

1 **TRANSIT INTEGRATION OF CARSHARING FOR AIRPORT GROUND**
2 **ACCESS**

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ABSTRACT

As air travel becomes more significant every day, the accessibility of the airports for the passengers are gaining more importance. Thus, mode choice in terms of airport access becomes a crucial issue. However, while choosing the mode of trip to airports, many passengers opt for comfort and; hence, they choose taxi or private vehicles, which causes an increase of traffic volume in the network. Therefore, to address this issue, a carsharing service to airports was proposed, and Istanbul Atatürk International Airport (IST) was inspected as a case study. The service structure makes use of the carparks of shopping malls in Istanbul. Passengers will simply arrive at one of the shopping malls by any mode and drive to the airport by one of the carsharing vehicles, and park it at the designated parking area at the airport. The service can also be used for the trips in the opposite direction. It was observed that the cost of carsharing is lower than of the private cars and taxis, and hence, carsharing may become an attractive trip mode for passengers who prefer comfort. For policy makers and authorities, several incentives to make the service beneficial were also suggested.

18 Keywords: Carshare, airport access, shopping malls, private vehicle

1 INTRODUCTION AND BACKGROUND

2 Airports are crucial infrastructures for connecting a city to the other cities around the world. It
3 is for this reason that the accessibility of an airport is one of the most critical factors for the
4 passengers. With a population of nearly 15 million as of 2016 (1), the city of Istanbul has one
5 of the most congested traffics in the world (2). One of the city's two airports, Istanbul Atatürk
6 International Airport (IST), is one of the world's busiest airports in terms of passenger traffic
7 (3). Due to the high traffic congestion in Istanbul, it is important to provide alternative modes
8 of transportation which will provide a decrease in the vehicular traffic generation by the airports
9 and create a more accessible and sustainable system for airport access.

10
11 IST has many alternative modes of transportation for accessing. A traveler can use the subway,
12 taxi, the airport shuttle namely "HAVABUS", private vehicle (auto) or may be dropped-off at
13 the airport by someone else. Excluding the subway choice, all other modes of transportation
14 generates a road traffic and this must be minimized as much as possible to decrease the traffic
15 congestion and the environmental pollution in Istanbul. While doing so, the characteristics of
16 the travelers must be taken into consideration.

17
18 Analysis for reducing the number of private vehicles and taxis has showed that there are types
19 of passengers that have the highest potential for behavioral change. This can be accomplished
20 by changing perception of difficulty for using an alternative mode of transportation and
21 providing more information for alternative modes of transportation such as drop-off or carshare
22 or rental. However, there are also other types of passengers which have a great resistance to
23 change their use of private vehicles for accessing the airport (4). Important factors for
24 passengers that are not using private vehicles are; on-time service, travel time, flexibility of
25 departure time, frequency of service, lower cost relative to driving and luggage storage capacity
26 (5). Carsharing is a potential alternative for airport access due to its economic, accessible and
27 environmentally friendly characteristic properties, which can satisfy these important factors for
28 airport travelers. Especially combining the use of carsharing with transit systems can aid this
29 goal tremendously.

30
31 Carsharing is becoming more and more a mainstream transportation mode, which is operating
32 worldwide in around 1100 cities as of 2004 (6). It should be noted that the passengers that are
33 inside the transit areas of influence are more likely to use public transit and for the passengers
34 that are not, reimbursements must be made so that those passengers may incline to use public
35 transportation by accessing them by their private cars or taxis (7). However, public
36 transportation may not cover the necessary gap, which is generated due to additional need for
37 transportation. This gap can be narrowed by carsharing, which would otherwise be closed by
38 the purchase of a new car, which will increase the number of vehicles in traffic gradually and
39 can change the mobility behavior of the travelers in a significant way (8). As the travel time
40 and the cost increases for a trip, the likelihood of preference of carsharing mode also increases,
41 making carsharing more and more attractive (9). Vehicle owners are realizing that by sharing
42 their vehicles, they have an opportunity to save money, which is another attractive property of
43 the carsharing systems. For example, 25% of the respondents of a survey made in San Francisco
44 who owned a personal vehicle are willing to share their personal vehicles (10).

45
46 In this study, a carsharing system for ground access to IST is proposed. The system that is
47 proposed here appeals to passengers that prefer to use their private vehicles or taxis. The private
48 vehicle and taxi users, who do not prefer to use public transportation but still seek the level of
49 comfort and rapidness of vehicular transportation, can use this system and can have significant
50 savings in terms of gas and parking cost. Furthermore, the traffic congestion within the city is

1 expected to be reduced. The system also benefits the use of public transportation as a mode of
 2 transportation and the car parks of the shopping malls, which will decrease the vehicular traffic
 3 near the airport and in Istanbul general.
 4

5 DATA AND RESULTS

6 The idea to propose the carsharing service was developed from the results of a survey conducted
 7 in IST during 4 random days in January 2015 with departing passengers, who were Istanbul
 8 residents. In the survey, convenience sampling method was used and the sample size was 546
 9 (7). Out of the 546 respondents, 237 passengers used auto and taxi mode while the remaining
 10 opted for the semi-rapid transit and drop-off modes to access IST. In this study, the target
 11 audience was the auto and taxi users because the study aimed to focus on deterring them from
 12 using their own vehicles and decrease the number of taxis already present in the traffic flow.
 13 Table 1 shows that majority (70.5 %) of these passengers preferred taxi to access IST.
 14

15 **TABLE 1 Frequencies of Auto and Taxi Modes**

	Frequency	%
Auto	70	29.5
Taxi	167	70.5
Total	237	100.0

17
 18 Transit area of influence can be defined as the certain area surrounding a transit station which
 19 is able to attract users for transit trips departing from that station (11). (7) found that being
 20 located in transit area of influence of stations was observed as a significant factor in mode
 21 choice to access IST. As can be seen in Table 2, ratio of the passengers whose origin of trips to
 22 IST were located in the transit area of influence of a station is 51.9 %. Thus, it can be argued
 23 that even though a significant number of passengers could access to semi-rapid transit, they
 24 avoided using it for various reasons.
 25

26 **TABLE 2 Frequencies of Passengers Inside and Outside of Transit Area of**
 27 **Influences**

	Frequency	%
Outside	114	48.1
Inside	123	51.9
Total	237	100.0

29
 30 The argument stated above can also be supported by statistical tests. Two chi-squared tests for
 31 statistical dependency were performed with 5 % level of significance. Firstly, dependency
 32 between access mode type (auto or taxi) and trip purpose of the passenger as business or non-
 33 business was tested. Table 3 shows the distribution of the mode types and trip purpose of the
 34 passengers, as well as the associated chi-squared test. Significance of the chi-squared test
 35 implies that choice of auto or taxi is independent on the purpose of the trip.
 36

TABLE 3 Dependency of Trip Purpose of Travel Mode

	Non-Business	Business	Total
Auto	36	34	70
Taxi	95	72	167
Total	131	106	237
	Value	Significance	
Pearson Chi-Square	0.594	0.441	

Secondly, the same chi-squared test was applied for mode choice and location of the trip origin whether it is inside the transit area of influence of a transit station. The data is given in Table 4, and it can be seen from the significance value that the two conditions do not dependent on each other. Hence, these independencies show that the interest in comfort of auto or taxi for airport access, trip purpose and location of the trip origin with respect to transit stations are irrelevant.

TABLE 4 Dependency of Transit Area of Influence on Travel Mode

	Outside Influence Area	Inside Influence Area	Total
Auto	38	32	70
Taxi	76	91	167
Total	114	123	237
	Value	Significance	
Pearson Chi-Square	1.522	0.217	

Our proposal is implementing a carsharing service between various points of Istanbul and IST in order to offer a lower trip cost for passengers who preferred to use taxi and private vehicles, These various points can be the shopping malls in Istanbul, because they have sufficient parking spaces, that public areas of the city lacks. As of 2017, there are 95 shopping malls in Istanbul. These are shown in Figure 1.

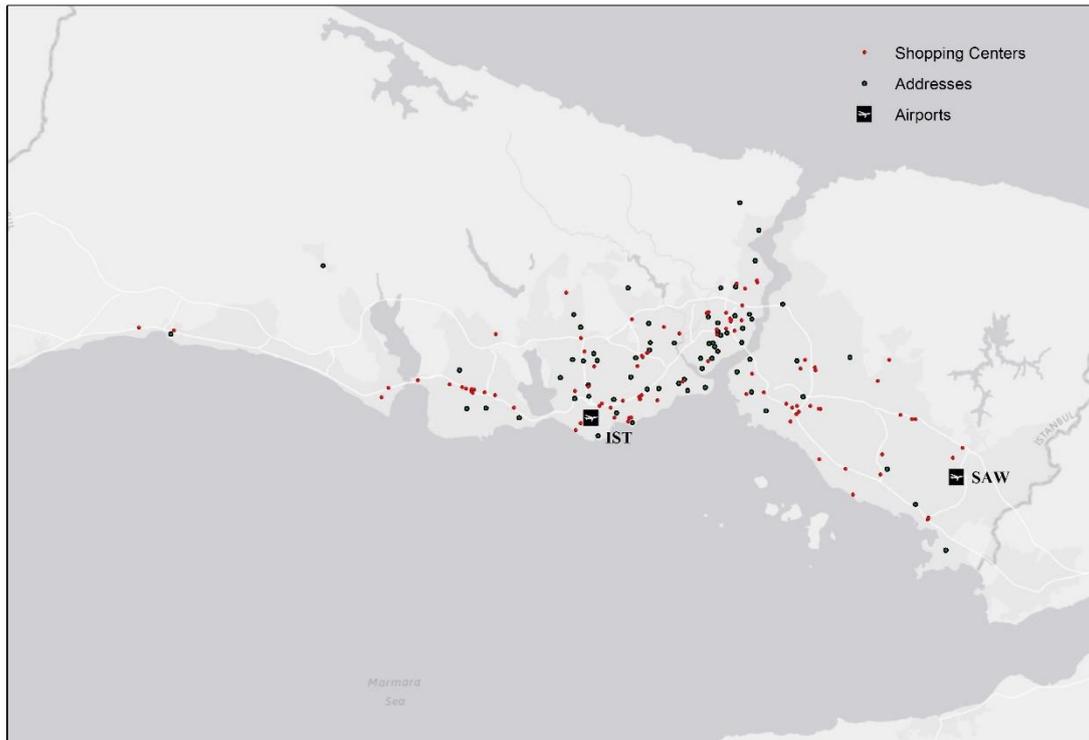


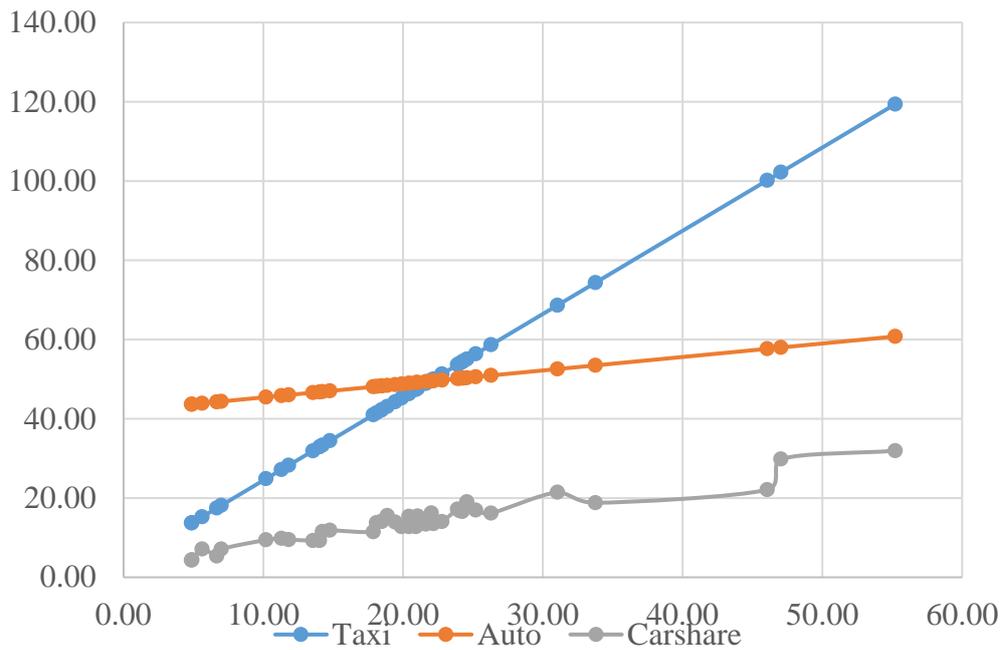
FIGURE 1 Map of Istanbul with shopping C-centers and addresses of respondents

The aim is attracting the passengers who use auto and taxi for airport access to these shopping malls to use carsharing. There is an existing carsharing service with parking lots located in several shopping malls (12). A passenger can arrive at one of the shopping malls easily and take a carsharing vehicle to access IST, and can park the vehicle at the designated area at IST carpark. Hence, the passenger will pay less compared to taxi and private auto and travel in comfort. The cost breakdown of carsharing, taxi and private auto is given in Table 5. It is assumed that the passenger will leave his/her car at the IST carpark for at least 24 hours, where the corresponding parking fee is 42 TL (13). It is also assumed that the passenger will only pay for one-hour usage cost (2 TL) in addition to the cost per distance (2 TL is the minimum fixed cost, varies with vehicle brand) (14). The cost per distance of each mode is given as 0.55, 2.1 and 0.34 TL/km for carsharing, auto and taxi modes, respectively (14–16). Hence, it can be inferred that even though the cost per distance of carsharing is more than of the auto, total cost to use private vehicle to access IST is more than the carsharing cost. Furthermore, it is easy to observe that cost of carsharing is less than that of taxi. Therefore, one can conclude that carsharing has the lowest cost among the three alternatives.

TABLE 5 Cost Structure of Travel Modes to IST

	Cost	
	TL/km	Fixed (TL)
Carsharing	0.55	2
Taxi	2.1	3.45
Auto	0.34	42 (One-day)

1 The cost structure with respect to distance can also be observed in Figure 2. 39 districts with
 2 malls located very close to them were included. Even though one can access the nearest
 3 shopping mall by many modes, the study considered only walking, bus and metro modes for
 4 that. This is because the study assumed that changing many modes to access malls would make
 5 the carsharing usage to IST unattractive. In Figure 2, it can be seen that carsharing has the
 6 smallest cost among the all modes, even though the taxi cost is close to it when the trip distance
 7 is low. However, as the distance increases, cost of taxi becomes the highest of the three modes
 8 of subject. Taxi and auto costs are linear but cost of carsharing do not show any linearity due
 9 to the variable costs of reaching the nearest shopping mall.
 10



11 **FIGURE 2 Costs of Travel Modes to IST**

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 14 **CONCLUSIONS**

15
 16 This study focused on people who preferred auto and taxi modes to access IST and aimed to
 17 divert them to carsharing for that purpose. By doing so, it was possible to obtain a sustainable
 18 transportation mechanism in this context.

19
 20 Results of the study reveal the proposal of the carsharing service to IST from various points in
 21 Istanbul. These various points can be the carparks of the shopping malls. Passengers will simply
 22 access to these shopping malls by their private vehicle or public transit. Obviously, carharing
 23 can also be used for the trips in the opposite direction, and carpark of IST will have a dedicated
 24 area for carsharing vehicles. Istanbulcard may be used for the payments for the proposed
 25 carsharing service, which is the card used for payments in public transportation system in
 26 Istanbul. This would provide an automatic and easy payment system for users (17).

27
 28 There can be many incentives for users, carsharing companies and the bus authority in Istanbul.
 29 For the carsharing companies, the rent for the designated parking areas in the shopping malls
 30 and at IST may be reduced. The authorities may pay the remaining part of the rent. On the other
 31 hand, the bus ridership may increase thanks to the trips between the origin point of the

1 passengers and the shopping malls; which is a positive contribution to the bus authority. This
2 can also be supported by (6), which explained that carsharing can be a good complement to
3 public transit. Finally, for the users, one can name two incentives. First, if they access the
4 shopping malls by their own vehicles, they may pay a reduced fee to the shopping malls for
5 parking. Second, they may pay discounted public transit fee if they access the shopping malls
6 by transit.

7
8 With the carsharing service, there will be a positive outcome for the traffic network as well. As
9 people get used to the carsharing concept in the long term, car ownership may reduce in future,
10 as shown by other studies (18, 19). Thus, in this context, one can see this carsharing service for
11 airport ground access as a starting point.

12
13 In time, the system familiarity among the users will be established and once it is done, the
14 carparks for this service may not only be the ones of the shopping malls. Currently, the
15 authority, Istanbul Metropolitan Municipality, owns carparks named ISPARK throughout the
16 city. There are 45 carparks with a total capacity of 14000 cars (20). So, in future, they should
17 be used for carsharing services as well, because the number of shopping malls in the city is
18 limited compared to number of ISPARK locations.

19
20 There is an ongoing construction of a new airport in Istanbul. It is expected to start operating in
21 late 2018. The proposed service can also be implemented for that airport and the secondary
22 airport of Istanbul, Sabiha Gökçen International Airport (SAW), as well. Future studies may
23 focus on the situation in other cities and impact of carsharing along with future ground access
24 projects to the airports.

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