	36.24	38.30	31.51	32.80	39.60	36.51	37.52	37.76	
		SD	28.315	27.021	25.156	20.210	21.662	23.089	25.208	31.081	26.213	26.913	
		SAG	25.7%	14.2%	59.8%	17.7%	13.5%	21.5%	7.9%	12.9%	31.0%	25.6%	
	25-40	N	9081	4254	563	130	1469	1211	658	1050	783	19199	
		Mean	37.35	38.55	25.10	36.96	28.85	33.33	39.77	32.77	29.48	35.86	
		SD	28.678	25.876	22.222	23.489	24.191	26.459	27.778	26.651	27.453	27.444	
		SAG	33.1%	54.7%	6.3%	39.7%	34.8%	32.9%	33.0%	32.3%	27.3%	33.2%	
	41-64	N	7791	2368	166	126	1802	1316	921	1259	711	16460	
		Mean	37.69	37.96	26.58	39.16	28.30	31.58	41.18	36.76	36.38	36.18	
		SD	30.009	26.947	20.750	30.263	22.972	25.854	26.255	30.838	32.223	28.662	
		SAG	28.6%	30.0%	2.0%	40.8%	41.9%	33.9%	47.8%	43.5%	30.6%	28.7%	
	65 +	N	1056	47	44	5	297	204	208	224	101	2186	
		Mean	32.79	37.45	19.43	17.00	26.89	29.40	36.99	33.27	38.88	32.20	
		SD	28.592	25.747	21.867	8.367	22.121	26.155	22.368	29.775	33.671	27.410	
		SAG	3.4%	.6%	.4%	.7%	6.6%	4.9%	9.7%	7.0%	4.6%	3.4%	
Total		N	29223	7811	8440	319	4219	3820	1983	3056	2495	61366	
		Mean	35.08	38.37	26.41	37.90	28.85	32.10	40.02	34.83	33.87	33.81	
		SD	28.319	26.371	22.034	25.840	23.365	25.470	26.542	29.223	28.729	27.047	
		SAG	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

*Standard Deviation: SD, % of Sum in Age Group: SAG.

Table 4. The average of travel time by purposes

	N	Mean	Std. Deviation
School	17812	26.51	21.94
Shopping	7451	29.29	22.947
Social, sports and entertainment	9249	31.61	25.13
Others	5566	34.88	28.371
Friend visit	5567	35.77	29.497
Home	75938	36.67	28.268
Work	33178	38.76	26.12
Work follow-up	1444	38.83	28.566
Hospital-health center	3243	39.67	26.543
Total	159448	35.32	27.069

Table 5. Homogeneity of variances test

Levene Statistics	df1	df2	Sig. (p)
239.977	8	159439	.000

Table 6. The equality of travel time averages test

Welch Statistics	df1	df2	Sig. (p)
544.015	8	16740,850	.000

homogeneous or not. As shown in Table 5, it is seen that the homogeneity of variances hypothesis ($p < \alpha = 0.05$) is not proved at 95% significance level because F-value is (8, 159439)=239.977, $p = 0.000$ in Levene statistics.

As the hypothesis is not proved, instead of one-way ANOVA, it is applied to Welch's ANOVA, which is not affected by the hypothesis failure and asymptotically distributes F, in order to see whether there are differences in travel times by the purpose of travel.^{28,29,30} The results obtained are given in Table 6. According to Welch statis-

²⁸ Welch, 1947. ²⁹ Moore et al, 2009. ³⁰ Chen and Lam, 1989.

Table 7. Subgroups on travel time according to Games-Howell test

The purpose of travel	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
School	17812	26.51					
Shopping	7451		29.29				
Social, sports and entertainment	9249			31.61			
Others	5566				34.88		
Friend visit	5567				35.77	35.77	
Home	75938					36.67	
Work	33178						38.76
Work follow-up	1444						38.83
Hospital-health center	3243						39.67
Sig.		1.000	1.000	1.000	.736	.735	.708

tics, F-value (8, 16740,850)=54.015 appears as p=0.000 in Table 6. This shows that there are statistically considerable differences between the averages of travel times by the purpose of travel ($p < \alpha = 0.05$).

There are nine different purposes of travel under the scope of this study. It is important to determine that travel times vary by these purposes. In this case, it is applied to Games-Howell test, one of the post-hoc tests, to determine these different groups.^{31,32} There are no statistically considerable travel time differences between the purposes of travel in homogeneous subgroups. However, there are considerable differences in the purposes of travel appearing in different groups. According to Games-Howell test, homogeneous subgroups on the purposes of travel are given in Table 7. According to Table 7, school, shopping, social-sports and entertainment travels appear in totally different subgroups from other purposes with regard to average travel times. Work, work follow-up and hospital-health center travels appear in the same group while friend visit appears in the same group with both home travels and others.

While examining travel times, in order to determine the difference between men and women, it is important to separately review the purpose of travel by gender and examine whether there is any difference between them. According to analysis results of men in Figure 2, school travels are the shortest travels; work, work follow-up and hospital-health center travels are the longest travels in terms of the average time.

In order to determine whether there are differences in travel times by the purposes of travel or not, it is necessary to see whether variances are homogeneous in accordance with ANOVA test or not. As F-value (8, 98073)=138.928 is p=0.000 according to Levene statistics in Table 8, it is seen

that variances are not homogenous at 95% significance level in the analysis of men ($p < \alpha = 0.05$).

As this hypothesis is not proved, it is applied to Welch's ANOVA instead of one-way ANOVA test in order to see whether there are differences between travel times by the purposes of travel. It is given in Table 9 that Welch F-value (8, 9229,353)=332.193 is p=0.000. This shows that there are statistically considerable differences between

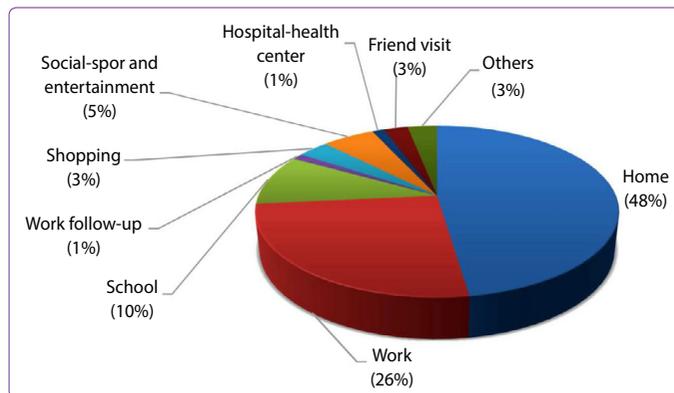


Figure 2. Summary information on travel time of men by the purpose of travel.

Table 8. The homogeneity of variance test in men

Levene Statistics	df1	df2	Sig. (p)
138.928	8	98073	.000

Table 9. The equality of travel time averages test in men

Welch Statistics	df1	df2	Sig. (p)
332.193	8	9229,353	.000

³¹ Games and Howell, 1976.

³² Stolone, 1981.

Table 10. Subgroups of average travel time in men according to Games-Howell test

The purpose of travel	N	Subset for alpha = 0.05				
		1	2	3	4	5
School	9372	26.60				
Shopping	3232		29.87			
Social, sports and entertainment	5429		31.26			
Others	3071			35.70		
Friend visit	2511			36.93	36.93	
Home	46715			37.66	37.66	37.66
Work	25367				38.87	38.87
Work follow-up	1125					39.10
Hospital-health center	1260					39.13
Sig.		1.000	.550	.115	.119	.468

the average travel time of men by the purposes of travel ($p < \alpha = 0.05$).

Homogeneous subgroups of the purpose of travels are given in Table 10. According to Table 10, school, shopping, social-sports and entertainment travels totally distinguish from other purposes. While friend visit appears in the same group with both home travels and others; work, work follow-up and hospital-health center travels appear in the same group.

When considering the purpose of travel in women, they spend the longest time for work, work follow-up and hospital-health center while they spend the shortest time for school and shopping travels according to Figure 3.

In the analysis of women, it is seen that variances are not homogenous at %95 significance level ($p < \alpha = 0.05$) as F-value (8, 61357)=96.799 is $p = 0.00$ in Table 11 according to Levene statistics.

As this hypothesis is not proved, it is applied to Welch's ANOVA instead of one-way ANOVA to see whether there are differences between travel times of women by the pur-

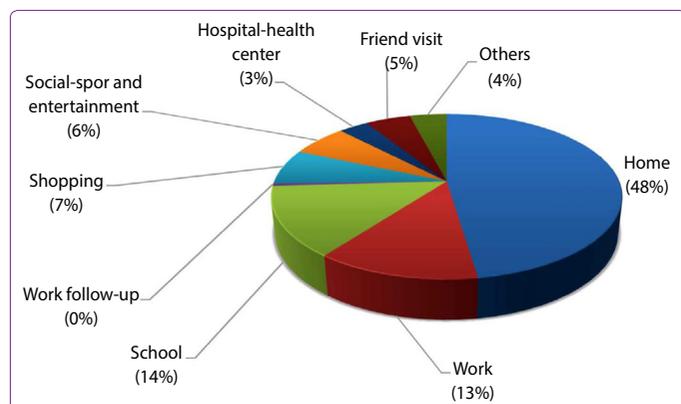


Figure 3. Summary information on travel time by the purposes of travel in women.

poses of travel. The results obtained are given in Table 12. According to Table 12, Welch F-value (8, 5474,585)=191.740 which has equated to $p = 0.000$ shows that there are statistically considerable differences between travel time averages in women by the purposes of travel.

In order to determine different groups of average travel time in women, homogeneous subgroups of the purposes of travel are given in Table 13 according to Games-Howell test, one of the post-hoc tests. According to Table 13 in terms of the average travel time, school and shopping; social-sports and entertainment, others and friend visit; others, friend visit and home; work, work follow-up and hospital-health center travels appear in the same groups.

It is applied to independent T-test for examining the travel time of two independent groups, women and men, by the purposes of travel by age groups. The value ($p < \alpha = 0.05$) in test result shows that there are considerable differences between the groups in the category of the test. According to T-test, it is seen that there are no considerable differences between the average travel times of young women and men by all the purposes of travel.

Table 11. Homogeneity of variances test in women

Levene Statistics	df1	df2	Sig. (p)
96.799	8	61357	.000

Table 12. The equality of travel time averages test in women

Welch Statistics	df1	df2	Sig. (p)
191.740	8	5474,585	.000

Table 13. Subgroups of the average travel time in women according to Games-Howell test

The purpose of travel	N	Subset for alpha = 0.05			
		1	2	3	4
School	8440	26.41			
Shopping	4219	28.85			
Social, sports and entertainment	3820		32.10		
Others	2495		33.87	33.87	
Friend visit	3056		34.83	34.83	
Home	29223			35.08	
Work	319				37.90
Work follow-up	7811				38.37
Hospital-health center	1983				40.02
Sig.		.151	.066	.918	.318

Statistics and tests, which are discussed in accordance with Table 14, focus on results of the categories with considerable differences in the following parts of the study. When considering in line with Table 14;

- It is possible to mention that there are considerable differences only between the average school-based travel

times of young age groups. P values by the purposes of travel are determined as (0.014, 0.015) for school travels. It has not been found that there are considerable differences between the home, work follow-up, hospital-health center, shopping, social-sports and entertainment-based travel times of these people ($p > \alpha = 0.05$).

- It is possible to mention that there are considerable differences between the average home, work, school, friend visit and others -based travel times by arbitrary women and men out of young-middle age groups. P values by the purposes of travel are determined as (0.000, 0.000) for home travels, (0.028, 0.028) for work travels, (0.000, 0.000) for school travels, (0.005, 0.006) for friend visit, and (0.000, 0.000) for others. Considerable differences are not determined between work follow-up, hospital-health center, shopping, social-sports-entertainment travels of these people ($p > \alpha = 0.05$).

- It is possible to mention that there are considerable differences between the average home and shopping-based travel times of middle-aged people. P values by the purposes of travel are determined as (0.000, 0.000) for home travels and (0.016, 0.016) for shopping travels. Considerable differences are not determined between the average travel time for school, work, work follow-up, hos-

Table 14. Independent Samples Test

Purpose of travel	Travel time (minute)	Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
15-24 age group school	EVA*	6.739	.009	-2.446	8008	.014	-1.346	.550	-2.425	-.267
	EVNA*			-2.437	7671.493	.015	-1.346	.552	-2.429	-.263
25-40 age group home	EVA	3.183	.074	11.018	23999	.000	4.213	.382	3.464	4.963
	EVNA			11.026	19217.842	.000	4.213	.382	3.464	4.962
25-40 age group work	EVA	.044	.834	2.194	16476	.028	1.017	.464	.109	1.926
	EVNA			2.203	7471.421	.028	1.017	.462	.112	1.922
25-40 age group school	EVA	29.245	.000	8.292	998	.000	13.603	1.641	10.384	16.822
	EVNA			8.003	783.482	.000	13.603	1.700	10.266	16.940
25-40 age group friend visit	EVA	2.192	.139	2.843	1603	.005	4.145	1.458	1.285	7.005
	EVNA			2.747	1024.539	.006	4.145	1.509	1.184	7.106
25-40 age group others	EVA	1.057	.304	5.436	1454	.000	7.655	1.408	4.893	10.417
	EVNA			5.458	1440.410	.000	7.655	1.402	4.904	10.406
41-64 age group home	EVA	6.837	.009	4.664	23224	.000	1.889	.405	1.095	2.684
	EVNA			4.596	15030.695	.000	1.889	.411	1.084	2.695
41-64 age group shopping	EVA	3.746	.053	2.410	3310	.016	1.932	.802	.361	3.504
	EVNA			2.410	3208.824	.016	1.932	.802	.360	3.504
65 + age group others	EVA	8.437	.004	-2.685	384	.008	-8.920	3.322	-15.452	-2.388
	EVNA			-2.407	147.020	.017	-8.920	3.705	-16.242	-1.597

*Equal variances assumed: EVA, Equal variances not assumed: EVNA.

pital-health center, shopping, social-sports and entertainment ($p>\alpha=0.05$).

- Considerable differences have been determined only between the average others based travel times of old people ($p=0.008, 0.017$). It is seen that there are no considerable differences between the average travel time for all purposes of travel except for others ($p>\alpha=0.05$).

Discussion and Conclusion

When analyzing general tendency of the participants in household survey, the average travel time varies by which ever purposes of travel. This basically emerges from different individuals' purposes of travel in different age groups. It is obvious that there is difference between access time of child-aged individuals to the schools which are close to their homes and access time of high-school or college students to the schools which are far away from their homes. It is also this kind of travel that woman or man in young age group executes the work travel longer than middle-aged woman and man. The destinations of shopping travels are possibly market, big shopping center and local business center. This causes shortening-extension of travel time. These differences also lead travel times to distinguish from each other.

When considering the averages of travel time by purpose, it is determined that the work, work follow-up and hospital-health center travels are the longest ones while school and shopping travels are the shortest ones. The main reason why school and shopping travels take short time is that students prefer to go to the closest school to their homes and individuals go to the closest grocery stores or markets. Owing to employment and economic concerns on earning income or the demand for getting quick solutions to their health problems, people can tolerate longer-distance travels.

Analyses show that there are statistically considerable differences between the averages of travel time. According to post-host tests conducted for determining the purposes which cause these differences, work and work follow-up appear in the same group while school and shopping are generally in different groups. School and shopping travels are generally executed more by individuals in different groups. Work and work follow-up travels appear in similar travel types and they generally refer to regular commuter trip to their home in a certain distance.

According to T-tests, there are not statistically considerable differences between the average travel times of child-aged participants in all purposes of their travels. When considering that these individuals spend most of the day at school or home, it is necessary to accept normal that there is no difference. The differences in travel time appear in mostly young and middle-aged participants. During

the day, the most active group is young-middle-aged individuals with the travel rate of 31.7%. It is inevitable that they have different travel times by different purposes of travel in urban transport.

In a male-dominant urban and community life, it is important to take the travel need of woman, old people, children, and disabled people into consideration and organize short term-long term transportation goals. In this context, it is necessary to provide more flexible working hours for women and increase job opportunities closer their homes. Transportation alternatives should be organized with urban administrators and employers if necessary. It is important for disadvantaged groups including woman, children, old and disabled people to develop door to door transportation services and make proper physical arrangements in transportation vehicles for their quick and safe access.

People of all ages should have equal right of transportation and access in urban transport. Therefore, it is necessary to increase individual-based transportation policies and develop public transportation, focusing on the access of people instead of approaches focusing on the mobility of vehicles.

In order to shorten travel time, prevent the use of transportation types more than one in urban transport, decrease the demand for multiple travels and minimize time loss in transportation, it is necessary to encourage mixed land-use areas. The integration of land use also should be enabled through transportation plan.

Cars are the main factor for extension of travel time in cities and slowing of public transportation speed. It requires integrating the use of car with public transportation systems and alternative transportation implementations like park-and-ride systems to shortening travel time. It is also important to take disincentive steps like road and area charge (congestion charge), taxation and increasing the car park prices to limit car dependency.

Beside children and old people, young and active population should be also encouraged to use public transportation through increasing their participation in urban life. Thus, they will ensure both more active and healthier urban life through increasing the quality of urban life and urban transport.

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