

MOBILITY CHARACTERISTICS OF DIFFERENT POPULATION GROUPS IN A LARGE METROPOLITAN AREA: ISTANBUL, TURKEY

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ABSTRACT

In this study, we attempted to answer the questions of who moves most and who moves least in the city of Istanbul. We presented the results of a comprehensive data collection effort regarding the characteristics of households and the household members as well as their trip productions and travel patterns in the metropolitan city of Istanbul, Turkey. Representation of the data for different socio-economic groups living in the city of Istanbul was quite high because all housing units in the database were randomly selected (PPS) based upon the population of all 986 neighborhoods in 32 districts plus the neighboring town of Gebze at the east boundary of Istanbul. Based on the results of the analyses, people who work make less home based-school and other-purpose trips but make more non-home based trips, compared to people with no-work. The highest total trip rate belongs to males, the senior citizens (>64 years old), people with post graduate education, with no job, with a valid driving license, and people living in a house allocated due to their official duty. The highest trip length belongs to males, middle age people (31-45 ages), people with post-graduate education, with job, with a valid driving license, and living in a house allocated due to their official duty.

Keywords: travel survey, mobility, trip rate, population groups, who moves most, Istanbul.

INTRODUCTION

Factors associated with who moves most and who moves least are always interest to social policy makers, city and transport planners. Different socio-economic groups have different mobility characteristics and patterns. Level of income, social and household status, auto ownership and employment have strong effects on people's mobility level and patterns. Different population groups or people with different socio-demographic and -economic

characteristics present different mobility characteristics. It is long known that high income and individual lifestyles affect travel behavior. For example, Pan et al. (2009) reported that the high average income of American families fostered societal values and individual lifestyles that heavily favor the private car over alternative modes of transportation. Another example of a frequently cited study of travel behavior for five San Francisco Bay Area neighborhoods showed that societal values and individual lifestyles, measured by various attitudinal variables, explained the highest proportion of variation in travel behavior (Kitamura, et al. 1997).

Household characteristics are also considered as factors affecting travel behavior of household members. For example, Zwerts et al. (2007) reported that the arrival of a child affected parents' travel behavior considered as trip making, number of trips and distance traveled. Not only the presence of children has an effect, but it was also found that the age of the (youngest) child influences parents' travel behavior strongly and this up to the age of 16 years. Moreover, the influence on parents' travel is different for mothers and fathers. In particular mothers take care for the transportation of the children. Secondly, from an exploratory study with couples before and after childbirth, the differences between men and women pointed out that women became some kind of "a taxi driver" of the child, even shortly after birth. The travel mode used for trip making was another point of interest. A travel behavior study revealed that men travelled more by car (as driver) and women more as a car passenger and by public transport. Also a difference before and after childbirth in the use of transport means was observed that the use of the car as driver decreased for men and increased for women (probably because women needed the car to bring or get the child).

Susilo and Maat (2007) concluded from their analyses examined commuting journeys in the Netherlands that the influence of urban form became less significant during this time and that individual and other factors were more important than the urban form and accessibility in determining the travel behavior of commuters.

A literature review of studies that focused on the travel behavior of older people suggested that the following factors affected travel behavior: age, gender, medical condition, ability to drive, cost of a trip, residential location (suburb vs. city), trip purpose, day of the week, time of day, income, and availability of a private vehicle. The results suggested that being elderly and/or retired had a negative effect towards drive, passenger and walk as compared with transit. This analysis helped in visualizing the finding that being elderly, driving costs and out-of-vehicle transit costs were more important determinants of shifts away from driving towards transit than were travel time changes (Lucas et al., 2007).

Pan et al. (2009) reported that higher income and car ownership were associated with longer travel distance, whereas the age, gender (female), and residential location variables were negatively correlated with travel distance. For instance, when income increases, people tend to switch from travel modes with lower mobility and less comfort to ones with higher mobility and more comfort. Older travelers and travelers in larger households were more likely to walk or ride a bike than to take the transit or drive. Note that neither gender nor car ownership showed a statistically significant effect on the relative likelihoods of choosing transit versus

walk/bike. However, they both became significant in explaining the odds ratio of choosing driving vs. walking or biking. The main interest of this study was in the variation of modal preference as it related to urban form characteristics. Location effects clearly showed statistical significance, even when the influences of socio-economic and trip time variables were all controlled for.

In this study, we attempted to answer the questions of who moves most and who moves least in the city of Istanbul. The structure of this paper is as follows: The next section gives some brief information on the characteristics of the study area. The following section analyzes the socio-demographic and –economic characteristics of the residents of the study area. The section of the analyses of daily internal urban trips comes next. The last section of the paper presents the conclusions of the current research and some recommendations for future research.

CHARACTERISTICS OF THE STUDY AREA

City of Istanbul

City of Istanbul is situated at the north-west of Turkey, a bridge between Asia and Europe. Its population is almost 13 million according to 2009 census. Istanbul is in the first 10 urban agglomerations out of 100 with its 5389 km² territory. The rate of population growth has been slowly declining in Istanbul, but it is yet high at over 3% per annum. The recent annual increase ranged from 0.4 to 0.5 million. With an annual growth of 3%, the population of Istanbul will have exceeded 20 million in 2023. At a lower growth derived from the past trend, the population will have reached 18 million. The 2023 comprehensive urban plan of the Istanbul Metropolitan Municipality suggests some measures to control the growth of population over 16 million. It is requisite to implement decisive policy instruments to curb the population density (IMM, Almec and Nippon Koei, Co, 2009).

2006 household travel survey revealed that the registered automobiles in the metropolitan region totaled to 1.33 million. With the expected economic growth, the number of motorized vehicles will increase rapidly by more than 3.14 times to 4.19 million in 2023. Registered automobiles per thousand of population were 111 vehicles in 2005 and will increase to 245 by 2023. In 2006, 31% of the metropolitan households owned one passenger car and 4% two or more. The passenger car ownerships are estimated to increase to 67% of the households in 2023 (IMM, Almec and Nippon Koei, Co, 2009).

Istanbul's highway network is classified by functional class from 1 to 5. Function class (FC) 5 stands for highways and expressways with 90 and 120 km/hr speed limit. FC from 1 to 3 stands for primary and secondary arterials and collectors. FC 4 is not mentioned here because the travel demand model did not consist them. Table 1 shows the roadway network lengths by functional classification.

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Table I – Functional Classification of Roads in 2006

Functional Class	No. of Links	Length (km)*
1. Primary Arterial	5.891	3.907,6
2. Secondary Arterial	4.958	4.743,1
3. Collector	1.574	3.274,4
5. Highway and Expressway (D-100 and E-80)	842	2.025,2
6. Ramps	1.748	517,8
Total	15.013	14.468,0

* Length equals to the multiplication of link length by the number of lanes.

Figure 1 shows the master plan projects by their completion period. The total investment required for the master plan projects amounts to US\$24.2 billion. US\$ 11 billion is required for 52 road projects and US\$13.2 billion for 16 railway projects. The total cost of 10 projects scheduled for completion after 2023 is US\$5.5

billion. Figure 2 shows the base network of railway lines. Gray lines represent the lines in operation. Red lines are the ones completed by 2013 and the green ones are to be completed between 2014 and 2018 (IMM, Almec and Nippon Koei, Co, 2009).

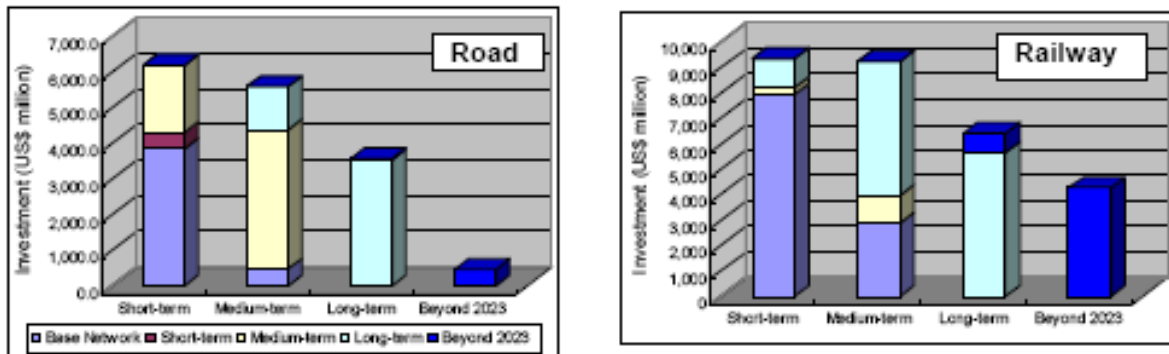


Figure 1 – Master Plan Projects by completion period



Figure 2 – Base network of railway lines

Figure 3 shows the Bosphorus crossing demand by daily 1000 passengers. The master plan proposes the completion of the 3rd bridge by 2023 as both railway and highway links across the Strait. The new bridge is needed simply to meet the expected growth of demand.

However, there are many arguments against the new bridge. Main arguments of the contention are the problem of land acquisition and the adverse impact on natural environment and landscape. The natural environment includes fresh water reservoirs and forest areas. It is necessary to undertake careful studies over these issues and explain the circumstances of project formulation until a general consensus begins to emerge (IMM, Almec and Nippon Koei, Co, 2009).

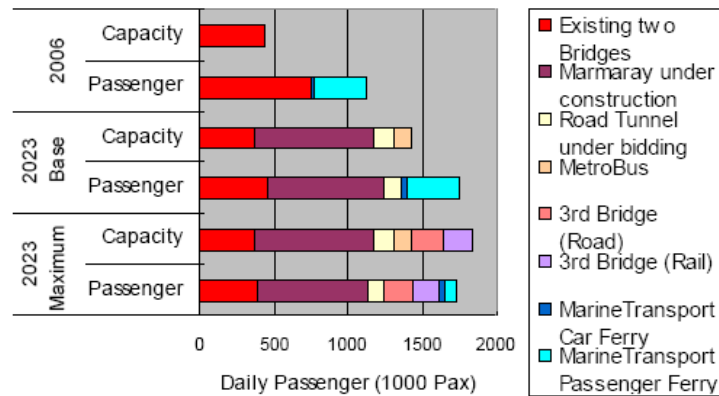


Figure 3 – Bosphorus crossing demand by daily passenger (1000 pax)

ANALYSIS OF SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE RESIDENTS LIVING IN THE STUDY AREA

Analysis of Individuals’ Characteristics

The scope of the 2006 household survey encompasses the households characteristics and transport behaviors of individuals living in the metropolitan city of Istanbul as well as urban part of the city of Gebze, which is just located at the east border of Istanbul. The population estimation of the survey study including the city of Gebze is 12 million and 6,014, of which 49.8% are females (5,973,496). Table 2 shows the age groups of the population in 2006. The highest percentage of the population (24.7%) is the persons between 31 and 45 years old.

Table 2 – Age classification of the Istanbul’s population in 2006

Classification	Age Group	No. of Persons	Percent
1. Pre-school	<6	954,423	7.95
2. Young	6–18	2,710,522	22.58
3. Lower-medium	19-30	2,800,021	23.32
4. Medium	31–45	2,890,362	24.07
5. Upper-medium	46–64	1,979,650	16.49
6. Senior	>64	670,904	5.59
Total		12,005,884	100.00

Table 3 shows the educational classifications of the population in 2006. The highest percentage of the population (61.7%) is the persons whose educations are from primary to high school. Percent of illiterate

people is quite high (14.12%). On the other hand, the number of post-graduated persons is extremely low (0.64%).

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Table 3 – Education classification of the Istanbul's population in 2006

Classification by Education	No. of Persons	Percent
1. Illiterate	1,694,255	14.12
2. No degree at all	1,850,639	15.43
3. Primary to High school	7,402,097	61.70
4. College-University	973,399	8.11
5. Post-graduate	76,881	0.64
Total	11,997,271	100.00

Table 4 shows driving license ownership by auto owning households of the population in 2006. While in no-auto households, only 20.8% of the household members own a license, 43.2% of members have a license in auto-owner households. Overall only 29% of the population (3,489,607) owns a drivers' license.

Table 4 – Driving License ownership by auto ownership of the Istanbul's population in 2006

Auto ownership	Driving License ownership	No. of Persons	Percent
No-auto households	1. No driving license	5,997,606	79.20
	2. Owns driving license	1,575,330	20.80
	Subtotal	7,572,936	100.00
Auto owner households	1. No drivers' license	2,518,772	56.82
	2. Owns driving license	1,914,277	43.18
	Subtotal	4,433,049	100.00
Total		12,005,985	100.00

In Istanbul metropolitan area (city of Istanbul and Gebze), about one-third of the population (34.6%) are employed. People who seek to work in the unemployed

population are extremely low (4.3%). Percent of homemakers in the unemployed population is the highest by 35.5%. Students and retired people are 18.0 and 12.0%, respectively.

Table 5 shows the home ownership data in 2006. In Istanbul, 58.0% of the population is home-owners. The rest are tenants and households living in houses allocated due to their official use or living in houses owned by their relatives who do not require a payment for rent.

Table 5 – Home-ownership of the Istanbul's population in 2006

Home ownership	No. of Persons	Percent
Home owner	6,940,608	57.99
Tenant	4,129,515	34.50
House allocated for official use	53,380	0.45
Not home owner but pays no rent	830,563	6.94
Other	13,956	0.12
Total Persons	11,968,021	100.00

Analysis of Households' Characteristics

The households included in the survey are classified by the number of workers, students, children (age less than 18), auto ownership, income, household type and size, and dwelling unit classification. The number of households projected in the study area is 3,391,141. Table 6 shows the household classification by the

number of workers. 81,4% percent of households consist of at least one worker. Little bit more than half of the households (51,3%) have one worker. Households without a worker is not very low (18,6%), though. Such households may be consisted of retired persons, families of martyrs or veterans who receive some income from the government, or people who receive income as in the form of rents from their real estate's or ones who do not disclose their employment for some reasons.

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Table 6 - Household classification by no. of workers

No. of workers in the household	No. of households	Percent of households	Percent of households having workers
None	633,065	18.64	na
One	1,742,045	51.29	63,05
Two	746,310	21.98	27,01
More than two	274,721	8.09	9,94
Total	3,396,141	100.00	100.00

Table 7 shows the household classification by the number of students. There is no student in 36,2% of the households in the study area. Households that have one student consist of 46.4% of the households having students. Those that have two students are 32.8%.

Table 7 - Household classification by no. of students

No. of students in the household	No. of households	Percent of households	Percent of households having students
None	1,230,052	36.22	na
One	1,005,075	29.59	46.40
Two	710,743	20.93	32.81
More than two	450,272	13.26	20.79
Total	3,396,141	100.00	100.00

Table 8 shows the household classification by the number of children less than 18 years old.

The percent of households without a child are 44,9%. Those that have at least one child is 55,1%. The percent of households with one child in those which have a child

are 43,5%. Those with two children are 38%. In the modern era, conditions of the consumption economy force both parents to work in most families for having better life conditions so that they tend to have fewer children.

Table 8 - Household classification by no. of children less than 18 years old

No. of children in the household	No. of households	Percent of households	Percent of households consisting children
None	1,525,894	44.93	na
One	813,485	23.95	43,50
Two	709,668	20.90	37,95
More than two	347,095	10.22	18,56
Total	3,396,141	100.00	100.00

Table 9 shows the household classification by automobile ownership. 63.9% of the households have no car. Overall out of 100, only 42 households have accessibility to a car, and only 12 out of 100 people have a car. The number of car per

driver's license is 0.60. In parallel to the economic development in the future, auto ownership will certainly increase by the household income increases.

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Table 9 - Household classification by automobile ownership

No. of autos in the household	No. of households	Percent of households	Average monthly income per household (TL)	Autos per household	Autos per person	Autos per driver's license
None	2,164,980	63.87	831.10	na	na	na
One	1,063,069	31.36	1331.79	1.00	0.28	0.87
More than one	161,839	4.77	2298.11	2.15	0.59	0.90
Subtotal	3,389,888	100.00	1057.87	0.42	0.12	0.60
Missing	6,253	na	na	na	na	na
Total	3,396,141	na	na	na	na	na

Table 10 shows the household classification by monthly income. It seems that the households in the study area have a very low income or they are not willing to disclose their real income. About half of the households (43.2%) have a very low income (less than 700 TL/month) and only a small percent of households (0.8%) have income higher than 5000 TL. Middle-class households with 1500-3000 TL income level are 11.9%. With the assumption of average income of 1500 TL, 85% of households have that or lower income. This shows a great inequality in income distribution over the population.

Table 10 - Household classification by monthly income

Household Classification	Income TL/month	No. of households	Percent of households
1. Very low	≤700	1,458,557	43.17
2. Low	701–1500	1,414,182	41.86
3. Medium	1501–3000	401,473	11.88
4. High	3001–5000	77,754	2.30
5. Very High	>5000	26,754	0.79
Total	>0	3,378,720	100.00

Table 11 shows the classification of household type. Households with parent and children living together have the highest percent (64.6%). Households with no children at all are not very low though (27.8%).

Table 11- Household type classification

Household type	No. of households	Percent of households
Households with both parents and children	2,194,995	64.63
Households with only one parent and children	258,461	7.61
Households with both parents but no children	556,199	16.38
Households with only one parent and others but no children	137,465	4.05
One person households	249,021	7.33
Total households	3,396,141	100.00

Table 12 shows the classification of household size by dwelling unit type. Households with four or more persons constitute the highest percent (49.2%) in all. 83.1% of all households live in apartments. Households living in single houses and apartments inside a gated community hold about the same percentage (8.7 and 8.2%, respectively). Single houses are preferred mostly by households with 4 or more people. It is the same for apartments, but two or more person-households prefer apartments inside a gated community.

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Table 12 - Classification of household size by dwelling unit type

Household size	Dwelling unit type											
	Single houses			Apartments			Apartments inside a gated community			Total		
	No. of household	Row %	Col %	No. of household	Row %	Col %	No. of household	Row %	Col %	No. of household	Row %	Col %
One	17492	7,1	6,0	205.956	83,4	7,3	23.416	9,5	8,5	246.864	100,0	7,3
Two	49606	7,5	16,9	548.455	82,8	19,6	64.621	9,8	23,5	662.682	100,0	19,6
Three	56776	27,9	19,4	66.764	32,8	2,4	79.736	39,2	29,0	203.276	100,0	6,0
Four	77797	8,5	26,5	759.696	83,3	27,1	74.163	8,1	26,9	911.656	100,0	27,0
Five or more	91627	12,3	31,2	622.185	83,3	22,2	33.329	4,5	12,1	747.141	100,0	22,2
Total	293298	8,7	100,0	2.803.932	83,1	100,0	275.264	8,2	100,0	3.372.494	100,0	100,0

ANALYSIS OF THE DAILY INTERNAL URBAN TRIPS

Analysis of Trips in the Study Area

Trips by residents in the study area excluding students in dormitories, tourists in hotels, and military people in barracks are estimated to be 16,498,237 made by 7,210,990 people in 2006. 50,7% of these trips were made by 3,728,939 people via motor-vehicles. Overall net trip rate (the number of trips per person who travelled) is 2.29, the rate for motor-vehicle trips is 2.24 and for pedestrian trips is 2.34.

The highest percent of trips by purpose is 36.4% for home based-work trips followed by home based-other and –school trips with 31.9 and 25.6%, respectively. Non-home based trips have the lowest share of all trips by 6.1%. This low percent shows that people usually tend not to disclose their trips other than compulsory ones and that interviewees tend to get tired while the survey progresses further and usually just report compulsory ones not the ones made on foot or ones that are made for purposes other than work or school. First row in trips made in motor-vehicles by purpose is home based-work trips by 51.6%, and the same for pedestrian trips is home based-other trips by 38.2%.

Table 13 shows the trip duration frequency distribution by travel mode. Almost half of the trips (46%) are the ones that ended up in 15 min. 80.2% of these trips are made on foot. After 15 min. pedestrians trips decreases by 50% and motor-vehicle trips increases by 220%. 71.0% of all trips are the ones that ended up in 30 min.

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Table 13 – Trip Duration Frequency Distribution

Trip duration (min.)	Travel Mode								
	On foot			By vehicle			Total		
	No.of trips	Row %	Col. %	No.of trips	Row %	Col. %	No.of trips	Row %	Col. %
0 – 15	6,083,224	80.23	74.78	1,422,255	18.76	17.01	7,582,144	100	45.96
15 – 30	1,628,808	39.40	20.02	2,518,630	60.92	30.11	4,134,047	100	25.06
31 – 45	161,412	12.62	1.98	1,133,340	88.58	13.55	1,279,404	100	7.75
46 – 60	146,650	8.60	1.80	1,580,442	92.73	18.90	1,704,409	100	10.33
61 – 90	51,917	4.88	0.64	1,027,035	96.57	12.28	1,063,504	100	6.45
91 +	62,736	8.54	0.77	681,786	92.79	8.15	734,726	100	4.45
Total	8,134,748	49.31	100.00	8,363,489	50.69	100.00	16,498,237	100	100.00

Table 14 shows the trip length frequency distribution by travel mode. 81.4% of all the trips are the ones that ended up in 10 km. Trips that ended up in 5 km constitute 68% of all trips (see Figure 1), 96.5% of pedestrian trips and 38.8% of motor-vehicle trips. 70% of trips between 0.1 and 5 km were made on foot. 94.8% of the trips between 5.1 and 10 km were made via motor-vehicles. After 10 km, while pedestrian trips decreases, motor-vehicle trips are increased (see Figure 2).

Table 14 – Trip Length Frequency Distribution

Trip Length (km)	Travel Mode								
	On foot			By vehicle			Total		
	No.of trips	Row %	Col. %	No.of trips	Row %	Col. %	No.of trips	Row %	Col. %
0 - 5	7,846,180	69.98	96.45	3,240,856	28.91	38.75	11,211,307	100	67.95
6 - 10	164,186	7.41	2.02	2,100,087	94.83	25.11	2,214,542	100	13.42
11 - 15	53,348	4.30	0.66	1,217,213	98.11	14.55	1,240,629	100	7.52
16 - 20	31,290	4.11	0.38	747,659	98.31	8.94	760,525	100	4.61
21 - 30	30,230	4.51	0.37	656,100	97.89	7.84	670,235	100	4.06
31 - 40	9,512	3.63	0.12	258,614	98.81	3.09	261,720	100	1.59
41 - 60	na	na	na	77,946	100.00	0.93	75,939	100	0.46
61 +	na	na	na	65,015	100.00	0.78	63,341	100	0.38
Total	8,134,748	49.31	100.00	8,363,489	50.69	100.00	16,498,237	100	100.00

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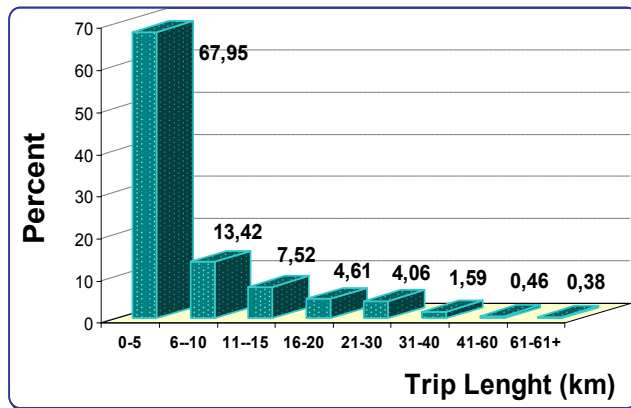


Figure 1 – Trip length frequency distribution (TLFD)

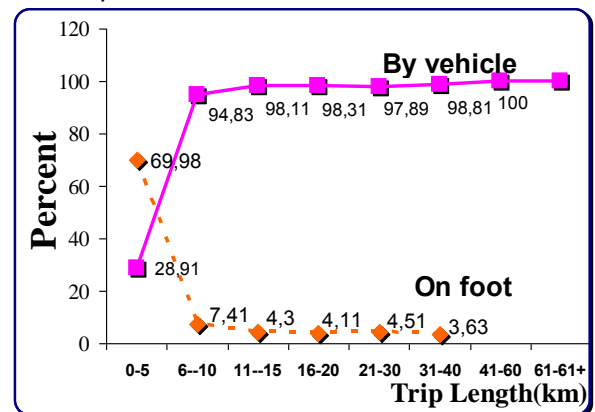


Figure 2- TLFD by travel mode

Trip characteristics of individuals are analyzed based on gender, age, education, work status, driving license and home ownerships classifications.

Analysis of Trips by Individuals' Characteristics: Gender

58.6% (9.675.961) of total trips per weekday (16.498.237) are made by males. Highest percent of trips done by males are home-based work trips by 46.7% and the lowest are non-home based trips by 7.2%. Females who did the highest percent of trips are home-based other trips by 43.4% and the lowest are non-home based trips by 4.5%. Males make more home-based work and non-home based trips than females. On the other hand, females make more home-based school and home-based other trips than males.

Though the net trips rates do not differ very much (2-5%) by gender, males travel longer in length and time than females by 48% and 25%, respectively. Table 15 shows the net trip rates and lengths by gender. Males travel more and longer than females by travel modes. Average motor-vehicle trip rates for males and females are 2.15 (4.9% higher) and 2.05, respectively. Average motor-vehicle trip lengths (km) for males and females are 24.93 (26.8% longer) and 19.66, respectively. Pedestrian trips of males are 12.1% longer than that of females.

Table 15 – Trip rates and lengths by gender

Classification by sex	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
Female	HBW	0.74	na	0.26	na	20.85	na	4.11	na
	HBS	0.43	na	0.82	na	14.97	na	3.4	na
	HBO	0.76	na	1.05	na	17.37	na	3.84	na
	NHB	0.12	na	0.08	na	12.07	na	2.57	na
	Total	2.05	na	2.2	na	19.66	na	3.96	na
Male	HBW	1.31	77.0	0.64	146.2	23.5	12.7	4.66	13.4
	HBS	0.24	-44.2	0.8	-2.4	16.18	8.1	3.48	2.4
	HBO	0.4	-47.4	0.68	-35.2	19.45	12.0	4.13	7.6
	NHB	0.21	75.0	0.09	12.5	20.92	73.3	3.23	25.7
	Total	2.15	4.9	2.2	0.0	24.93	26.8	4.44	12.1

Analysis of Trips by Individuals' Characteristics: Age

Out of 16,498,237 daily internal urban trips, young travelers' (age 6-18) trips constitute 30% (4.958.975). People who aged between 19 and 30 produced %25 (4.053.703) of all trips. Middle-aged group were the most active one and produced %26 (4.304.301) of all trips. After the age of 45, trips reduced to 15% (2.547.386). Vehicle trips increase by middle age and decreases later when the traveler ages further.

Table 16 shows the net trip rates and lengths by age groups. Middle-age (31-45 ages) group is the most active one by the highest trip rate of 2.17 and the length of 25.23 km of motor-vehicle travel. The least active one is the young people (6-18 ages) by the lowest trip rate of 1.98 and the length of 14.83 km of motor-vehicle travel. Regarding walking trips, the most active ones are older people (>64 age) by the highest trip rate of 2.45 and their trip lengths are the second lowest by 4.38 km after the young people's (3.74 km). The longest pedestrian travel belongs to lower medium (19-30 age) and middle-age people by 4.62 and 4.61 km, respectively.

Figure 3 shows that total trip rate increases by age but motor-vehicle trips decreases after middle age. Young people's (6-18 age) net trip rate on an average weekday is 2.23 and that reaches to 2.41 at the older people (>64 age). While young people make home-based school trips most by 1.70 trip rates, lower-medium and middle-age groups make home-based school trips most by 1.28 and 1.31 trip rates. Upper-medium and older people make home-based other trips most by 1.31 and 2.07 trip rates. Middle-age and upper medium people make home-based work trips most via motor-vehicles by 1.47 and 0,98 trip rates, and as a pedestrian they make home-based other trips most by 1.19 and 1.60 trip rates. The lowest trip rate for the groups older than young people is for home-based school trips and that for the young group is for non-home based trips.

Pan et al. (2009) reported that older travelers preferred to ride on a public transit vehicle or walk and bike rather than driver a car, and that trip length is inversely proportional by the age of traveler. In this study, it is similarly seen that when people get older, their trips by a vehicle decrease but their walk trips increase (see Figure 3), and that while people get older, their trip lengths by motor vehicles also decrease (see Figure 4).

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Table 16 – Trip rates and lengths by age groups

Classification by Age	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
Young 6–18	HBW	0.25	na	0.11	na	18.85	na	3.94	na
	HBS	1.4	na	1.71	na	12.75	na	3.39	na
	HBO	0.27	na	0.32	na	15.3	na	3.38	na
	NHB	0.06	na	0.04	na	11.01	na	2.44	na
	Total	1.98	na	2.18	na	14.83	na	3.74	na
Lower Medium 19-30	HBW	1.36	444	0.94	755	22.34	19	4.61	17
	HBS	0.18	-87	0.12	-93	27.93	119	5.04	49
	HBO	0.41	52	0.95	197	17.7	16	3.96	17
	NHB	0.18	200	0.12	200	18.33	66	2.92	20
	Total	2.13	8	2.13	-2	24.69	66	4.62	24
Medium 31–45	HBW	1.47	488	0.83	655	23.34	24	4.54	15
	HBS	0.02	-99	0.1	-94	16.37	28	3.72	10
	HBO	0.47	74	1.19	272	17.8	16	4.06	20
	NHB	0.22	267	0.13	225	20.99	91	3.21	32
	Total	2.17	10	2.25	3	25.23	70	4.61	23
Upper Medium 46–64	HBW	0.98	292	0.47	327	23.93	27	4.62	17
	HBS	0.01	-99	0.03	-98	18.42	44	3.14	-7
	HBO	0.93	244	1.6	400	20.23	32	4.2	24
	NHB	0.21	250	0.13	225	17.09	55	2.95	21
	Total	2.14	8	2.23	2	24.84	67	4.55	22
Older >64	HBW	0.29	16	0.12	9	23.06	22	4.28	9
	HBS	0	-100	0	-100	0	-100	0	-100
	HBO	1.6	493	2.2	588	19.77	29	4.1	21
	NHB	0.12	100	0.13	225	10.86	-1	2.96	21
	Total	2.02	2	2.45	12	21.41	44	4.38	17

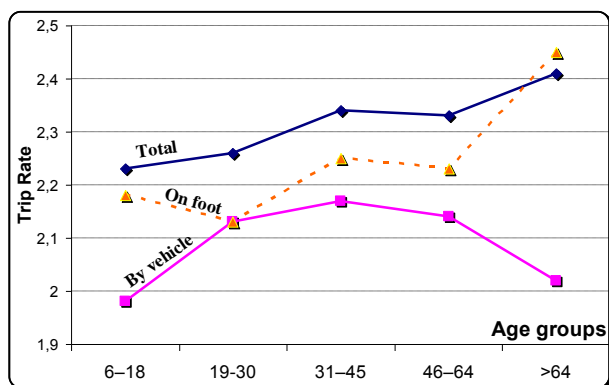


Figure 3 – Trip rate by age

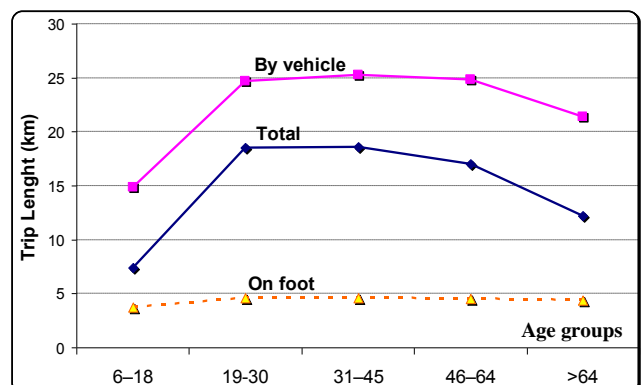


Figure 4- Trip length (km) by age

Analysis of Trips by Individuals' Characteristics: Education

Out of 16,498,237 daily internal urban trips, share of people with no degree at all constitute 24% (3.982.121). Trips of people with education from primary to high school constitute the highest share of all by 65% (10.624.846). Higher educated people's trips are only 11% (1.865.821) due to the lowest share in the population. By travel mode, among all groups, people with higher education (college-university and postgraduate education) make the highest percent of trips by motor-vehicles (%80) and the lowest percent of walk trips by 19%.

Table 17 shows the net trip rates and lengths by education classification. Trips rates increase by the increase in education level. With respect to travel modes, by the increase in education while pedestrian trips decrease, motor-vehicle trips increase. Regarding the trip purposes, people with a degree have the highest trip rate (1.00 to 1.41). Home based-school trips of college-university or higher education graduates are the lowest as expected. Non-home based trips of people with primary to high school degrees or with no degree at all are the lowest since they have lower income compared to the people with higher level of degrees. Non-home based and work trips have the highest increase rate with the increase in education level.

Figure 5 presents that while education level increases, trips rates by motor vehicles increases, and on the other hand pedestrian trips decreases. However, Figure 6 show that, while education level increases, motor vehicles trip lengths increases, same with the trip rates, but pedestrian trips do not change very much.

Table 17 – Trip rates and lengths by education

Classification by Education	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
No degree at all	HBW	0.31	na	0.09	na	19.76	na	3.97	na
	HBS	1.09	na	1.6	na	9.49	na	3.22	na
	HBO	0.49	na	0.49	na	16.64	na	3.56	na
	NHB	0.07	na	0.04	na	12.22	na	2.47	na
	Total	1.96	na	2.22	na	13.89	na	3.63	na
Primary to High school	HBW	1.15	271	0.66	633	22.25	13	4.54	14
	HBS	0.25	-77	0.34	-79	18.99	100	4.1	27
	HBO	0.54	10	1.1	124	18.59	12	4.07	14
	NHB	0.17	143	0.11	175	18.79	54	2.97	20
	Total	2.11	8	2.21	0	23.27	68	4.55	25
College-University	HBW	1.43	361	0.91	911	25.27	28	4.7	18
	HBS	0.07	-94	0.05	-97	25.65	170	3.72	16
	HBO	0.49	0	0.88	80	18.61	12	4	12
	NHB	0.23	229	0.18	350	18.07	48	3.28	33
	Total	2.23	14	2.02	-9	27.82	100	4.63	28

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HBW	1.4	352	0.76	744	25.96	31	4.77	20	
HBS	0.07	-94	0.05	-97	23.32	146	12.67	293	
HBO	0.55	12	1.01	106	18.74	13	4.51	27	
NHB	0.33	371	0.21	425	18.28	50	3.22	30	
Post-graduate	Total	2.35	20	2.03	-9	29.53	113	5.16	42

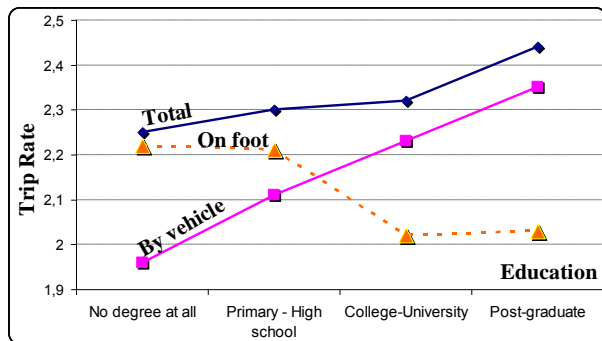


Figure 5 – Trip rate by education

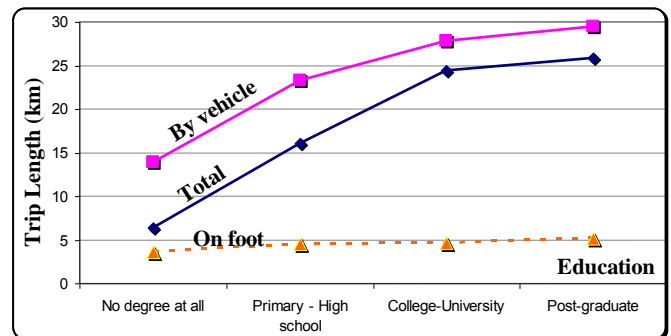


Figure 6- Trip length (km) by education

Analysis of Trips by Individuals' Characteristics: Work Status

Out of 16,498,237 daily internal urban trips, the number of trips of people who work is 7.657.839 (46%). Share of trips for people with no work is 15% higher than that for people who work (8.826.751 trips vs.). However, by travel mode, motor-vehicle trips for people with no work is 15% less than that for people who work, but their pedestrian trips are 165% higher than that for people working.

Out of 8,363,489 trips by motor-vehicles, 66% (5.396.827) and, out of 8.134.748 trips on foot, 27% (2.261.012) are made by people who work. Mode split for people who work is 70% of trips made by motor-vehicles and 30% on foot.

First row in the trips made by people who work is home-based work trips by 78.4%. However, that is home-based other trips for people who does not work by 49.2%. Second row for the people who does not work is home-based school trips by 46.8%. Non-home based trips for people with no work is 46% less than that for people who work.

Table 18 shows the net trip rates and lengths by work status. The rate of trips made by motor-vehicles for people who work (2.16) is 6% higher than that for people with no work (2.03). However, the rate of trips made on foot for people who works 9% less (2.06 vs. 2.26). Regarding the travel length, people who work travel 20 (4.76 vs. 3.98 km) to 37% (25.55 vs. 18.62 km) more than people with no work on foot and by motor-vehicles, respectively.

Regarding trip purposes, motor-vehicle trip rates of home-based school and home-based other for people who work are less than those for ones who do not work by 98 and 81%, respectively. For pedestrian trips the rates are similarly less by 97 and 66% less. However, non-home based trip rates are higher by 91 and 71% for motor-vehicle and pedestrian trips,

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respectively. Trip lengths of people who work are only lower by 2 and 7% for home-based other trips made on foot and by motor-vehicles, respectively. For other trip purposes, trips of working people are longer by 14 to 89% by modes of travel.

Table 18 – Trip rates and lengths by work status

Classification by work status	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
Doesn't work	HBW	na	na	na	na	na	na	na	na
	HBS	0.82	na	1.12	na	15.42	na	3.43	na
	HBO	1.09	na	1.06	na	18.74	na	3.97	na
	NHB	0.11	na	0.07	na	11.32	na	2.49	na
	Total	2.03	na	2.26	na	18.62	na	3.98	na
Works	HBW	1.72	na	1.55	na	22.87	na	4.51	na
	HBS	0.02	-98	0.03	-97	18.63	21	3.91	14
	HBO	0.21	-81	0.36	-66	17.52	-7	3.91	-2
	NHB	0.21	91	0.12	71	21.37	89	3.72	49
	Total	2.16	6	2.06	-9	25.55	37	4.76	20

Figure 7 shows that the total trips rates for people who work (2.26) is %2 less than that for people with no work (2.31). Figure 8 present that trips lengths made by all travel modes for people who work is higher than those for people with no work.

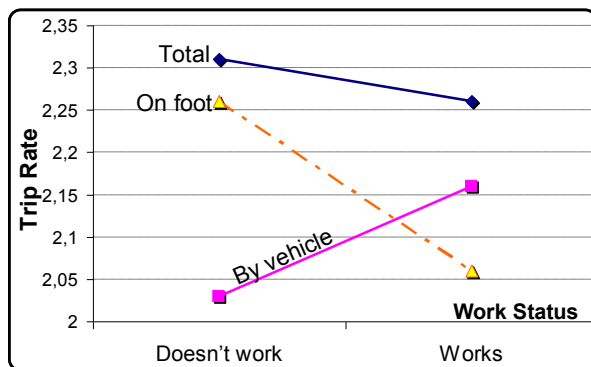


Figure 7 – Trip rate by work status

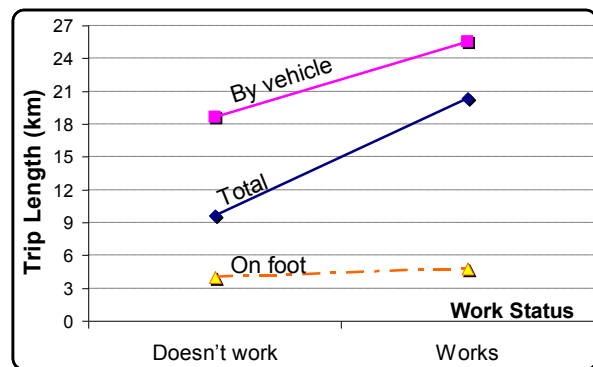


Figure 8- Trip length (km) by work status

Analysis of Trips by Individuals' Characteristics: Driving License Ownership

Out of 16.497.024 daily internal urban trips, the number of trips made by people with a valid driving license (10.446.082 trips 63% of all) are 73% higher than those made by people without a license. Regarding travel mode, pedestrian trips by people with a license (6.605.848) made on foot are 297% higher than those made by people with a license (1.662.603), but their motor-vehicle trips are 13% lower.

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Table 19 shows the trip rates and lengths by driving license ownership. Regarding trip purposes, people with a license have 10% higher motor-vehicle trip rate (2.22) but 3% lower pedestrian trip rates (2.15) than those have none (2.01 and 2.22). However, trip lengths for people with a license are always higher than those for people without for all trip purposes and travel modes (4 to 90%).

Table 19 – Trip rates and lengths by driving license ownership

Classification by owning a driving license	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
Does not own a valid driving license	HBW	0.79	na	0.32	na	21.17	na	4.43	na
	HBS	0.56	na	1	na	14.11	na	3.42	na
	HBO	0.56	na	0.82	na	17.94	na	3.86	na
	NHB	0.1	na	0.07	na	13.68	na	2.64	na
	Total	2.01	na	2.22	na	19.44	na	4.05	na
Owns a valid driving license	HBW	1.41	78	0.96	200	23.79	12	4.62	4
	HBS	0.07	-88	0.05	-95	26.77	90	5.51	61
	HBO	0.49	-13	0.99	21	18.9	5	4.26	10
	NHB	0.25	150	0.16	129	20.6	51	3.45	31
	Total	2.22	10	2.15	-3	26.57	37	4.82	19

Figure 9 and 10 show trip rates and lengths by travel modes. Results are highly similar to those presented in Figure 7 and 8. Total and motor-vehicle trip rates increases by owning a driving license by pedestrian trip rate decreases with the ownership of a license. Trip lengths are always higher for all modes by owning a license.

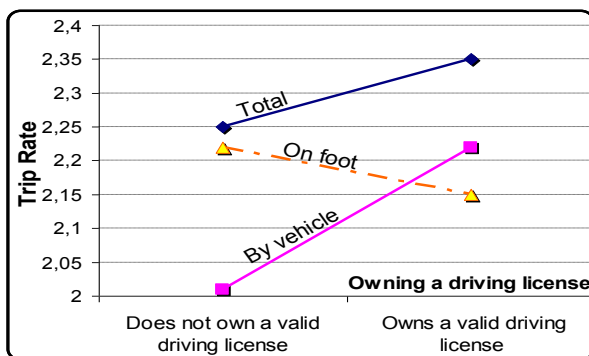


Figure 9 – Trip rate by owning a driving license

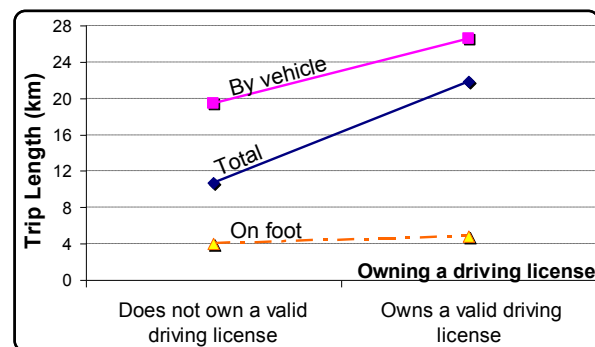


Figure 10- Trip length (km) by owning a driving license

Analysis of Trips by Individuals' Characteristics: Home-ownership

Out of 16,445,503 daily internal urban trips, home makes make the highest number of trips (9,415,581 trips constitute 51%) of all. Tenants make 5,705,344 (%35) trips, make 1,209,360 (%7) trips, and lastly, people who use allocated houses for their official use make 93,881 (%5) trips.

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Table 20 shows the trip rates and lengths by home ownership. Motor-vehicle trip rates do not differ very much for different home ownership (2.06 to 2.12). Regarding trip purposes, while tenants and people who use allocated houses for their official use make home-based work trips most, households who are not home owners but pay no rent make home-based other trips most. Home-based work and other trips of homeowners are the highest and almost equal in numbers. Non-home based trips are the lowest for all household types. Regarding travel modes, motor-vehicle-trips are higher than pedestrian trips for home-owners but it is vice-versa for other household types.

Figure 11 show the trip rates by travel modes. Average pedestrian trip rates of all homeowner types are higher than motor-vehicle trip rates of them. Regarding trip purposes, the lowest rate is made for non-home based trips for all homeowner types. Home-based work trips are highest trips made by motor-vehicles for all homeowner types. Figure 12 show the trip lengths by travel modes. Pedestrian trip lengths are shorter than motor-vehicle trip lengths for all homeowner types. Regarding trip purposes, the longest trips are home-based work trips made by vehicle or on foot, and the shortest trips are home-based school trips made by motor-vehicles and none-home based trips made on foot.

Table 20 – Trip rates and lengths by home ownership

Classification by home ownership	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
Home owner	HBW	1.05	na	0.39	na	23.4	na	4.74	na
	HBS	0.33	na	0.76	na	15.88	na	3.56	na
	HBO	0.58	na	0.95	na	19.1	na	4.12	na
	NHB	0.17	na	0.09	na	17.44	na	3.01	na
	Total	2.12	na	2.20	na	23.29	na	4.36	na
Tenant	HBW	1.23	17	0.55	41	21.31	-9	4.4	-7
	HBS	0.26	-21	0.84	11	14.57	-8	3.27	-8
	HBO	0.43	-26	0.71	-25	17.15	-10	3.77	-8
	NHB	0.18	6	0.08	-11	20.05	15	2.71	-10
	Total	2.11	0	2.18	-1	22.16	-5	4.05	-7
House allocated for official use	HBW	0.85	-19	0.77	97	25.48	9	6.08	28
	HBS	0.57	73	0.8	5	25.03	58	4.06	14
	HBO	0.52	-10	0.85	-11	25.23	32	5.22	27
	NHB	0.12	-29	0.16	78	22.06	26	4.26	42
	Total	2.06	-3	2.58	17	27.76	19	5.54	27
Not home owner but pays no rent	HBW	1.03	-2	0.37	-5	22.47	-4	4.43	-7
	HBS	0.35	6	0.92	21	15.42	-3	3.43	-4
	HBO	0.54	-7	0.93	-2	18.07	-5	3.75	-9
	NHB	0.2	18	0.11	22	18.38	5	2.75	-9
	Total	2.12	0	2.33	6	22.61	-3	4.13	-5

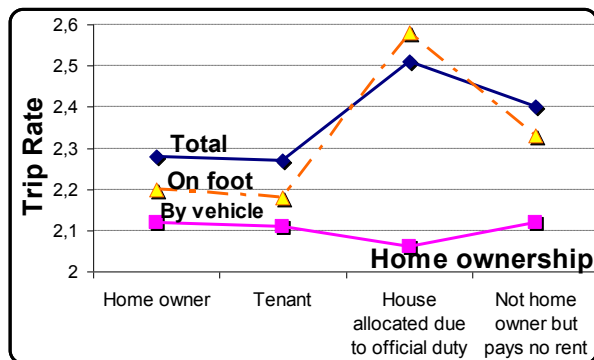


Figure 11 – Trip rate by home ownership

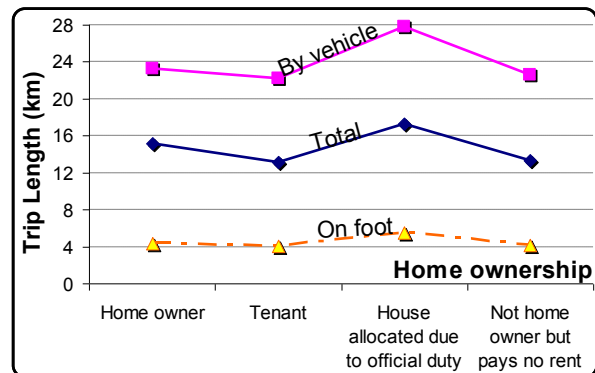


Figure 12- Trip length (km) by home ownership

Trip characteristics of households are analyzed based on the number of workers, students, children, automobile ownership, income, dwelling unit and family type classifications.

Analysis of Trips by Households' Characteristics: The Number of Workers

In parallel to the increase in the number of workers in households, trips rates do increase. For example, trip rate is 27% higher in one worker households than that of households with no worker. Similarly, trip rates in two and more than two worker households are 52 and 106% higher than that of households with no worker, respectively.

Table 21 shows trip rates by travel mode and trip purposes. Motor-vehicle trip rates increase by 7, 39 and 74% for one, two and more than two workers available in the households compared to the trip rate for the households with no worker. Pedestrian trips increase by a lower rate by 15, 16 and 44%. Motor-vehicle trip lengths also increase dramatically by 7, 40 74% for one, two and more than two workers available in the households compared to the trip rate for the households with no worker. Pedestrian trips lengths also increase very significantly by 11, 19 and 53% for one, two and more than two workers available in the households, respectively.

Regarding trip purposes, home-based school trips decrease by 11, 24 and 47% for one, two and more than two workers available in the households compared to the trip rate for the households with no worker. The availability of workers in the household also decreases home-based other trips by 63, 68 and 67% but increases non-home based trips by 30, 75 and 85%.

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Table 21 – Trip rates and lengths by number of workers in the household

Classification by no. of workers	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
None	HBW	na	na	na	na	na	na	na	na
	HBS	0.62	na	0.91	na	24.71	na	5.77	na
	HBO	2.08	na	2.48	na	26.92	na	5.7	na
	NHB	0.2	na	0.16	na	14.2	na	3.1	na
	Total	2.9	na	3.55	na	30.88	na	6.93	na
One	HBW	1.49	na	0.6	na	23.43	na	4.82	na
	HBS	0.55	-11	1.8	98	18.58	-25	5.33	-8
	HBO	0.78	-63	1.53	-38	23.42	-13	5.27	-8
	NHB	0.26	30	0.15	-6	21.24	50	3.21	4
	Total	3.09	7	4.08	15	33.02	7	7.67	11
Two	HBW	2.55	na	1.32	na	33.2	na	5.67	na
	HBS	0.47	-24	1.31	44	19.69	-20	5.06	-12
	HBO	0.67	-68	1.29	-48	22.19	-18	5.31	-7
	NHB	0.35	75	0.19	19	20.45	44	3.45	11
	Total	4.04	39	4.11	16	43.2	40	8.23	19
More than two	HBW	3.67	na	2.35	na	43.48	na	7.78	na
	HBS	0.33	-47	1.18	30	18.4	-26	5.34	-7
	HBO	0.68	-67	1.38	-44	22.67	-16	5.8	2
	NHB	0.37	85	0.19	19	24.8	75	3.4	10
	Total	5.04	74	5.1	44	53.7	74	10.59	53

Figure 13 shows the trip rates by travel mode. The trip rates for all modes increase while the number of workers increases. Dramatic increases are observed in motor-vehicle trips. Figure 14 shows the variations in trip lengths by travel mode. Though the lengths of pedestrian trips do not vary much, vehicle trip lengths increase dramatically while the number of workers increases.

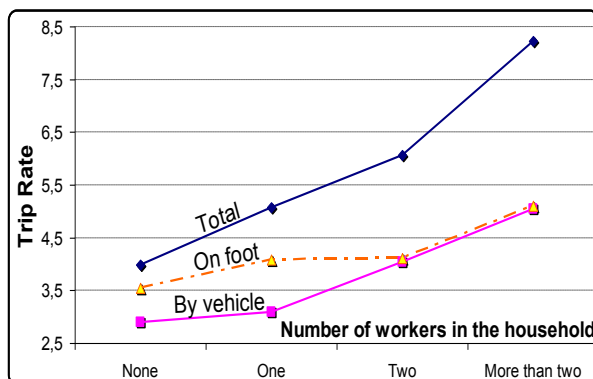


Figure 13 – Trip rate by no. of workers in the household

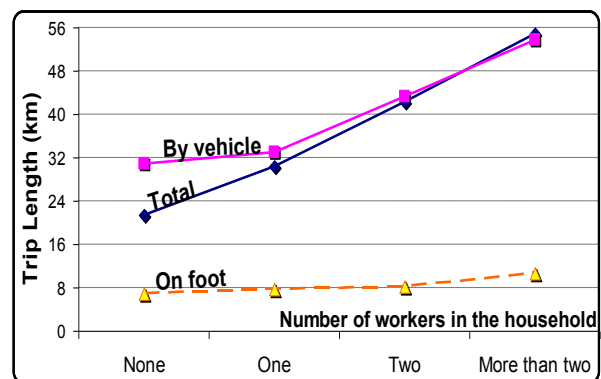


Figure 14- Trip length (km) by no. of workers in the household

Analysis of Trips by Households' Characteristics: The Number of Students

In parallel to the increase in the number of students in households, total trips rates do increase. For example, trip rate is 17% higher in one student households (4.62) than that of households with no student (3.96). Similarly, total trip rates in two (6.50) and more than two-student households (8.73) are 64 and 120% higher than that of households with no student, respectively.

Table 22 shows the trip rates and lengths by number of students in the household. The availability of students in the household increases the number of motor-vehicle and pedestrian trips per household. Motor-vehicle trips per household increases significantly with the availability of two and more than two students in the household by 18 and 37%, respectively. However, the pedestrian trips increase dramatically by 38 and 75% for two and more than two-student households compared to the households with no student. Similarly, trip lengths by motor-vehicles and on foot increased greatly by 17 to 34% and 42 to 97%, respectively.

Figure 15 shows the trip rates by travel mode. Trip rates for all modes increase while the availability of students increases, especially the pedestrian rates increases dramatically. Figure 16 shows the variations in trip lengths by travel mode. Though the lengths of pedestrian trips do increase moderately, vehicle trip lengths increase dramatically by the availability of students.

Table 22 – Trip rates and lengths by number of students in the household

Number of students in the household	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
None	HBW	1.53	na	0.83	na	28.95	na	5.3	na
	HBS	na	na	na	na	na	na	na	na
	HBO	1.32	na	2.35	na	27.78	na	5.64	na
	NHB	0.35	na	0.16	na	23.2	na	4.12	na
	Total	3.21	na	3.33	na	33.93	na	6.17	na
One	HBW	1.69	10	0.79	-5	26.24	-9	4.99	-6
	HBS	0.42	na	1.02	na	16.63	na	3.58	na
	HBO	0.81	-39	1.57	-33	23.9	-14	5.33	-5
	NHB	0.29	-17	0.16	0	21.06	-9	3.23	-22
	Total	3.21	0	3.55	7	35.35	4	6.83	11
Two	HBW	1.99	30	0.80	-4	30.97	7	5.73	8
	HBS	0.84	100*	2.21	117*	19.53	17*	5.09	42*
	HBO	0.71	-46	1.41	-40	22.56	-19	5.49	-3
	NHB	0.26	-26	0.16	0	20.25	-13	3.45	-16
	Total	3.80	18	4.58	38	40.54	19	8.59	39
More than two	HBW	2.52	65	1.17	41	34.82	20	6.56	24
	HBS	1.11	164*	3.39	232*	22.3	34*	7.06	97*
	HBO	0.53	-60	1.15	-51	21.63	-22	5.72	1
	NHB	0.24	-31	0.12	-25	22.11	-5	3.25	-21
	Total	4.41	37	5.83	75	46.29	36	10.89	76

*These numbers are the differences in percent with the households with one-student available.

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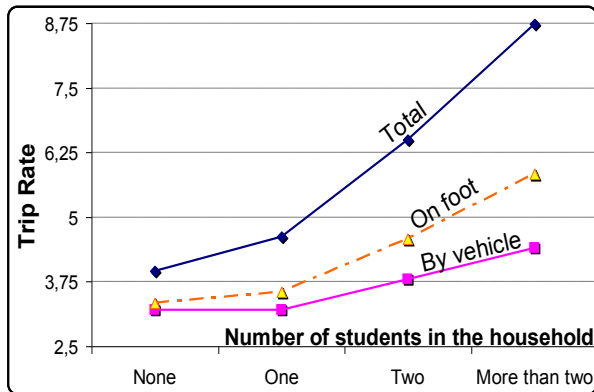


Figure 15 – Trip rate by no. of students in the household

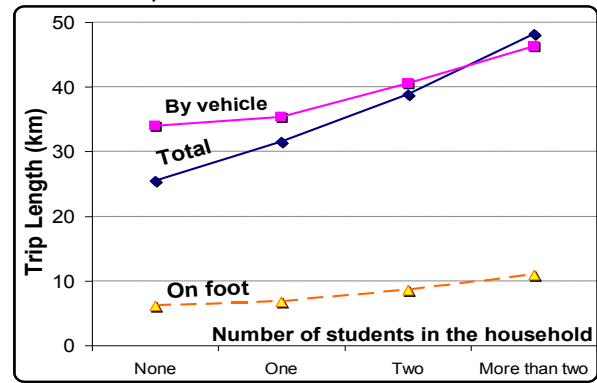


Figure 16- Trip length (km) by no. of students in the household

Analysis of Trips by Households' Characteristics: The Number of Children

In parallel to the increase in the number of children in households, total trips rates do increase by 29%. Total trip rate in one children households (5.32) is 29% higher than that of households with no child (4.14). Similarly, total trip rates in two (6.47) and more than two-children households (8.52) are 56 and 106% higher than that of households with no child, respectively. It is interesting to observe that the increase in trips rates by the availability of children in households is very similar to that by the availability of students.

Table 23 shows the trip rates and lengths by number of students in the household. Increase in motor-vehicle trips rates vary between %4-7, but pedestrian trip rates do increase dramatically by 17-104%. Regarding trip purposes, in parallel to the increase in the number of children in households, pedestrian trips per household increase, except home-based work trips. School trips are increased by 100% by the increase in the number of children in the household.

Table 23 – Trip rates and lengths by number of children in the household

Number of children in the household	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
None	HBW	1.89	na	1.01	na	31.46	na	5.71	na
	HBS	0.19	na	0.08	na	30.47	na	6.42	na
	HBO	1.05	na	1.89	na	24.73	na	5.18	na
	NHB	0.3	na	0.16	na	19.72	na	3.4	na
	Total	3.43	na	3.14	na	39.08	na	6.4	na
One	HBW	1.95	3	0.94	-7	29.66	-6	5.51	-4
	HBS	0.61	221	1.19	1388	18.4	-40	3.82	-40
	HBO	0.8	-24	1.39	-26	22.88	-7	5.28	2
	NHB	0.3	0	0.15	-6	21.3	8	3.12	-8
	Total	3.67	7	3.66	17	39.32	1	7.12	11
Two	HBW	1.73	-8	0.71	-30	26.81	-15	5.38	-6
	HBS	0.85	347	2.38	2875	16.31	-46	4.93	-23
	HBO	0.71	-32	1.44	-24	22.34	-10	5.26	2
	NHB	0.27	-10	0.16	0	22.07	12	3.39	0
	Total	3.56	4	4.69	49	35.6	-9	8.34	30
More than two	HBW	1.74	-8	0.84	-17	26.61	-15	5.75	1
	HBS	0.93	389	3.8	4650	17.37	-43	7.11	11
	HBO	0.74	-30	1.64	-13	23.32	-6	6.11	18
	NHB	0.27	-10	0.14	-13	20.92	6	3.13	-8
	Total	3.68	7	6.42	104	35.67	-9	11.22	75

Figure 17 shows the trip rates by the availability of children in the household and travel mode. Though motor-vehicle trip rates do not vary much, pedestrian trips rates do increase dramatically by the availability of children. Figure 18 shows very little variations in trip lengths by travel mode.

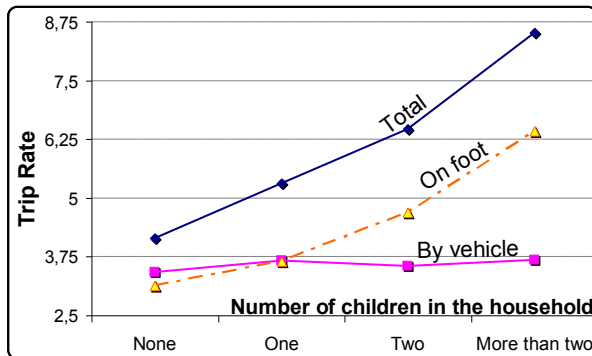


Figure 17 – Trip rate by no. of children in the household

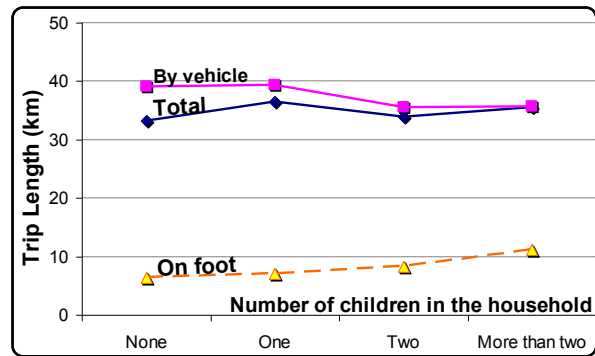


Figure 18- Trip length (km) by no. of children in the household

Analysis of Trips by Households' Characteristics: Automobile Ownership

In parallel to the increase in auto ownership in the household, total, motor-vehicle and pedestrian trips rates do change by +7, +22 and -6%, respectively. With respect to trip purpose, every automobile in the household increases non-home based trip rate by 68%. While the trip rates for the households with more than one car for all trip purposes made on foot decreased, motor-vehicle trip rates increased.

Table 24 shows the trip rates by travel mode and purpose. Automobile ownership increases non-home based trips made by motor-vehicles by 85 and 215% for one-car and more than one-car households compared to those with no-car. However, auto ownership decreases the pedestrian trip rates of two-car households dramatically for trips of home-based work, school and other purposes by 21, 15 and 14%, respectively.

Table 24 – Trip rates and lengths by number of automobiles in the household

Number of automobile in the household	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
None	HBW	1.79	na	0.95	na	28.2	na	5.65	na
	HBS	0.43	na	1.64	na	18.58	na	5.26	na
	HBO	0.76	na	1.62	na	22.7	na	5.29	na
	NHB	0.2	na	0.14	na	17.59	na	3.17	na
	Total	3.18	na	4.36	na	33.71	na	7.91	na
One	HBW	1.91	7	0.71	-25	30.16	7	5.22	-8
	HBS	0.62	44	1.69	3	19.8	7	5.31	1
	HBO	0.99	30	1.54	-5	24.65	9	5.46	3
	NHB	0.37	85	0.16	14	22.53	28	3.34	5
	Total	3.89	22	4.1	-6	41.86	24	7.63	-4
More than one	HBW	2.15	20	0.75	-21	35.68	27	6.66	18
	HBS	0.85	98	1.4	-15	23.66	27	5.64	7
	HBO	1.23	62	1.39	-14	26.15	15	5.54	5
	NHB	0.63	215	0.23	64	25.86	47	4.65	47
	Total	4.86	53	3.77	-14	55.55	65	8.17	3

Figure 19 shows the trip rates by the availability of children in the household and travel mode. Though motor-vehicle trip rates do not vary much, pedestrian trips rates do increase dramatically by the availability of children. Figure 20 shows that though almost no variations are observed in pedestrian trip lengths, vehicle trip lengths increase dramatically by the availability of automobile in the household.

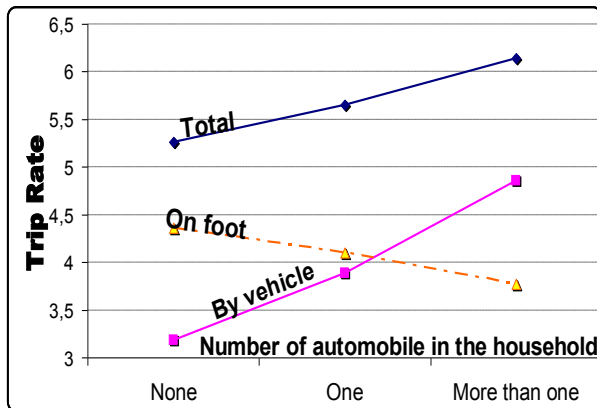


Figure 19- Trip rate by no. of automobile in the household

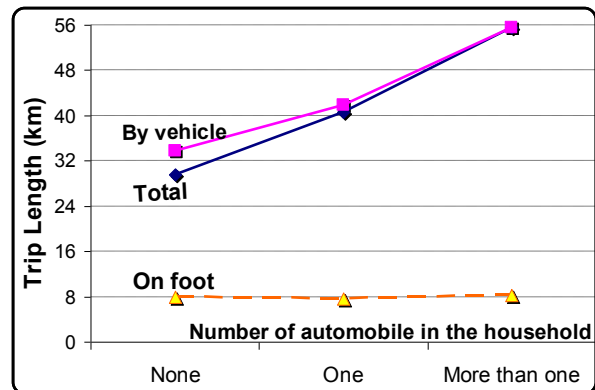


Figure 20- Trip length (km) by no. of automobile in the household

Analysis of Trips by Households' Characteristics: Level of Income

In parallel to the increase in household monthly income, total trips rates do increase by 11 to 12%, compared to the household with the lowest income (<700 TL per mo.). Highest income group's increase is only lower than that by 6%. While household income increases, motor-vehicle trips per household also increases by %16 to 58%, but pedestrian trips decreases by 1 to 28%. With respect to trip purposes, motor-vehicle trips per all trip purposes increase by income; however, pedestrian and total trips rates decreases for home-based school and other purposes. The highest increase is observed in non-home based trips by 42 to 171%.

Table 25 shows the trip rates by travel mode and purpose. Increase in monthly income level increased non-home based trips made by motor vehicles and on foot. With respect to travel lengths, for high income groups (over 1500 TL per mo.) while the travel lengths of non-based trips made by motor-vehicles increased, pedestrian trip lengths decreased.

Figure 21 shows that while motor-vehicles trip rates increase, pedestrian trips decrease by monthly income level. It is interesting to see that total trip rates decrease after 5000 TL income level. Figure 22 shows that though almost no variations are observed in pedestrian trip lengths, vehicle trip lengths increase dramatically by the monthly income level of the household.

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Table 25 – Trip rates and lengths by level of income

Income level (TL)	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
< 700	HBW	1.52	na	0.72	na	26.54	na	5.43	na
	HBS	0.45	na	1.81	na	19.45	na	5.58	na
	HBO	0.89	na	1.69	na	23.9	na	5.35	na
	NHB	0.22	na	0.13	na	18.55	na	3.02	na
	Total	3.08	na	4.35	na	32.98	na	7.95	na
701 – 1500	HBW	1.93	27	0.98	36	28.51	7	5.69	5
	HBS	0.53	18	1.63	-10	18.22	-6	5.07	-9
	HBO	0.82	-8	1.54	-9	23.78	-1	5.36	0
	NHB	0.28	27	0.16	23	20.95	13	3.49	16
	Total	3.57	16	4.31	-1	37.23	13	7.91	-1
1501 - 3000	HBW	2.31	52	1.12	56	35.02	32	5.64	4
	HBS	0.62	38	1.09	-40	20.98	8	4.62	-17
	HBO	0.93	4	1.4	-17	23.21	-3	5.3	-1
	NHB	0.42	91	0.21	62	22.54	22	3.56	18
	Total	4.28	39	3.83	-12	47.35	44	7.27	-9
3001 - 5000	HBW	2.35	55	0.93	29	38.58	45	6.11	13
	HBS	0.75	67	0.89	-51	26.92	38	5.16	-8
	HBO	1.13	27	1.4	-17	23.53	-2	5.41	1
	NHB	0.54	145	0.25	92	23.18	25	2.91	-4
	Total	4.77	55	3.47	-20	56.17	70	7.04	-11
> 5001	HBW	2.2	45	0.89	24	39.17	48	5.17	-5
	HBS	0.87	93	0.92	-49	25.69	32	6.93	24
	HBO	1.17	31	1.14	-33	26.07	9	4.37	-18
	NHB	0.62	182	0.18	38	23.86	29	2.5	-17
	Total	4.86	58	3.12	-28	59.11	79	6.28	-21

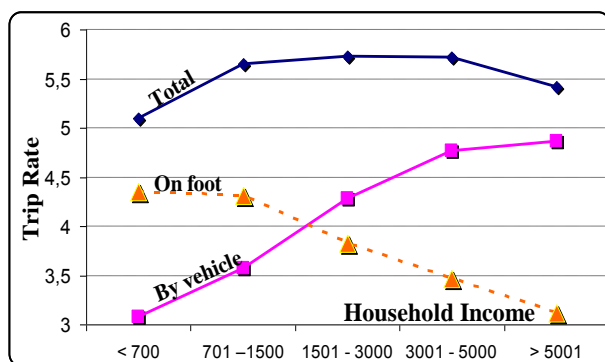


Figure 21– Trip rate by household income

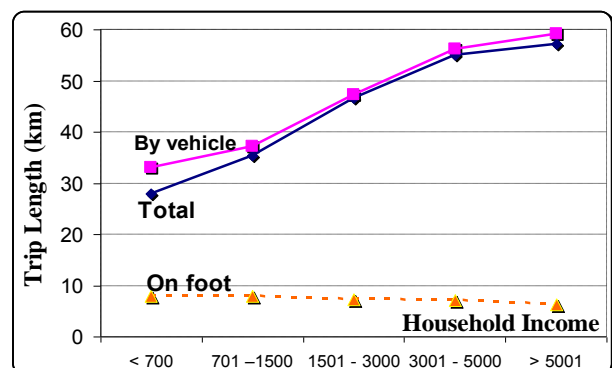


Figure 22- Trip length (km) by household income

Analysis of Trips by Households' Characteristics: Dwelling Unit Type

Households living in various dwelling unit types presented different trip generation characteristics. The highest trip rate (5.72) belongs to people living in single houses. Households living in buildings other than single houses make fewer trips per household. Dwellers living in apartments and apartments inside a gated community produce lower trip rates by 5 and 9%, respectively, compared to households living in single houses.

Table 26 shows the trip rates by travel mode and purpose. Regarding the travel purpose, dwellers living in apartments and apartments inside a gated community produce higher trip rates for home-based work and non-home based trips but lower trip rates for home-based school and other trip purposes, compared to households living in single houses.

With respect to travel modes, households living in single houses and apartments produce similar motor-vehicle trip rates but 19% lower than that of dwellers in apartments inside a gated community. Pedestrian trip rates of households living in apartments and apartments in a gated community are 4 and 22% less than those living in single houses.

Table 26 – Trip rates and lengths by dwelling unit type

Dwelling unit type	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
	HBW	1.8	na	0.8	na	34.37	na	7.29	na
	HBS	0.52	na	1.68	na	23.77	na	7.27	na
	HBO	0.9	na	1.7	na	30.29	na	7.06	na
	NHB	0.22	na	0.13	na	22.93	na	3.79	na
Single houses	Total	3.44	na	4.31	na	43.85	na	10.44	na
	HBW	1.83	2	0.87	9	28.27	-18	5.38	-26
	HBS	0.49	-6	1.5	-11	18.49	-22	5.05	-31
	HBO	0.84	-7	1.6	-6	22.62	-25	5.11	-28
	NHB	0.28	27	0.16	23	20.28	-12	3.19	-16
Apartments	Total	3.45	0	4.13	-4	36.14	-18	7.57	-27
	HBW	1.93	7	0.54	-33	35.72	4	6.2	-15
	HBS	0.68	31	1.17	-30	23.57	-1	5.27	-28
	HBO	1.1	22	1.45	-15	26.99	-11	5.95	-16
Apartments inside a gated community	Total	4.1	19	3.37	-22	49.52	13	7.6	-27

Figure 23 shows that total trip rates for the households living in apartments decrease compared to dwelling units in single houses. It is interesting to see that total trip rates decrease after 5000 TL income level. Figure 24 shows that though almost no variations are observed in pedestrian trip lengths, vehicle trip lengths increase dramatically by the monthly income level of the household.

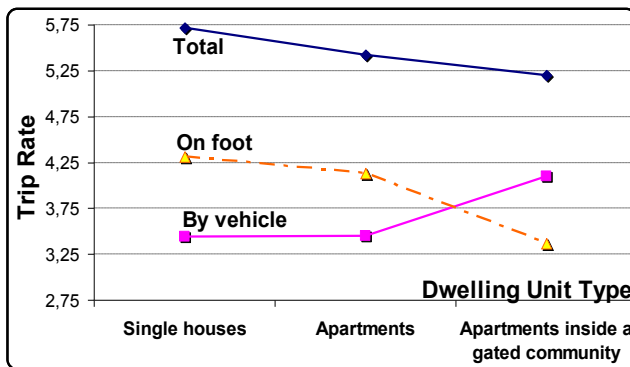


Figure 23– Trip rate by dwelling unit type

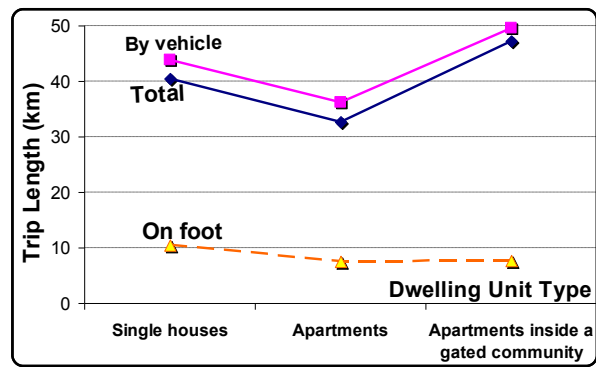


Figure 24- Trip length (km) by dwelling unit type

Analysis of Trips by Households' Characteristics: Household Type

Different household types presented different trip generation characteristics. The availability of both parents and the children in a household yielded the highest trip rate by 6.17. The lack of one parent reduced the trip rate by 18%; however, the lack of child in households with both parents available reduced the rate by 42% compared to the households with both parents and children. Similarly, the rate for the households with both parent and no child is 29% less than that for the households with one parent and children available.

Table 27 shows the trip rates by travel mode and purpose. Regarding the travel purpose, the lack of children reduced work, school and non-home based trips but increased other purpose trips. School trips are decreased substantially by 92%

With respect to travel modes, households living in single houses and apartments produce similar motor-vehicle trip rates but 19% lower than that of dwellers in apartments inside a gated community. Pedestrian trip rates of households living in apartments and apartments in a gated community are 4 and 22% less than those living in single houses.

Table 27 – Trip rates and lengths by household type

Household type	Trip Purpose	Trip Rate				Trip Length			
		By vehicle	%	On foot	%	By vehicle	%	On foot	%
Households with both parents and children	HBW	1.93	na	0.85	na	29.74	na	5.57	na
	HBS	0.63	na	1.85	na	19.04	na	5.27	na
	HBO	0.86	na	1.59	na	23.79	na	5.52	na
	NHB	0.3	na	0.16	na	21.14	na	3.36	na
	Total	3.72	na	4.44	na	39.74	na	8.34	na
Households with only one parent and children	HBW	1.68	-13	0.84	-1	29.29	-2	5.67	2
	HBS	0.5	-21	1.27	-31	19.94	5	5.18	-2
	HBO	0.91	6	1.54	-3	22.62	-5	5.19	-6
	NHB	0.25	-17	0.15	-6	19.51	-8	2.88	-14
	Total	3.35	-10	3.8	-14	36.12	-9	7.46	-11

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Households with both parents but no children	HBW	1.67	-13	0.78	-8	28.84	-3	5.38	-3
	HBS	0.05	-92	0.08	-96	23.07	21	4.92	-7
	HBO	0.98	14	1.92	21	26.17	10	5.16	-7
	NHB	0.26	-13	0.18	13	20.73	-2	3.24	-4
	Total	2.96	-20	2.95	-34	34.23	-14	6	-28
Households with only one parent and others but no children	HBW	1.93	0	1.44	69	32.02	8	7.23	30
	HBS	0.57	-10	0.58	-69	28.63	50	6.83	30
	HBO	0.8	-7	1.2	-25	23.9	0	4.8	-13
	NHB	0.33	10	0.18	13	19.78	-6	3.49	4
	Total	3.62	-3	3.4	-23	40.12	1	7.63	-9
One person households	HBW	1.02	-47	0.56	-34	22.14	-26	3.98	-29
	HBS	0.1	-84	0.05	-97	20.4	7	6.07	15
	HBO	0.78	-9	1.37	-14	17.54	-26	3.67	-34
	NHB	0.26	-13	0.14	-13	17.27	-18	2.75	-18
	Total	2.17	-42	2.12	-52	24.09	-39	4.14	-50

Figure 25 shows that the availability of parents or other adults and children increases trips rates by travel mode. The rates for the households with no children are always lower than those with children except in households in which there is no child but other adults. Figure 26 shows the same trend as in Figure 25, except the lengths of trips made on foot did not vary very much for different household types.

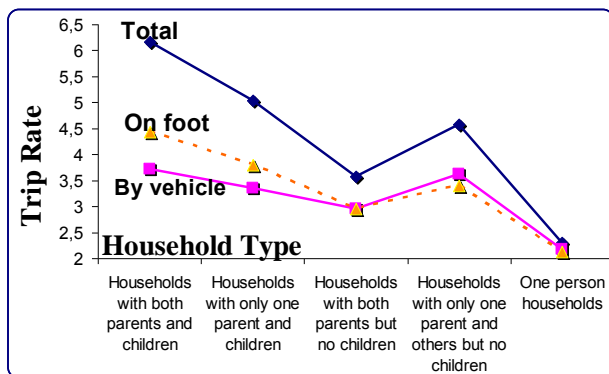


Figure 25– Trip rate by household type

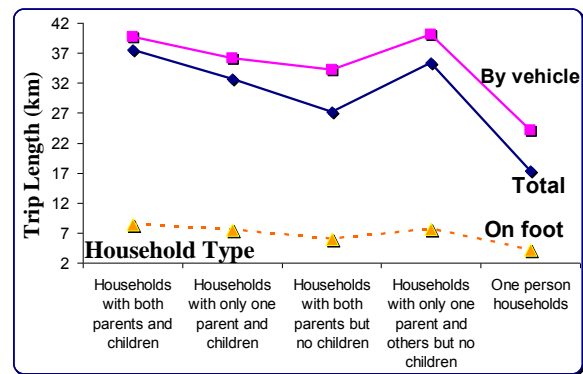


Figure 26- Trip length (km) by household type

CONCLUSIONS OF THE CURRENT RESEARCH AND RECOMMENDATIONS FOR FUTURE RESEARCH

In this study, we analyzed the mobility characteristics of individuals and households as a whole in the study area of the metropolitan city of Istanbul, Turkey. By this study, it is attempted to answer the questions of who moves most and who moves least in the city of Istanbul. The results of a comprehensive data collection effort regarding the characteristics of households and household members as well as their trip productions (net trip rates) and travel patterns (trip lengths) in the metropolitan city of Istanbul, Turkey are as follows:

1. Characteristics of household members:

- a. The study area has a pretty young population. People 30 and below are about 53.85% of the total of 12,006,014 populations. In contrary to this advantage, people with the degree lower than college-university constitute almost all of the population (91.25%).
- b. People with a driving license are estimated to be 29%. 43% members of the auto-owner households have a license.
- c. About one-third of the population in the study area is employed. People who seek to work in the unemployed population are extremely low (4.3%). Percent of homemakers in the unemployed population is the highest by 35.5%.
- d. In Istanbul, 58.0% of the population is home-owners.

2. Characteristics of households as a whole:

- a. The number of households projected in the study area is 3,391,141. Table 5 shows the household classification by the number of workers. 81,4% percent of households consist of at least one worker. Little bit more than half of the households (51,3%) have one worker. Households without a worker is not very low (18,6%), though.
- b. There is no student in 36,2% of the households in the study area. Households that have one student consist of 46.4% of the households having students. Those that have two students are 32.8%.
- c. The percent of households without a child (person less than 18 years old) are 44,9%. Those that have at least one child is 55,1%. The percent of households with one child in those which have a child are 43,5%. Those with two children are 38%. In the modern era, conditions of the consumption economy force both parents to work in most families for having better life conditions so that they tend to have fewer children.
- d. 63.9% of the households have no car. Overall out of 100, only 42 households have accessibility to a car, and only 12 out of 100 people have a car. The number of car per driver's license is 0.60. In parallel to the economic development in the future, auto ownership will certainly increase by the household income increases.
- e. It is observed that the households in the study area have a very low income or they are not willing to disclose their real income. About half of the households (43.2%) have a very low income (less than 700 TL/month) and only a small percent of households (0.8%) have income higher than 5000 TL. Middle-class households with 1500-3000 TL income level are 11.9%. With the assumption of average income of 1500 TL, 85% of households have that or lower income. This shows a great inequality in income distribution over the population.
- f. Households with parent and children living together have the highest percent (64.6%). Households with no children at all are not very low though (27.8%).
- g. Households with four or more persons constitute the highest percent (49.2%) in all. 83.1% of all households live in apartments. Households living in single

houses and apartments inside a gated community hold about the same percentage (8.7 and 8.2%, respectively). Single houses are preferred mostly by households with 4 or more people. It is the same for apartments, but two or more person-households prefer apartments inside a gated community.

3. Characteristics of the daily internal trips:

- a. Trips by residents in the study area excluding students in dormitories, tourists in hotels, and military people in barracks are estimated to be 16,498,237 made by 7,210,990 people in 2006. 50,7% of these trips were made by 3,728,939 people via motor-vehicles. Overall net trip rate (the number of trips per person who travelled) is 2.29, the rate for motor-vehicle trips is 2.24 and for pedestrian trips is 2.34.
- b. The highest percent of trips by purpose is 36.4% for home based-work trips followed by home based-other and –school trips with 31.9 and 25.6%, respectively. Non-home based trips have the lowest share of all trips by 6.1%. This low percent shows that people usually tend not to disclose their trips other than compulsory ones and that interviewees tend to get tired while the survey progresses further and usually just report compulsory ones not the ones made on foot or ones that are made for purposes other than work or school. First row in trips made in motor-vehicles by purpose is home based-work trips by 51.6%, and the same for pedestrian trips is home based-other trips by 38.2%.
- c. Almost half of the trips (46%) are the ones that ended up in 15 min. 80.2% of these trips are made on foot. After 15 min. pedestrians trips decreases by 50% and motor-vehicle trips increases by 220%. 71.0% of all trips are the ones that ended up in 30 min. 81.4% of all the trips are the ones that ended up in 10 km. Trips that ended up in 5 km constitute 68% of all trips, 96.5% of pedestrian trips and 38.8% of motor-vehicle trips. 70% of trips between 0.1 and 5 km were made on foot. 94.8% of the trips between 5.1 and 10 km were made via motor-vehicles. After 10 km, while pedestrian trips decreases, motor-vehicle trips are increased.

Here the followings are regarding who moves most and who moves least in the city of Istanbul:

- a. The highest total trip rate belongs to males with respect to gender of traveler, the senior citizens (>64 years old), people with post graduate education, people with no job, people with a valid driving license, people living in a house allocated due to their official duty. The highest trip length belongs to males, middle age people (31-45 ages), people with post-graduate education, with job, with a valid driving license, and living in a hose allocated due to their official duty.
- b. Similarly, the households with more than two workers, two students, two children and one automobile, with 1501-300 TL income level, and the households living in single houses, and households with both parents and children living together produce the highest total trip rate. The longest trips belong to households with more than two workers, two students, one child and one automobile, with the highest income level (>5,001 TL), and the

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households living in apartments in a gated community, and households with both parents and children living together.

- c. The lowest total trip rate is produced by females, young people (6-18 ages), people who have no degree at all, who work, who has no valid driving license, and tenants. The lowest trip lengths belong to the people with the lowest trip rate, except those who have a job.
- d. Likewise, the households without workers, students, children and automobiles, with less than 700 TL income level, and the households living in apartments in a gated community, and one-person households produce the lowest total trip rate. The lowest trip lengths belong to the households with the lowest trip rate, except those who live in apartments inside a gated community.

The followings are the recommendation for future research regarding the subject of who moves most and who moves least:

- e. Two-level analyses (such as travel behavior analyses with both age and gender data at the same table or figure) might lead to more valuable conclusions.
- f. Modeling of trip rates and lengths with multiple linear regressions sure adds more values to such analysis of trip production of individuals and household members.
- g. Testing some plan scenarios under different individual and household characteristics can be another avenue to utilize the models developed.

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