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Examining the Carsharing System in Terms of Urban Transportation

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ABSTRACT

With the increasing population in the world, individual vehicle ownership is increasing day by day. The increase in individual vehicle ownership causes heavy traffic jams in the city centers. In addition to traffic congestion, noise pollution, harmful gas emission, parking lot problems also increase. Besides, the fact that most of the vehicles use petroleum derivatives, which are a depleted energy source, pose big problems for the economy. In this context, various studies are carried out to reduce the use of individual vehicles and to prevent the mentioned problems. One of these studies is the carsharing system. In this study, the applicability of the vehicle sharing system was investigated by surveys of Erzurum Metropolitan Municipality personnel. The city is divided into certain regions, taking into account the locations of individuals' homes. Later, the carsharing model was created with the mobile application designed for individuals living in the region. Monthly total economic gain and savings per individual were calculated in the analysis made as a result of the model. Thanks to the study, it has been revealed that the carsharing system within the institutions provides feasibility and many advantages.

1. INTRODUCTION

Various policies are implemented across the world to reduce the use of individual vehicles by people. The most important of these is the development of public transportation systems. But often the capacity of public transport systems may be insufficient. In addition to this, the increase in the number of transfers may be among the reasons that direct people to the use of individual vehicles. For this reason, methods that will be an alternative to public transportation systems are being developed. Thanks to the alternative methods applied, problems in traffic can be minimized. Also, performance situations can be determined by observing the applied changes [1-3].

The carsharing system (CSS) is encouraged to reduce the use of individual vehicles and to increase the occupancy of these vehicles in developed and developing countries [4]. There are different types of systems. In the first model, the individual is applied by sharing his car with other people going in the same direction or accompanying the person with the individual's car. In this model, it is enough for only one of the individuals sharing cars to have a car. In the case of cars in more than one individual, carsharing can be made with a single vehicle, provided that a certain cycle is achieved [5]. In the developing version of this model in recent years, it is provided with the help of mobile applications or websites, and to make travel companions on long distances. In this structure, the individual can find his companion by sharing his/her location, destination, and date information. Thus, it saves money by sharing travel expenses with others [6-8]. Again, for this situation, at least one of the individuals traveling together has a car.

In the second model, there is a car rental process similar to the normal car rental system. Thanks to the car rental process with other individuals, the costs are greatly reduced. The most important advantage is that you don't have to bring the car back to where you bought it [7-9]. Companies applying this system give a membership card to the user who is a member. With this card, the vehicle to be rented can be opened and closed. The person can find the vehicle closest to the region where the car rental process will begin and travel by the people who will share the car [10,11]. They can leave the vehicle in the region where the journey ends. Since car rental companies can see from which location the vehicles are picked up and left, they are charged accordingly. On the other hand, renting individuals pay the expenses along the way together. While this model is actively used in many developed countries in the world, it is limited to only big cities such as Istanbul in our country [12-14].

In the third model, as in the second model, there is a rental car for transportation. However, instead of the company car, individuals' personal cars are rented and traveled. In this system, the person who hires his car earns money. But, since the system has various security weaknesses, its use is less

frequent. Thanks to the CSS models, increasing in-vehicle occupancy rates, reducing the number of vehicles in traffic, transporting the same number of people with less fuel and vehicles, contributing to both the economy of the individual and the country, reducing the exhaust emission, creating a culture of travel together, developing feelings of co-existence and social responsibility, and occupancy in parking areas reduction of the rate is provided [15-17]. It is aimed to speed up the working process of the building by producing web sites and mobile applications in many developed and developing countries that take into account these benefits of the CSS. Thanks to these applications, the reliability, and usability of the system are increased. Besides, the end-of-journey evaluation can be made about the people traveling together. With this situation, the possibility of choosing the companion may also arise in individuals using the CSS [18,19].

In this study, a CSS has modeled as a result of the surveys conducted by the Erzurum Metropolitan Municipality (EMM) personnel. In this model, the areas where the surveyed individuals have their homes are divided into certain regions. With the mobile application design, the status of participation in the CSS has examined. According to the status of participation in the CSS, monthly total economic gain and savings per individual have calculated.

2. MATERYAL AND METHOD

2.1. Survey data

EMM, which is determined as the study area, is located in the most central location of the city. A survey was conducted on 100 staff working in various departments in the main building of the municipality. With the questions asked in the questionnaires, the usability of the CSS was investigated. In the questions asked, the locations of the individuals' homes, what is the transportation to the workplace, the status of joining the CSS, the fuel characteristics of their vehicles, and the most disturbing issues in transportation were determined. The percentage of answers given as a result of the surveys conducted are shown in Fig. 1.

When the responses are examined, a great majority of the municipal employees provide their transportation with the help of motor vehicles. 16% of the centrally located people provide transportation to the workplace on foot or by bicycle. The remaining 84% prefer cars or public transport. Also, more than half of these individuals provide their transportation with their vehicles. This can cause serious traffic jams and parking problems. As a matter of fact, these issues and fuel costs are included in subjects that individuals find most disturbing in transportation. The attitudes of these individuals towards the CSS were also determined to reduce the problems stated by the individuals. A large number of individuals approach the car-sharing system positively. Individuals who prefer motor vehicles in accessing their workplaces and homes, find the car-sharing system useful and who can participate in this system contain a 76% segment. 8% of people think that the CSS is not suitable for them and prefer to provide transportation with their personal vehicles. In this regard, the applicability of the CSS appears to be quite high.

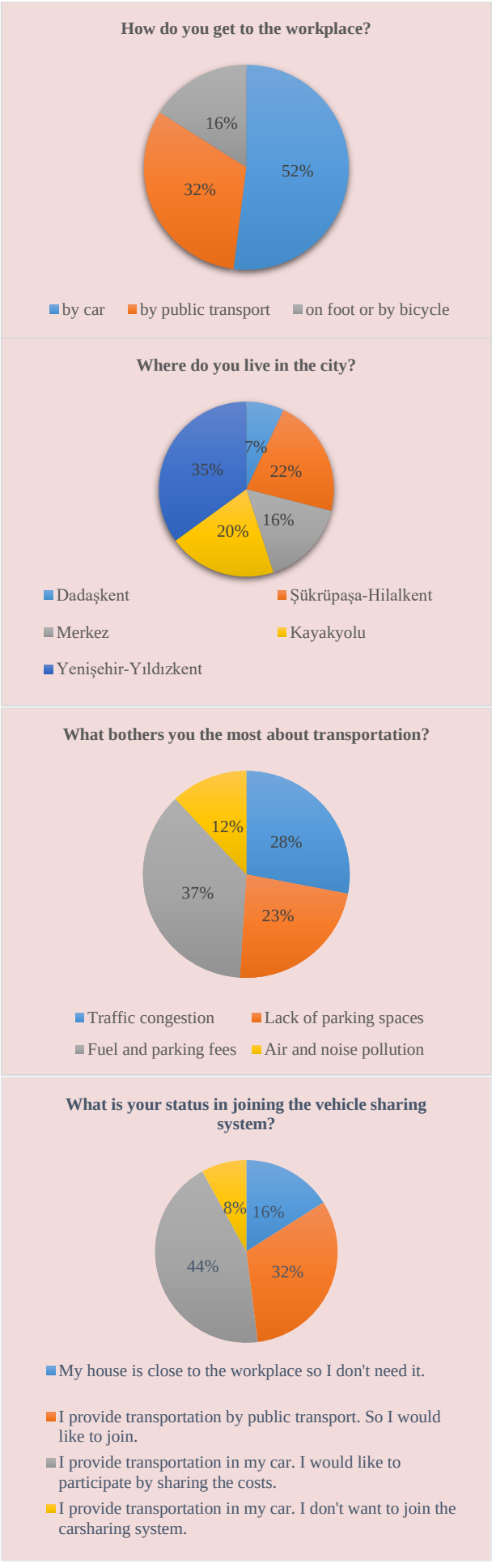

Figure 1. Percentage of EMM employees' responses to the survey questions

2.2. Study area

EMM, which is determined as the study area, is located in the most central location of the city. As a result of the surveys, the locations of these individuals' homes are located in five regions. These regions are named as Dadaşkent, Kayakyolu, Merkez, Yenişehir-Yıldızkent, Şükrüpaşa-Hilalkent due to their locations. The average distances of these regions to EMM and their areas are shown in Figure 2. 7% of individuals are located in the Dadaşkent region, which is approximately 6.4 km from the workplaces [20,21]. The other 3 regions, which are accessible by motor vehicles, are at an average distance of 3 kilometers from the workplace (Fig. 2).

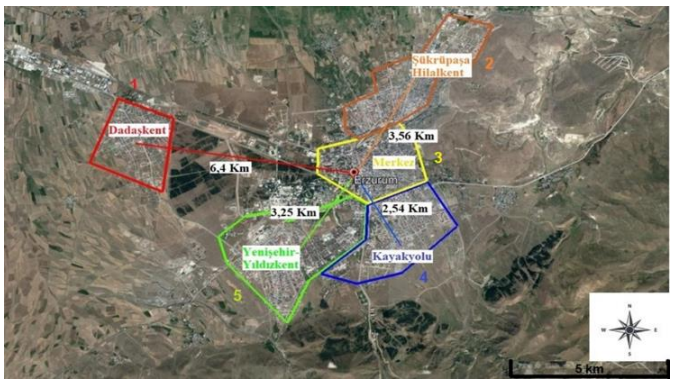

Figure 2. Average distances of the regions to EMM (The average distances shown are highway distances)

In the region where EMM is located, there are important public buildings such as the Provincial Directorate of Environment and Urbanization, Palandöken District Governorate, Land Registry, and Cadastral Regional Directorate, Erzurum Courthouse. It is known that many citizens, as well as individuals working in these buildings, have visited these public buildings. In this case, an important vehicle density emerges. Although there are parking areas around the region, it is insufficient and due to this density, contrary parking is frequently encountered at the roadside.

2.3. Carsharing system

A mobile application interface has been created for individuals to make travel companions via CSS. Individuals who register to this interface with their personal information indicate whether they have a vehicle and in which location they reside. Then, if they own the car, they specify how many passengers they can get in their car, the meeting time and address they have set to go to work, and finally their phone number and the unit they work for. If the individual does not own the vehicle, he/she can see the phone number of the individuals who own the vehicle in this region and request to use the CSS in the tab after stating in which region he/she is living and can communicate with them. In this way, individuals who intend to use CSS will be able to choose the people to use this system. The interface designed for this system is shown in Fig. 3.

Figure 3. Mobile application interface designed for CSS

3. RESULTS AND DISCUSSION

With the grouping created for the CSS structure, it was decided to take 2 or 3 passengers for each car, excluding the driver. Because the individuals demanding to join the system requested this direction to have a comfortable journey and to minimize delays. There are 44 cars in total for individuals who want to join the carsharing system. Rotating the cars in the same region on a weekly basis is important to ensure equality. If the vehicle is shared as a result of the examination and where the locations of the individuals are taken into account, the sharing status is given in Tab. I was obtained.

TABLE I
DATA OBTAINED IN CASE OF APPLICATION OF CSS BY REGIONS

Region No	Number of Individuals	Number of individuals who want to join CSS	Number of individuals who do not want to participate in CSS	Number of vehicles in people who want to join CSS	Number of vehicles used with CSS
1	7	7	0	4	2
2	22	19	3	12	5
3	16	0	16	-	-
4	20	18	2	11	5
5	35	32	3	17	8
Total	100	76	24	44	20

Before the CSS system, 44 of 76 individuals requesting to join this system provide their transportation, while 32 provide their transportation by public transportation. With the CSS application, taking into account the locations of these individuals, the number of vehicles required was 20. In this case, the number of vehicles in use decreased by approximately 55%. This provides significant gains in the name of fuel and parking fees. In addition to this situation, the total amount of 32 people pay daily for public transportation is 122 TL. The fuel consumption and the resulting charges for the vehicles are shown in Tab. 2.

TABLE II
CALCULATION OF THE EARNINGS OBTAINED BY THE IMPLEMENTATION OF CSS

Region No	Daily fuel fee (TL) before CSS	Daily fuel fee (TL) after CSS	Daily parking fee (TL) before CSS	Daily parking fee (TL) after CSS	Daily-earnings (TL)	Monthly earnings (TL)
1	28,16	14,08	8	4	18,08	415,84
2	46,99	19,58	24	10	41,41	952,43
3	-	-	-	-	-	-
4	30,73	13,97	22	10	28,76	661,48
5	60,78	28,6	34	16	50,18	1154,14
Total	166,66	76,23	88	40	138,43	3183,89

* Parking fees are calculated on a monthly subscription.
* Fuel charges have calculated separately for diesel, gasoline, and LPG vehicles.
* Calculation has made considering that there is an average of 23 working days in 1 month.

When the table is examined, if the CSS system is applied, a saving of 138,43 TL per day is provided for automobile fuel and parking fees. Besides, 122 TL is saved for individuals who provide their transportation by public transportation. When both cases are calculated monthly, Tl 5989.89 is saved. An average of 78.81 TL of monthly income is earned per individual participating in the system. The implementation of CSS is quite easy, but the gains are also high. Especially in the long term, it can provide serious financial gains for individuals. On the other hand, situations such as air pollution, traffic congestion, insufficient parking areas, and noise pollution, which increase due to the increase in the number of vehicles in daily life, can be significantly reduced with the CSS method.

4. CONCLUSION

In this study, in addition to the existing methods, the applicability of CSS within the institutions was investigated. A mobile application interface is designed based on the locations of individuals' homes and whether they own a vehicle or not. Accordingly, as a result of the survey conducted for 100 individuals working in the EMM, it was determined that 76 individuals wanted to participate in CSS. For these individuals, daily and monthly expenses were calculated by determining the usage of public transportation, fuel prices of individual vehicles, and parking fees. Then, the expenditures that will occur by calculating CSS are calculated. When both cases are compared, a saving of nearly 6 thousand TL per month is achieved. In addition to this financial gain, since the number of vehicles in traffic will decrease, delays can be reduced, parking areas can be found, harmful gas emissions and noise pollution can be reduced. Since the system has such a beneficial aspect, the CSS system should be widely used, especially in areas where government agencies and business centers are located. Also, individuals can be encouraged by government agencies to increase the usability of the system. Accordingly, it is possible to design more livable cities.

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