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Environmental Impacts of Changes in Travel Behaviour with Covid-19

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Abstract

During the Covid-19 pandemic, life in cities has slowed down. Many countries around the world have taken measures to reduce the spread of the epidemic. While flexible working strategy is being implemented in some workplaces, some workplaces have adopted the method of working from home online with the suitability of working conditions. Such strategies brought about by restrictions have also affected transportation, which is indispensable for societies and the most important infrastructure system of cities. Within the scope of this study, how much less damage to the environment as a result of not using private automobiles for home-work travels with the strategy of working from home will be investigated with the determined sample. Information about their automobiles was obtained from the people in the sample determined by the survey method. The amount of CO_2 emitted to the environment due to home-work travels was calculated and the results were evaluated.

1. INTRODUCTION

The rapidly infecting Covid-19 virus, which emerged in Wuhan, Hubei, China, was proclaimed as an epidemic by the World Health Organization on 11 March 2020 and the first case of Covid-19 was found in Turkey on this date. With the emergence of the coronavirus, many countries around the world have taken various measures to prevent the spread of the epidemic. While cough and shortness of breath, which are symptoms of coronavirus, reveal people's needs for clean air, the restrictions imposed by countries and the fact that people have to stay in their homes clearly have revealed the need for open spaces in cities. With these effects on people, the coronavirus epidemic emphasizes the importance of drawing attention to air pollution, which has an important place in environmental pollution.

Turkey has also brought many restrictions to prevent the spread of the pandemic, like other countries. Many restrictions have been imposed, such as interruption of education, curfews for people over 65 and under 20, transportation restrictions, restrictions in industrial production and the closure of some workplaces. In the study of transportation restrictions in the city of Wuhan, where COVID-19 occurred, it was found that the restrictions reduced the rate of spread of the virus [1]. With the interruption of education, students continued their education with the distance education system and the mobility of transportation in the city decreased. One strategy to reduce the epidemic is to switch to flexible working method in public institutions and organizations. The move to flexible working in public institutions and organizations has been a shift to flexible working in some private sector businesses, while some organizations and businesses have adopted the method of working from home.

The home-working model can be effectively implemented in areas such as banking, insurance, computer programming, training, etc., but it cannot be implemented for jobs that require personal rapport and contact,

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require the use of a number of special equipment or require labour [2]. The concept of 'Working from Home' has been a topic of discussion and global study by researchers over the past 10 years. However, these studies have become much more important due to the Covid-19 outbreak and are considered as a new business model used to prevent the contagion of the epidemic [3]. The home-working model that has developed due to Covid-19 has brought its advantages. With working from home, time spent on the road or in traffic is reduced, dead times in the workplace are utilized and productivity is increased. Individuals will decrease their fatigue levels and will be able to spare time for activities to feel more energetic, spend more time with their families, take care of children, help children with distance education, and meet the needs of adults. The flexible structure of working from home creates these advantages. For employers, various expenses such as transportation, food, fuel, stationery and energy use are decreasing [4]. The home-working model has also reduced people's mobility in transport. With the work-from-home strategy that comes with the pandemic process, people do not make their home-work travels or travel when necessary. This enables people to save energy spent in transportation and reduce the damage to the environment.

Emission values in the transportation sector have an important rate that cannot be underestimated. The 2020 National Inventory Report, which was created under the United Nations Climate Change Framework Agreement, the emissions in the transport sector have a rate of 213,3% higher than in 1990 in 2018. In 2018, 84.5 Mt of CO_2 emission was emitted in the transportation sector and 93.4% of the emissions in transportation originated from road transport [5]. Although CO_2 emission values are not separated in terms of transportation types in road transport, it is obvious that it has an important role.

There is a variety of transportation types that people prefer on their urban journeys. These preferred types of transport can be duplicated as a bus, metro, minibus, taxi or private vehicle. Some features are also effective in choosing the modes of transportation. People pay attention while selecting transportation mode to many features such as being safe, comfortable, priced, accessible, frequent service and travel time. People who have economic freedom, who attach importance to comfort and security and the use of time may prefer to use private automobiles in urban transportation on the grounds that public transportation cannot provide these features. Due to the risk of transmission of the Covid-19 virus, people during the pandemic process turned to the use of private automobiles because they thought they could isolate themselves more and felt safe. People traveling by public transport in the normal times prefer alternative transportation methods during the pandemic period. Driving a private automobile has an indispensable role in people's lives.

Within the scope of this study, it has been aimed to contribute to the literature by observing how much less CO_2 is emitted to the environment by making people, stay at home with the strategy of working from home provided by the pandemic period. The research was conducted on academicians who were observed to use private automobiles more frequently. Data were obtained through online surveys made to academicians of Gazi University's Department of City and Regional Planning and the Department of Traffic Planning and Implementation.

In the chapters followed, the scope and method of the research, the place of the transportation sector in the carbon footprint, the change in carbon emission during the pandemic period, the use of private automobile, the method of working from home and the evaluation of the data obtained will be mentioned and concluded.

2. SCOPE AND METHOD OF THE RESEARCH

During the pandemic period that caused by Covid-19, the method of working from home has been applied in Turkey. In this study, CO_2 is emitted to the environment and damage is given compared by working from home and not using private automobiles by people.

The mixed method in which qualitative and quantitative data are used together in the study. In this study, the literature had been firstly reviewed. With the literature review, qualitative information was obtained general information about the pandemic and its strategies, the importance of carbon footprint in the transportation sector, the change in carbon emissions during the pandemic process, and the effects of private automobile use by searching various articles, books and reports.

The primary data source of the study has been the questionnaires conducted with academicians who are used to drive their automobiles to faculty. Due to the restrictions brought by the pandemic period, the surveys were conducted online on Google Forms. Contributors to the study have been academicians, commuting to Gazi University Maltepe Campus, from the Department of City and Regional Planning and the Department of Traffic Planning and Application. The questionnaire was sent to 42 academicians via e-mail, and feedback was received from 28 of participants. Due to the fact that the emission value of LPG cars could not be calculated in some survey results and a different type of transportation was preferred other than private automobiles, the survey data of 22 participants were evaluated. When there was incomplete information about the automobile, it was calculated by taking the average of the emission values of the automobiles that had the same characteristics according to the brand, type and fuel used.

In online survey, the district they came from to the campus and type of transportation they preferred are asked. In the survey, academicians who generally drive private automobiles were asked the brand, engine characteristics, model and fuel type of the car they use to learn about the carbon dioxide emission of the automobile. Another question in the survey was how many kilometers the distance from home to work was. With this question it was aimed to calculate the amount of CO2 created by people's private automobiles according to the distance they drove from home to work.

According to the data obtained from the survey, the CO_2 emission values of the automobiles were found and checked from the official websites of the automobile brands in terms of the model and fuel type. Features such as automobile weight, size, wheel diameter, changes in CO2 emission rates by years have been ignored, and the CO2 emission values of new automobiles calculated at the factory were taken as basis. For the models that are not currently available on the official websites of the automobile brands, the telephone numbers of the services were searched and the CO_2 emission value of the automobile was obtained. The emission value of some automobiles due to the lack of information about automobiles, such as brand, engine, model, etc. the average emission value of the automobiles with the same features as given in the survey was taken and accepted as the automobile emission value. The arithmetic mean of the CO_2 emission values given as interval values was taken. Then, the amount of CO_2 produced by the academicians according to the kilometers they took during their home-to-work travels was calculated.

3. THE ROLE OF THE TRANSPORT SECTOR IN THE CARBON FOOTPRINT

Carbon footprint is the measurement of the damage to the environment caused by human activities in terms of the amount of greenhouse gas produced in unit carbon dioxide. Carbon footprint consists of two main parts, primary and secondary. While CO_2 emission arising from domestic energy consumption, transportation and burning of fossil fuels form the primary carbon footprint, CO2 emission resulting from the process from the production of the products to their deterioration also constitutes the secondary carbon footprint. Secondary carbon footprint covers primary footprint [6].

It has been expressed that the main sector is the energy industry, which has 71,6% of man-made greenhouse gas emissions in the Turkey 2020 National Inventory Report. The CO_2 rate in the energy sector in 2018 was stated as 85.8%. 22.6% of the emissions originating from the energy sector was known as the transportation sector. The transportation sector has an important role in greenhouse gas [5].

Moreover, the transportation sector is an important component of economic growth. The sector grows rapidly due to the increasing demand for transportation in developed and developing countries. This is a problem in many countries in terms of increasing energy consumption and the amount of carbon footprint. [7].

Transportation sector is classified as domestic aviation, road transport, railways, domestic water-borne and other transport in the Turkey 2020 National Inventory Report. As in the report, the values of emissions increased by 213.3% in 2018 compared to 1990. When annual average increase rate of emissions was analyzed, a rate of 7.4% has been found. Comparing greenhouse gas emissions according to the classification in the transportation sector, road transport has a very high rate like 93.4% [5]. It is obvious

how important role this ratio has in global warming, climate change and air pollution. The graph of carbon footprint changes in the transportation sector between 1990-2018 in Turkey is given in Figure 1.

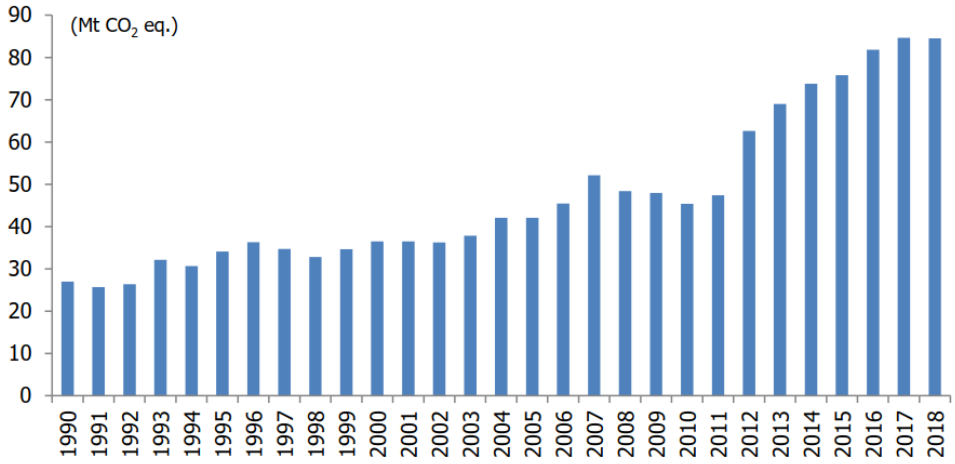

Figure 1. *Greenhouse gas emissions in the transport sector, 1990-2018 (Turkey National Inventory Report, 2020)*

The graph in Figure 1 showed a rapid increase in the carbon footprint of the transportation sector in Turkey in 2012. After 2012, the carbon footprint continued to increase continuously. Fuel types have a great impact on road transport, which has an important place in the carbon footprint of transportation. When the carbon emission factors (CEF) are specified in the Intergovernmental Panel on Climate Change (IPCC) guideline for each fuel type, the type with the highest carbon emission value is diesel (20,2 tC/TJ). Diesel is followed by gasoline (18,9 tC/TJ) and then LPG (17,2 tC/TJ) [22]. Until 1997, only diesel and gasoline were used as fuel in road transport. The use of LPG started in 1997 and its consumption increased gradually. Then, while gasoline consumption decreased, diesel fuel consumption and LPG consumption increased. Diesel fuel consumption decreased from 2007 to 2010 due to the global economic crisis. A remarkable increase in diesel fuel consumption has been observed in the following years [5]. The values of emissions according to the type of fuel in road transport in Turkey have been shown in Figure 2.

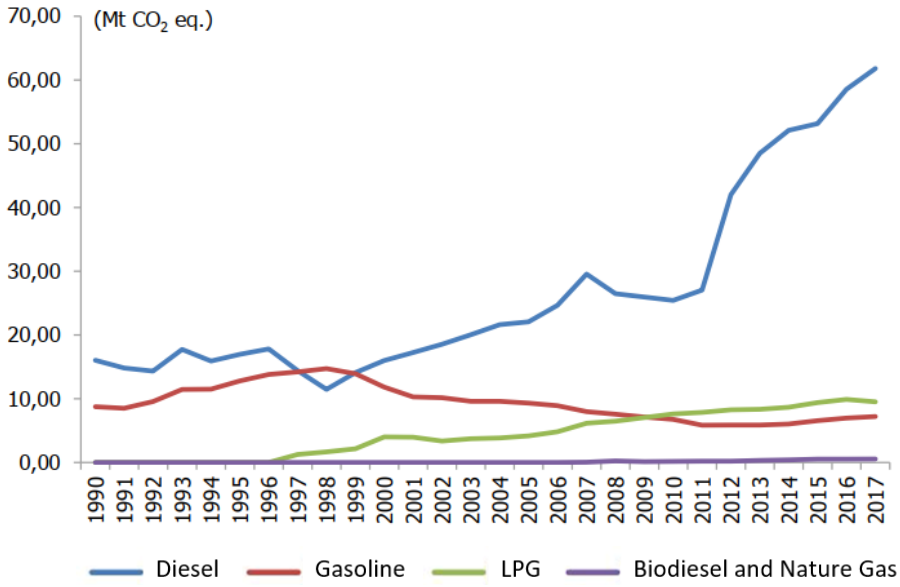

Figure 2. *Distribution according to type of fuel in road transport emissions, 1990-2018 (Turkey National Inventory Report, 2020)*

Figure 2 shows that the emission value obtained due to the diesel fuel type is higher than the others. The main reasons are that diesel automobiles produce more CO_2 emissions and the use of diesel automobiles is more preferred than other types.

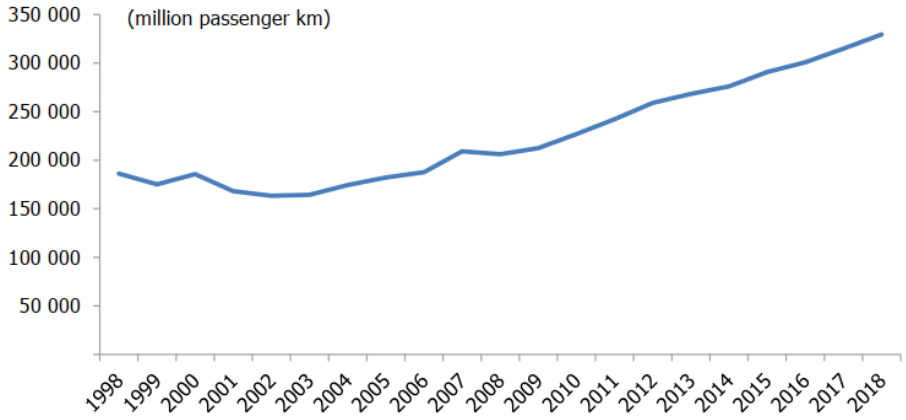

Figure 3. *Road passenger-km, 1998-2018 (OECD Passenger Transport Turkey Data, 2020)*

The number of passengers per km increases every year (Figure 3). This demand for road transport in the transportation sector increases the rate of carbon footprint day by day. Therefore, the CO_2 emission value created due to the road transport increases continuously and causes environmental problems.

4. CHANGE IN CARBON EMISSIONS DURING THE PANDEMIC PERIOD

Due to Covid-19, the decrease in industrial activities and traffic density has improved air's quality. Air pollution monitoring satellites of NASA and the European Space Agency found significant reductions in nitrogen dioxide in China during quarantine compared to January 1-20 with February 10-25 before. With the spread of the epidemic, it has been observed that the rate of nitrogen dioxide has decreased worldwide. The Covid-19 Pandemic has reduced the global air pollution rate by 6 percent [8]. Dolphins at Ortaköy shore and Uludağ from Istanbul have been seen clearly and this is the evidence of the visible reduction in air pollution.

Due to the Covid-19 pandemic, people stayed at their homes, mobility in transportation decreased, travel slowed down restrictions in hotels, cafes, restaurants and stagnation in the tourism sector prevailed. The effects of reducing greenhouse gas emissions were expected due to restrictions and low use of services. Because of the pandemic, people stayed at home and this brought land, sea and air travels to a level where they could stop. The fuel type most badly affected by this situation was gasoline.

In the summary of the May 2020 Global Energy review report of the Energy and Natural Resources Experts Association, it was stated that there was a 5% loss of demand in oil and this was due to the aviation and road restrictions, which constitute 60% of the global oil demand [9]. It was stated that road transport activities decreased by 50% compared to 2019 average. Globally, CO_2 emission has been expected to decrease by 8% with less energy consumption due to all these restrictions. A decrease of 8% means approximately 2.6 gig tons (Gt), i.e., 2.6 x 1012 kg reduction is expected. This means that the CO_2 emission returns to what it was 10 years ago. This decline means about 6 times more the emission decrease in the economic crisis in 2008-2009 and 2 times the total decrease experienced after the second world war [9]. However, as mentioned in academic reviews, it is considered that the returns in emissions may be higher than the decrease experienced in previous crises.

5. PRIVATE AUTOMOBILE USE

Turkey has focused on road transportation. It has been seen that the length of the road network increased after 2000s. In addition, it is seen that individual automobile ownership has increased with the developing economy. The reasons for the increase in automobile ownership can be providing comfort, flexibility, being fast and low in cost, etc.

The increase of the suburbs in the cities and the urban sprawl has been effective in people's daily use of private automobiles. Although it is thought that using a private automobile has various advantages

individually, it is highly harmful to the environment. Many negative effects such as traffic jam, noise-air pollution and increase in traffic accidents are observed with the use of private automobiles. Automobile takes much space and causes traffic jam and brings many problems.

Private automobile use has become a situation that individuals prefer and do not want to give up. However, the length of distances and the preference of private automobiles increase the energy consumption and require a significant use of the energy budget in the cities. This situation creates unsustainable results [10].

Figure 4 shows the proportions of the main elements that make the carbon footprint of an average person in the society. Private automobile use has a high rate of 10% in the carbon footprint created by a person.

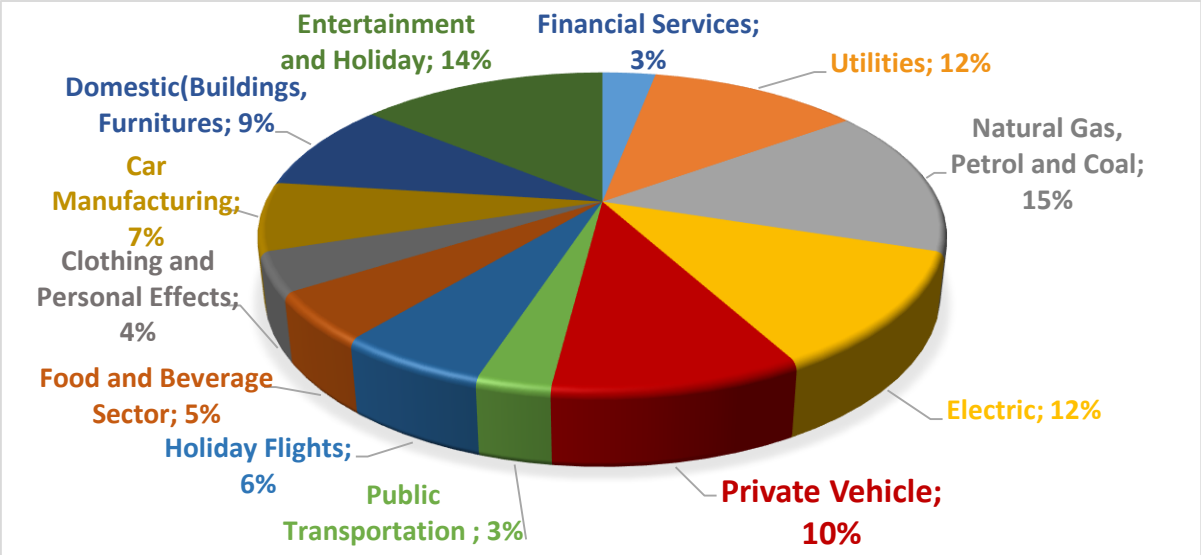

Figure 4. *Proportional distribution of the main elements that make the carbon footprint of an average person [15]*

Automobile ownership and increased use of automobiles also vary according to the income status of the people. People who have higher income are more likely to own an automobile. Academicians who can be considered in middle-high income groups are also likely to own an automobile in Turkish cities. For this reason, this research was carried out with the participation of academicians.

6. THE METHOD OF WORKING FROM HOME

The "working from home" method, which is one of the travel demand management strategies, is also called with different concepts such as “remote working” and “teleworking”. The method of working from home has been the subject of research by many scientists. Due to the Covid-19 outbreak, many countries have had to change their working system and create different strategies such as flexible working, rotating work or working from home. The method of working from home has also become an alternative strategy in the appropriate professions during this pandemic period. It has been a very favorable strategy especially for occupational fields that use information technologies and do not have to use special tools in the job.

In order for the method of working from home to be efficient, it should be addressed to professional groups suitable for this method. The main professions suitable for working from home are mentioned as educational services, professional, scientific and technical services, management of businesses and companies, finance and insurance, informatics by Dingel and Neiman (2020) [11]. The professions that are not suitable are stated as transportation and storage, construction sector, retail trade and sales, agriculture, forestry, fishing, accommodation, food and beverage sectors [11]. In the Covid-19 period, digital transformation, which was tried to be carried out in many businesses and services, led to rapid

breakthroughs in experience, knowledge, innovation and technology, especially in developing countries [12].

The adoption of the method of working from home caused by the Covid-19 virus has brought some advantages and disadvantages. Rubin et al. discussed the advantages of working from home as being able to carry out home and work-related activities together, providing flexibility, saving, saving time, utilizing the dead time in traffic, providing comfort and being energetic. They addressed the disadvantages of working from home with consequences such as inability to meet face to face with colleagues, lack of experience in working from home, reduction of social contact, failure to balance work and life, problems of focusing, ergonomic problems, and insufficiency of the technology and equipment [13].

Working from home has become a law in some countries. For example, "Tele-work Development Law" was enacted in the USA in 2010. In Turkey, the paragraph has been added to Article 14 of Law number 6715 in 2016 related to the remote working. It is described as "Working remotely; It is defined as a business relationship established in writing based on the principle that the worker performs his / her job at home or outside of the workplace with technological communication tools within the scope of the work organization created by the employer; The procedures and principles regarding remote working will be determined by the regulation to be issued". However, a regulation on this issue has not been published yet. Remote working is expected to be determined by a contract between the employer and the employee.

Since the method that has not been seen in Turkey before suddenly comes to daily life, the law is not clear and people have lack of knowledge, it has caused some negative consequences. Despite all these negative sides, it has made citizens experienced about the method of working from home.

7. EVALUATION OF THE OBTAINED DATA

In this part of the study, the survey results, which are the primary source of the research, will be mentioned. The survey was carried out with the participations of the academicians in the Department of City and Regional Planning and the Department of Traffic Planning and Implementation in Gazi University Maltepe Campus. Gazi University Maltepe Campus is located between Celal Bayar Road and Gazi Mustafa Kemal Road, and its location is shown in Figure 6.

Figure 6. *Gazi University Maltepe Campus Google Earth view, 10.01.2021*

In the survey, first of all, the preferred transportation mode have been investigated. The amount of CO_2 generated by private automobile travels would be analysed and private automobile users were evaluated. The most important data in the survey has been the brand, engine, model information and the type of fuel used. Due to this information, the CO_2 emission values produced by the cars were found.

It has been seen that 4 of 28 academicians participating in the survey use public transportation during their home-work travels, only 1 of them come to the settlement on foot and the other 23 use private automobiles. In the survey conducted within the scope of this study, it has been seen that approximately 82% of the academicians have home-work travels by using a private automobile. One of the participants using private automobiles uses LPG as fuel type. The CO2 emission value of this participant was eliminated.

When analyzing the distance of home-work travels in the survey, it has been seen that the participants travel between 1 km and 33 km. The average travel distance of the participants who have their home-work travels by using a private automobile was approximately 14 km.

Table 1. *Home-Work Travel Distance of Participants Using Private Automobiles*

Distance (km)	**The Number Of Participants**
0-10 km	11
11-20 km	4
21-30 km	6
31+ km	1

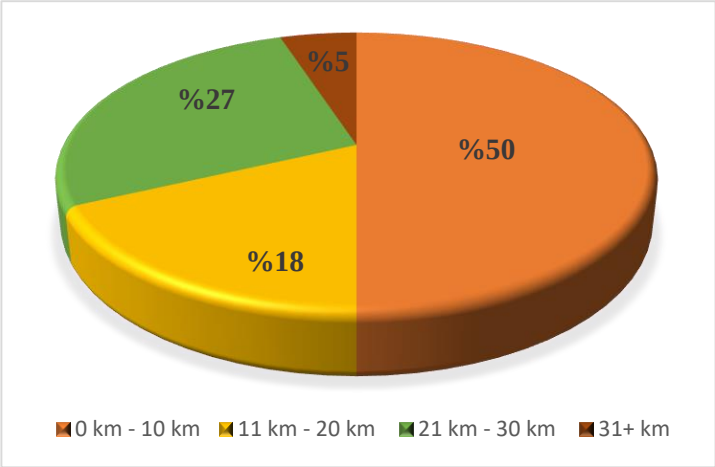

Figure 7. *The proportions of Home-Work Travel Distance of Participants Using Private Automobiles*

Table 1 shows the groupings of participants according to their home-work travel distance. When data was rated, it has been seen in Figure 7 that 50% of the participants who use private automobiles are at home-work travel distance of 10 km or less.

An important point in the CO2 emission rate is the fuel type of the automobiles. CO2 emission values resulting from the burning of automobiles vary according to the type of fuel. As mentioned in the third section, according to the IPCC guideline, the fuel type that produces the most CO2 emissions is diesel. Then gasoline and LPG follow it in order. 14 participants who drive private automobiles and whose survey results have been evaluated use gasoline and 8 participants drive diesel automobiles. The percentage rates of private automobile users according to the type of fuel they prefer can be seen in Figure 8.

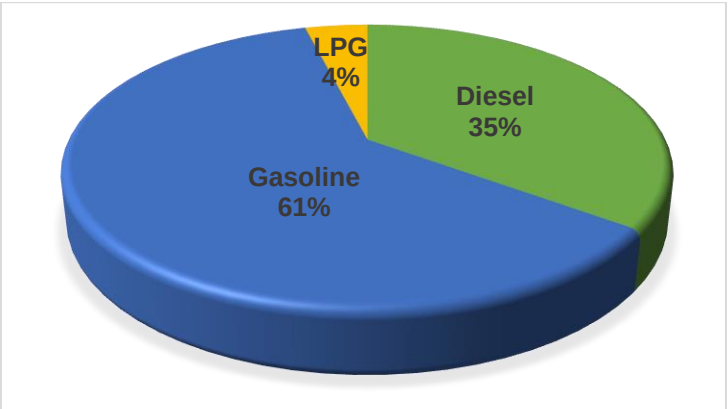

Figure 8. *Percentage of the number of automobiles by fuel type*

The LPG fuel type with the coefficient of lowest emission production has the lowest preference of 4% (Figure 8). It has been seen that the most preferred fuel type is gasoline. The reason for this situation depends entirely on the preferences of the participants. Considering the possibility of automobile preference, it can be thought that the fuel price is not effective in the preferences of the majority, since the income level of the group can be considered to be medium-high. Choosing gasoline powered automobiles is a more positive approach in terms of emission production than diesel automobiles. It is not known whether the users' preferences are conscious or not, and this issue may be another area of research into how people reflect their knowledge of the emission value and the use of private automobiles.

Table 2. *Survey data and CO_2 emission values of automobiles*

	From which district do you come to Gazi University Maltepe Campus?	If you use a private automobile, what is your automobile's brand, model and engine?	What is the fuel type of your automobile?	How long is the distance between campus and your home? (km)	CO_2 emission value of the automobile (g / km)	CO_2 amount (g) produced daily in home-work travel (One Way)
1	Ayrancı	Citroen C-elysee 2014 Model	Diesel	4	104	416
2	Birlik Mah.	Mercedes B 1.8 dizel	Diesel	7	125	875
3	Urankent	Renault Symbol 1.5 Turbo Dizel 90 HP	Diesel	11	96-101	1083.5
4	Cebeci	Renault Captur Icon 1.5 dci 90 edc 2017 Model	Diesel	8	103	824
5	Türkkonut	Fiat Egea 1.3 Turbo Dizel	Diesel	30	105	3150
6	Yaşamkent	Nissan Qashqai 1.6 DCI Skypack Xtronic Dizel 2015 Model	Diesel	25	123-127	3125
7	Aydınlıkevler	Renault Clio 1.5 dizel	Diesel	6	111,8[1]	670.8
8	Keçiören	Subaru 2.0 Turbo Dizel 160 HP	Diesel	10	158	1580
9	İncek	Bmw 118İ Hatcback 1.5 (136) Joy Plus 2018 Model	Gasoline	24	137	3288
10	Öveçler	Volkswagen Polo 1.0 TSI	Gasoline	11	105	1155
11	Çayyolu	Mercedes c180 2013 Model	Gasoline	22	157	3454
12	Yaşamkent	Audi Q2 Benzinli 1400cc	Gasoline	25	124-130	3175
13	Batıkent	Sandero 0.9 Turbo Benzinli 90 HP 2017 Model	Gasoline	17	130	2210
14	Gaziosmanpaşa Mah.	Opel Astra 1.6 Benzinli 2013 Model	Gasoline	5	111	555
15	Öveçler	Volkswagen Polo 1.0 TSI 95 PS	Gasoline	10	105-106	1055
16	Gazi Mah./Çankaya	Mitsubishi Lancer 1.8 2009 Model	Gasoline	5	160	800
17	Balgat	Honda Civic 1.6 2006 Model	Gasoline	9	159	1431
18	Etimesgut	Volkswagen Polo 1.2 Tsi 2017 Model	Gasoline	25	114	2850
19	Ayrancı	Hyundai Getz 1.4 motor 2010 Model	Gasoline	6	141	846
20	Keklik Pınarı	Hyundai ix35 1.6 Benzin 2013 Model	Gasoline	11	158	1738
21	Çayyolu	Volkswagen Touareg	Gasoline	32	276,5[2]	8848
22	Ayrancı	Hyundai Getz	Gasoline	7	144,3[3]	1010.1

1 Since the model information of the automobile is missing, the emission values of all Renault Clio Diesel automobiles have been averaged.
2 Since the model information of the automobile is missing, the emission values of all Volkswagen Touareg Gasoline automobiles have been averaged.
3 Since the model information of the automobile is missing, the emission values of all Hyundai Getz Gasoline automobiles have been averaged.

In Table 2, automobile information of the participants, automobile CO_2 emission values found in the light of this information, and CO_2 emission values created by one-way travel according to the distance of home to work are given.

Figure 9 shows that the CO_2 emission values of the automobiles vary between 96-277 g / km, however, they are intensified between 96-160 g / km. The average CO_2 emission value of diesel automobiles is 116.28 g / km, the average CO_2 emission value of gasoline automobiles is 144.66 g / km and the average CO_2 emission value of all automobiles is 134.4 g / km.

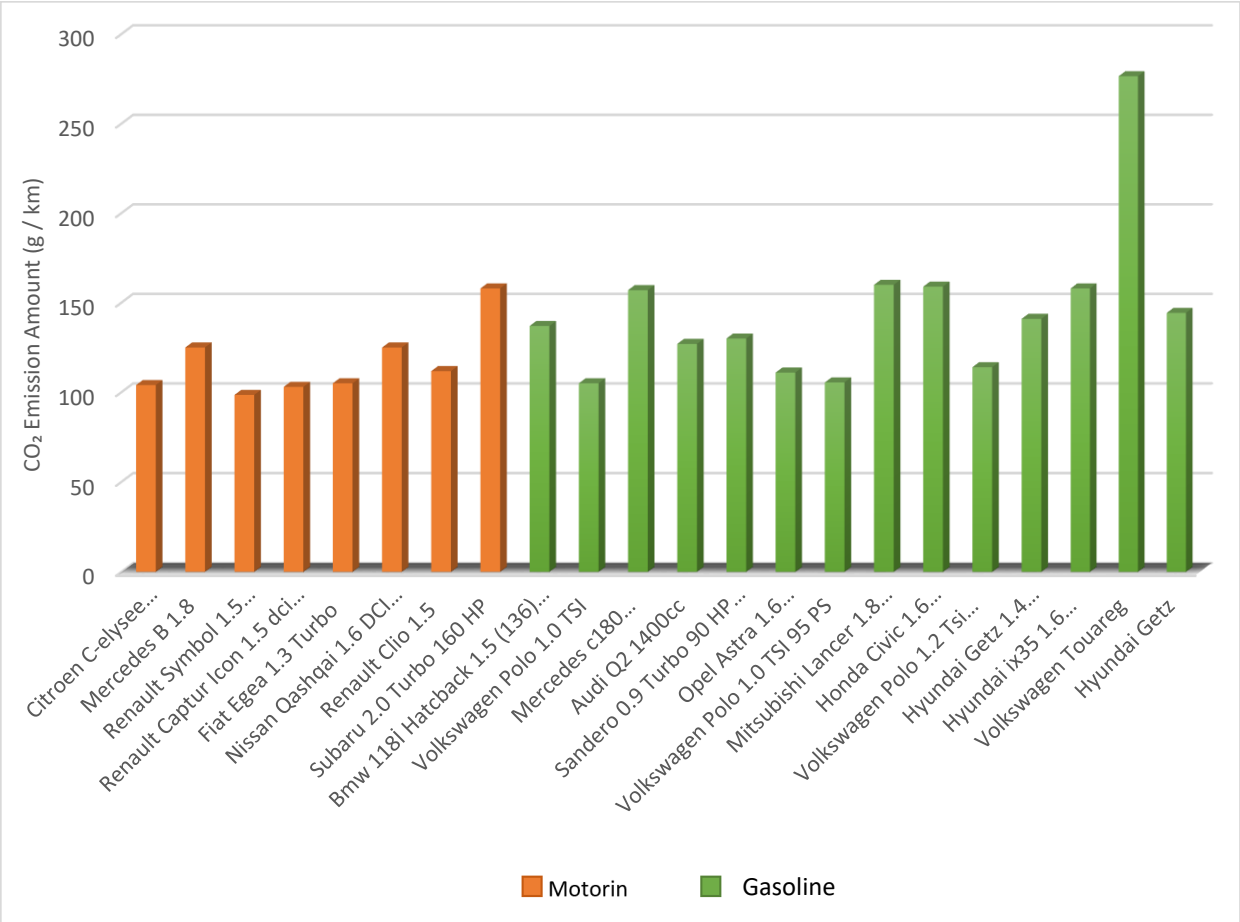

Figure 9. *CO_2 emission values of participants' automobiles*

In road transport according to TURSTAT (Turkey Statistical Institute) 2019 data, the emission value of diesel powered automobiles as a fuel type is expected to be higher. In this research, it has been found that the average CO_2 emission values of diesel automobiles are lower than the average CO_2 emission values of gasoline automobiles. This may be due to the fact that the emission values of the preferred automobiles are intensified within a certain range and the number of participants using gasoline automobiles is higher than the number of participants using diesel automobiles, and therefore the density of preferences in type of fuel cannot be prevented. As a result, conducting a survey with a larger rate of samples or collecting data on this issue can be a way to provide clearer information.

Table 2 shows the CO_2 emission values produced by the participants at one-way home-work travel. In Figure 10, the graph of the CO_2 emission values produced by the participants using diesel powered automobiles between home and work is given.

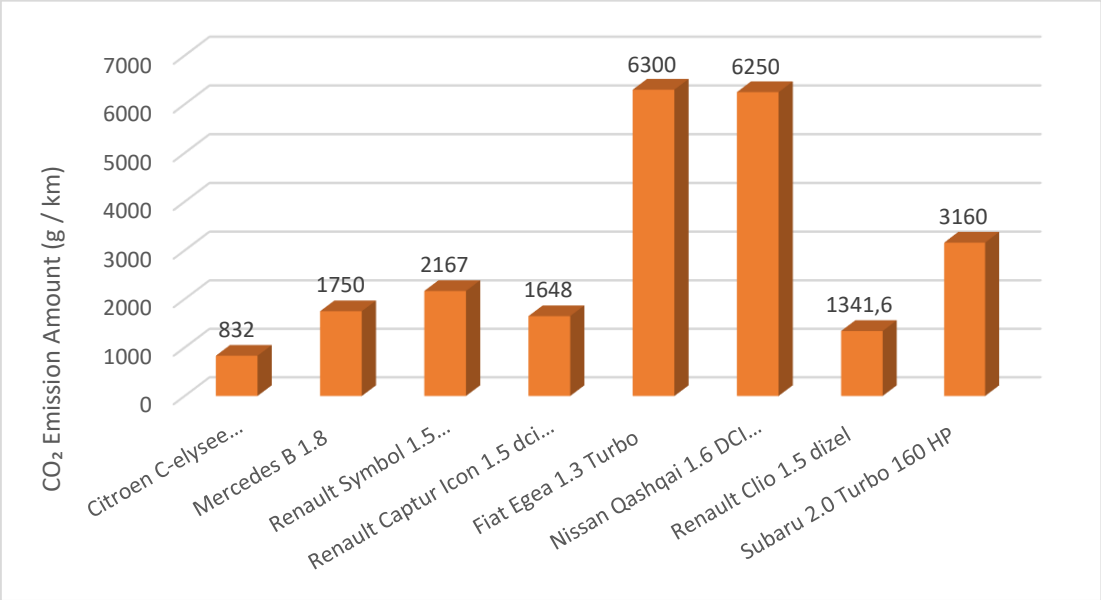

Figure 10. *The amount of CO_2 emission produced by diesel automobiles with one-way home-work travel*

The emission values of the automobiles vary considerably according to the brands, the engines and the models. Therefore, people should pay attention to CO_2 emission values and be conscious while buying an automobile in order to cause less damage to the environment. The average CO_2 amount produced by the participants using diesel automobiles during their home-work travels is 1465.5 grams with one way and 2931 grams of CO_2 emission with both-way to commute in a day. Approximately 3 kg of CO2 are produced in a day by an academic driving a diesel automobile, and approximately 60 kg of CO_2 are produced in a month (assuming 20 working days). It is known that an average tree can absorb approximately 25 kg of CO_2 a year, so that a tree can absorb the 1-month amount of CO_2 produced by only 8 academicians using diesel automobiles in 2.4 years (28 months 24 days).

Figure 11 shows the amount of CO_2 produced by the participants using gasoline powered automobiles during their home-work travel. In the graphic, it is seen that some automobiles produce too much emission due to their features. One of the participants driving gasoline automobiles has an average of 2315 grams of CO_2 emission with a one-way travel and 4630 grams of CO_2 produced by both-way travel from home to work. Approximately 4.6 kg CO_2 produced in a day by an academic using a gasoline automobile is 92 kg CO_2 per month (assuming 20 working days). Therefore, since 14 academicians participating in this research commute using gasoline automobiles, the amount of CO_2 one of them produces in one month is equal to the amount of CO_2 that a tree can absorb in approximately 3.7 years (44 months 12 days). These calculations show that, first of all, duties and responsibilities towards the environment and nature must be fulfilled individually, and acted consciously. It should be realized how much responsibility is attributed to trees and nature, and how much is expected from them to absorb that amount.

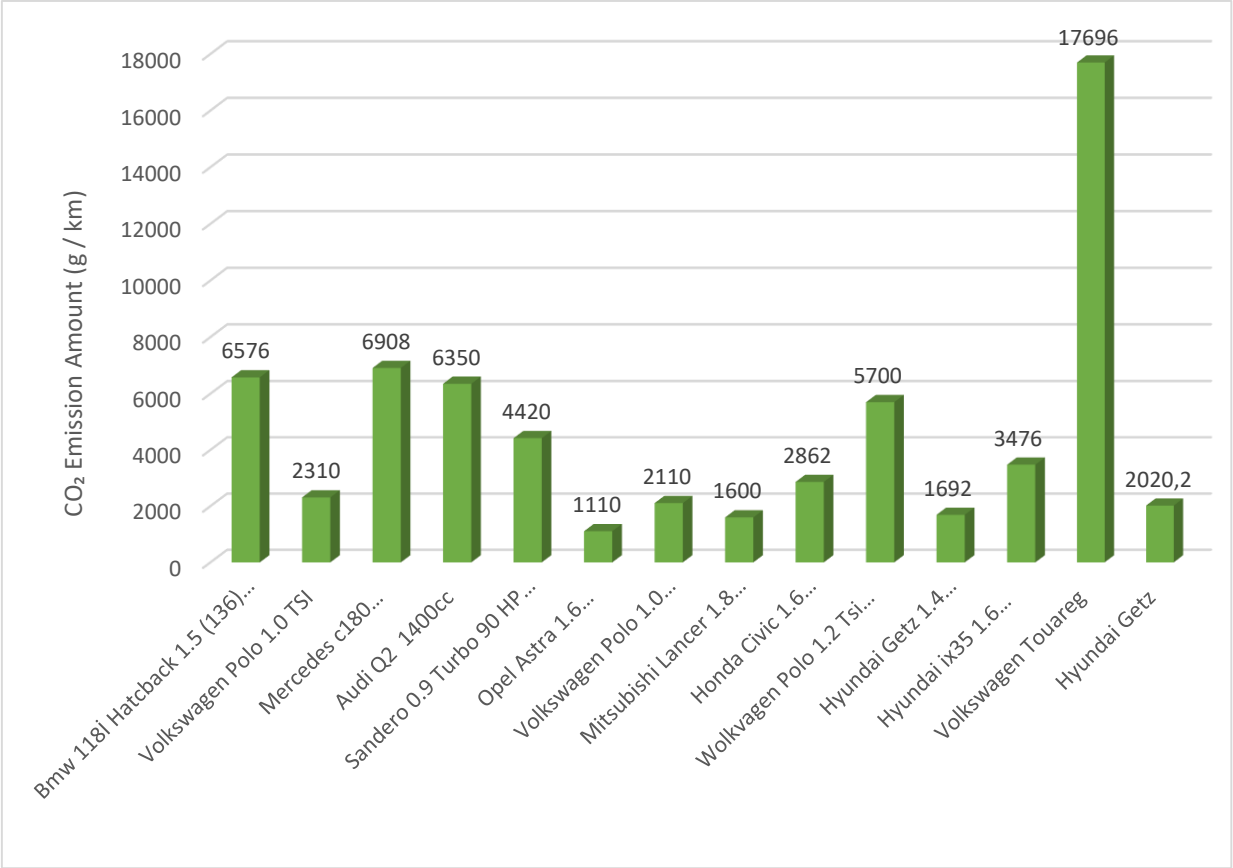

Figure 11. *The amount of CO_2 emission produced by gasoline-powered automobiles with one-way home-work travel*

Figure 12 shows the distribution of the CO_2 amount created as a result of the relationship between the CO_2 emission value of the automobiles and the distance between home and work. In the chart, the serial red trend line has been determined according to the automobile CO_2 emission value and the distance of the participants from home to work. It is seen that the amount of CO_2 produced towards the upper right corner of the chart increases while the amount of CO_2 produced towards the lower left corner of it decreases. In the light of the survey data, the amount of CO_2 under the serial trend line varies between 800 grams and 1738 grams. In terms of the survey data the amount of CO_2 above the series trend line varies between 2210 grams and 8848 grams.

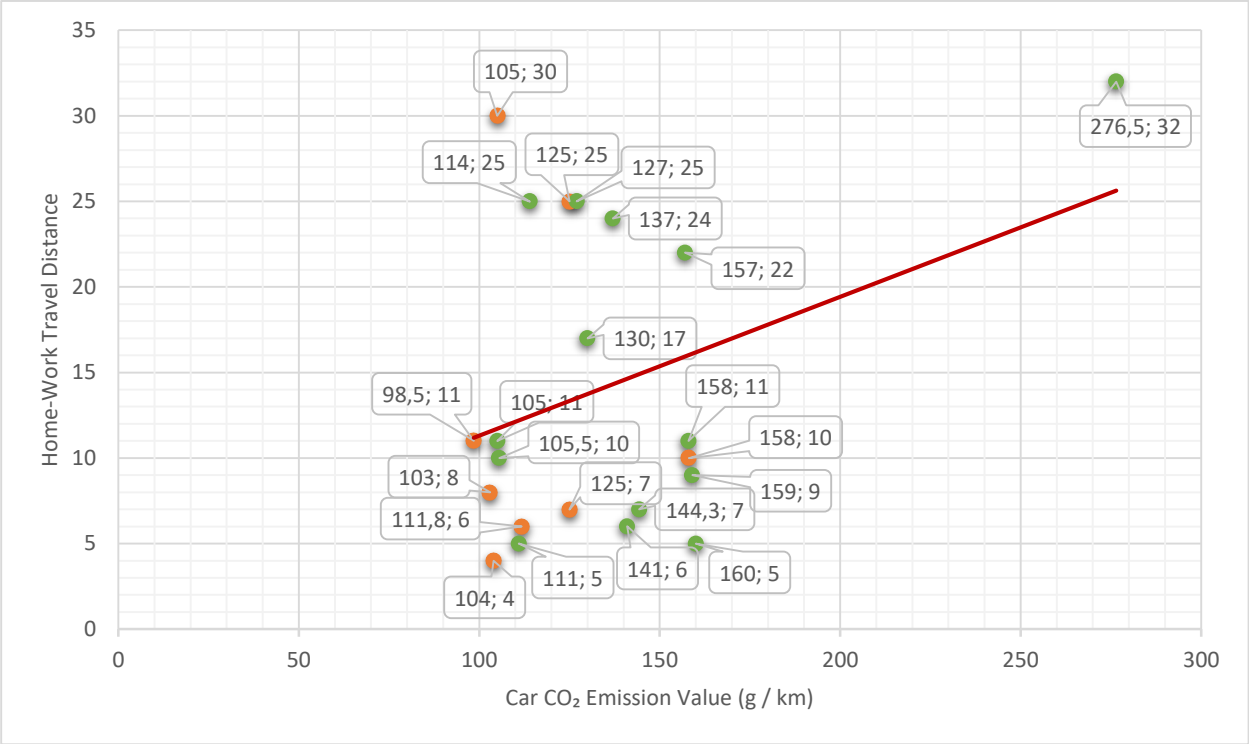

Figure 12. *Evaluation of automobile CO_2 emission value and home-work travel distance*

Figure 12 shows the emission values of diesel and gasoline automobiles are intensified below the serial trend line. According to TURKSTAT's 2019 data, the emission value produced by diesel automobiles is expected to be higher. However, in this research the amount of CO2 emission produced by gasoline automobiles and the average amount of CO_2 produced by one person is higher than diesel powered automobiles. The reason for this is that the number of diesel automobiles is lower, and the diesel powered automobiles which has less amount of CO2 emission compared to the one produced by gasoline automobiles are preferred.

According to the results of the survey and the necessary calculations, the total amount of CO2 produced by one-way travel to work of the participants, which consists of 22 academicians, is 44139.4 grams in one day, and therefore, the total amount of CO_2 produced by both-way travel from home to work is 88278.8 grams. The amount of CO_2 produced by one participant in a day is 2006 grams with one-way travel while it is 4012 grams of CO_2 they produce with both-way travel. Assuming that the participants produce 4 kg of CO_2 in a day due to their home-work travel, it has been seen that they produce 960 kg of CO_2 in a year (assuming 20 working days in a month and calculating as 4x20x12). On the website of the Aegean Forest Foundation, under the heading "How Many Trees Do I Owe to Nature?", it is seen that the amount of CO2 produced from a 5-hour flight is 920 kg and the amount of CO2 produced from a 6-hour flight is 1092 kg [38].

The compensation of the carbon emission is provided by an equivalent saving to the amount of CO_2 emission. The most effective method to reduce and offset CO_2 emissions is to plant or donate trees and protect forests. In the Covid-19 period, if a person did not travel home to work with a private automobile from March 2020 to March 2021, he / she would prevent the spread of 960 kg of CO_2 gas into the environment and enable us to get cleaner air. When compared, this amount with the amount of CO2 produced as a result of air travel, the participants need to plant about 3 trees annually.

8. CONCLUSION AND RECOMMENDATIONS

The rate of greenhouse gases produced as a result of human activities increases in the atmosphere and causes global warming, climate change and air pollution. CO_2 gas, which constitutes 80% of greenhouse gases, arises as a result of the combustion of fuels used by automobiles besides many reasons. Due to the

Covid-19 pandemic, the activities of individuals were restricted, and home-work travels decreased. In the research, a survey was conducted on the determined sample to learn how little CO_2 emission had been produced to the environment due to reduced home-work travels. According to the results obtained from the data, it has been seen that the average amount of CO_2 produced by diesel automobiles is less than the amount produced by gasoline automobiles, however, this can be due to the fact that the individuals in the sample intentionally or unintentionally prefer automobiles with low CO_2 emission values, which is seen in Figure 12. In the results, it has been seen that an individual prevents approximately 4 kg of CO_2 gas emission by not traveling home to work for just one day. With this research, it has been clearly demonstrated that a total of 21187 kg of CO_2 gas emission value can be prevented in a year, assuming 20 days of work per month in the sample with the method of working from home, which the Covid-19 pandemic has adopted and enabled us to gain this experience. This value produced in a year shows that 52 trees should be planted for the CO2 emission value produced by only 22 individuals each year. In fact, it is clear that the individuals in this sample, who are very small part of the province and country in general, emit a high amount of CO_2 due to only using private automobiles, and this situation should be considered throughout the country, even the world; and as a result, policies should be developed by taking CO_2 emissions serious. The effects and importance of the reduction of CO_2 emission values and the method of working from home as a result of some restrictions, have been seen in the research. It has been seen that it is possible to reduce CO_2 emissions by developing other strategies to reduce the use of private automobiles at home- work travel.

The method of working from home, where the Covid-19 pandemic enables us to gain this experience at work, can be developed according to the business sector and its applicability can be increased after the pandemic period. In addition, one of the strategies that can be implemented is to reduce CO_2 emission produced by home-work travels as a result of reducing working days, provided that the working hours of individuals remain the same at work.

Reducing the use of private automobiles is of great importance in transportation, environment and traffic areas. As can be seen in the research data, even though individuals come from the same or nearby districts, using private automobiles as a single person is one of the most damages to the environment and transportation. Instead, individuals can share their automobiles and reduce CO_2 emissions. Automobile sharing systems are not very developed in the country, but individuals can give up this habit by establishing this system among themselves and contribute to the development of the system. Another method is to be carried from home to work with a shuttle. The development of the bus service method will reduce the areas occupied by individuals in traffic alone, save time if systematized, and most importantly, will have an important role in reducing harmful gases emitted to the environment. It is of great importance that institutions develop strategies that support their employees to use this bus service system.

Although it is necessary to reduce the use of private automobiles, automobiles using environmentally friendly fuel should be preferred in areas where it is necessary to use. Automobiles that do not harm the environment such as hybrid automobiles, solar powered automobiles, electric automobiles should be produced, preferred and encouraged. The speed, comfort and flexibility adopted by private automobile users should be provided in public transportation and private automobile users should be directed to use public transportation with incentives. The harmful gas emission values given to the environment should be targeted to be zero by the countries. In addition to the use of private automobiles, automobile sales strategies should be developed according to the CO_2 emission values of automobiles in order to increase the awareness of individuals and to provide them with knowledge. Environmentally friendly strategies such as increasing the prices and taxes of automobiles with high CO_2 emission values can be developed.

The most important limitation of this study is that the research was conducted online and the number of participants was small and the sample was limited. For this reason, it is thought that a new research that evaluates people's approach to different study strategies and different types of transportation can be useful. This new research can be held in universities and institutions where there is a wider sample and developed and presented the strategies proposed according to the institutions in this research.

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