A PROPOSAL TO INVESTIGATE ENGINEERING SOLUTIONS FOR PRIVATE CAR USAGE IN ISTANBUL

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Abstract

Private car usage is a problem for the environment and the world. The problem is that these private cars produce gasses that causes damage to human life and plants. These damages to the environment put lives in danger. It causes deaths and will result in disasters in long term. This study aims to decrease the private car usage with the help of three engineering solutions. These three solutions will be all mobile applications. They will promote and encourage using public transportation and bicycle usage in order to reduce private car usage. Later on, these solutions will be assessed in terms of practicality, environmental and cost. These assessments will be held with research methodologies such as, literature review, market research and case study. The results of these research shows that best solution for reducing private car usage is, encouraging people to use public transportation by giving them promotions such as free rides.

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I. INTRODUCTION

In the world, there are more than 1.6 billion cars [1]. Also, every second, two new vehicles enter to the roads and by 2030, this number will be more than four [2]. These numbers are already problematic in the world. For the case of Istanbul, there are more than four million registered cars [3]. Assuming there are unregistered cars too, these numbers seem to be huge. Another thing about Istanbul is that, total number of 22 cities in Turkey is equal to the number of private cars in Istanbul [4].

These private cars, damage the environment more than people seem to recognize. These private cars produce gas that damages the environment. They produce significant amount of, nitrogen oxides, carbon monoxide and particulate matter. This particulate matter alone is responsible for premature deaths up to 30 thousand per year [2]. Without a doubt, these cars are a threat for the environment. It is also said that most of the environmental impact of an automobile, maybe up to 80 or 90 percent, is due to fuel consumption and emissions of air pollution [5]. Climate scientists say that is it is driving global warming [5].

Obviously, there is a connection between population and private car usage. Istanbul is the most crowded city in Turkey with nearly 15 million population [6]. Which is why the most number of private car owners are Istanbul. It is not hard to realize that with population increasing, private car ownership increases with it also. According to [7], a Chinese writer, private car ownership and pollution increases proportionally.

The purpose of this study is to find the root causes of private car usage in Istanbul, which is the city that has most private cars in Turkey, and find three engineering solutions for this problem [8]. With these proposed solutions it is aimed to reduce this private car usage and help the environment by reducing the gasses that are damaging the environment for everyone’s sake.

II. PROBLEM DEFINITION

The problem of private car usage in Istanbul can be determined with the following questions:

- “Who” – The people that are influenced by this problem is everyone. Since it causes damage to the environment, everyone has to suffer from it.
- “What” – The problem is that with population increasing, private car usage increases with it. Which damages the environment.

- "When" – The problem occurs right now and most probably, this situation will be worse in the future since there will be more than three billion cars in the world [9].
- "Where" – The problem occurs In Istanbul.
- "Why" – The problem is that, people want to have their own private cars but they do not consider the damage to the environment.
- "How" – These private cars, produce gas that damages the environment and they cause air pollution [5]

The problem is that there are too many private cars in Istanbul. As mentioned before, the number of cars is equal to sum of 22 cities in Turkey [4]. Therefore, the problem can be divided in to two parts. First one is that private car usage damages the environment and human health. Second one is there are too many private cars.

A. Private car owners damaging the environment and human health

Private car usage is a big part of air pollution [5]. The air pollutants such as, carbon monoxide, nitrogen oxides, sulfur dioxides are being produced by vehicles [10]. These cars are the problem because they are being powered by gasoline and diesel fuels. For a car to work, these fuels are burnt inside the cars and then air pollutants that were mentioned before are released to the air [11]. These gasses are accountable for damages to both human health and plants [5]. Private car ownership is harmful even when the car doesn't work anymore. When these private cars are useless, they are turned into junks. These junk cars also a damage to the environment. They raise problems such as, ozone layer depletion, climate change and water contamination. [12]. Ozone layer depletion occurs when people do not stop using their private vehicles even when they are in no condition to work ideally [13]. Water contamination occurs when the fluid of these junk cars leaks from their containers and they seep to the ground [12]. With these kind of reasons, private cars have negative effect on both humans and their environments.

B. There are too many private cars

Another root cause is that there are too many of these private cars that are damaging the environment. There are reasons such as, convenience and freedom are the reasons why people would like to own a private vehicle [14]. Also, people are amused by the practicality of these private cars, the idea of going to a place on your own, and that it saves time by doing so [15]. People In the world, number of cars produced, only the produced not the total number, increases year by year. In 2002 total of 41 million cars were produced. By 2010 this number increased to 58 million and by 2016 this

number was up to 72 million [16]. For Istanbul, in 2000 there were approximately one million cars in Istanbul. However, this number increased to two million and six hundred thousand by 2008 and now it is more than 4 million [17]. So, it is not hard to say that these number of cars are increasing rapidly and the situation in Istanbul is the same. With these kinds of perks of having a private car, people are more leaned on to owning a private vehicle which are a problem to world.

III. PROPOSED SOLUTIONS

To reduce the private car usage in Istanbul, in order to help the environment and people, there are some solutions that can change this situation. For example, owning electric cars could be a solution in the long term. However, number of electric cars are way too little. To be more specific, there are four million registered cars in Istanbul and only three thousands of those vehicles are electric cars [3],[18]. More current solution would help environment right away, which are encouraging people to use public transportations and bicycles. These solutions are based on those aspects.

A. A mobile app that gives promotions for using public transportation

This will be a mobile app where people will be able to download in their smartphones without any price. This application will be done by the government to help the environment and that's why it should be free. Then they will scan a QR code on the bus from this application, which will allow for the app to calculate the distance that the user has made with that public transportation. After going for a specific distance, user will be rewarded with a free ride of public transportations for the day. User will be able to use public transportations without paying any prices for that day. With this solution it is aimed to increase the amount of usage of public transportations by using promotion methods. This method could be seen as coupons. With this method people will be able to have free rides without contacting any kind of manufacturer, they will not need to compete in any kind of race for the free rides and they will be able to save money [19].

B. A mobile app that gives promotions for riding a bicycle

This solution is similar to the first one. This solution works as follows. People will be able to download this application to their smartphones without any price. This application could be provided by the brands that are willing to help the environment. Of course, it could be provided by the

government also, which may then have to make deals with coffee shops and brands. Then, to use this app, they will have to open the app and they should not close the app while riding the bicycle. This app will keep track of the distance that user has made with a bicycle. After a specific distance, users will have discount on some clothing brands or coffee places. To use this discount, they will only have to show their application and the discount that they got to the store. This distance will be calculated by the speed of the user. For example, more than 5 km/h but less than 20 km/h. This is to prevent false users who are using any other kind of transportation vehicles. With this solution it is again aimed to reduce private car usage. This solution tries to encourage people by using discount method, which is a method that is again proven to be effective [20].

C. A mobile app where all of the public transportations are accessible

This solution is again a mobile app for the users. With this solution people will be able to use any kind of public transportation in Istanbul with only one application. Also, users will not need any plastic cards to use them. After downloading the application, people will be able to transfer money to their accounts, to use public transportations, they will be able to see the departure times of the public transportations and they will be able to access them. They will only need to bring their phones closer to the scanners and it will be possible for them to access that public transportation. The aim of this solution is to get rid of some steps of using public transportation, which may be frustrating for people, and encourage more people to use public transportation.

IV. CRITERIA FOR ASSESSING SOLUTIONS

This investigation and solutions will be assessed in terms of practicality, environmental and cost.

A. Practicality

These solutions in general should be practical for people to use them. Also, they will be user-friendly which is proven to be an effective method having users in an application [21].

1) *Practicality + A mobile app that gives promotions by using public transportation:* People have to use mobile phones and their cameras in order to use this app. Practicality of this solution were assessed.
2) *Practicality + A mobile app that gives promotions by riding a bicycle:* People will only have to open this app on their phones to get a discount on this app. In order to have their discount they will only need to show their app in that store. Practicality of this solution were assessed.

3) *Practicality + A mobile app where all of the public transportations are accessible:* The purpose of this solution is already to make public transportation usage more practical. Also, practicality of this solution was assessed.

B. Environmental

These solutions were assessed if they are environmental or not.

1) *Environmental + A mobile app that gives promotions by using public transportation:* Since this solution is a mobile app it expected to be environmental. It was assessed in these terms.
2) *Environmental + A mobile app that gives promotions by riding a bicycle:* This solution is again an app so it is expected to be environmental too. Also, it was assessed too.
3) *Environmental + A mobile app where all of the public transportations are accessible:* Finally, this solution is an app also. This was also assessed.

C. Cost

Since these solutions are just mobile apps, it is not expected to be expensive [22]. However, they are different types of apps and they require different integrations so the costs can differ.

1) *Cost + A mobile app that gives promotions by using public transportation:* This app will require some camera integrations so cost was assessed in terms of that.
2) *Cost + A mobile app that gives promotions by riding a bicycle:* This app will require some algorithms to calculate distance and speed so cost was assessed in terms of that.
3) *Cost + A mobile app where all of the public transportations are accessible:* This app will have some integrations in the phone that will require to use different aspects of the phone. So, cost was assessed in terms of that.

V. RESEARCH METHODOLOGY

Since the solutions will be assessed in terms of cost, practicality and environmental, some research methodologies will be used in order to find the most relevant information. The methods are literature review, case studies and market research.

A. Literature reviews

Literature review is a methodology of reviewing published information of a subject or area [23]. With this method environmental effects of using public transportation and private car usage will be analyzed. The solutions were be assessed, which will help the investigation to be more trustworthy.

B. Case studies

This method is for comparing an approach with a real-life context [24]. With this method, similar apps that are in real life will be compared to the solutions. By this comparison, the effectiveness of apps was assessed. The apps will be compared in terms of their environmental, cost and practical aspects.

C. Market Research

Market research method is basically for evaluating costs of a product. With this method, the costs of the solutions were assessed with help of analyzing similar applications in terms of their integrations.

VI. RESULTS AND ANALYSIS

All of three solutions were assessed with the help of research methods that were mentioned before. These solutions were assessed in terms of their practicality, environmental and cost. These criteria are assessed by numerical grading. Practicality was graded out of four, environmental was graded out of six and cost was graded out of three. The results were based on these gradings.

A. A mobile application that gives promotions for using public transportation

1) Practicality: In terms of practicality, this solution has its pros and cons. First of all, this solution does not require a high-end device. Only owning a smartphone is necessary for this and the other solutions. This is seeming to be very practical since most of the people in Turkey already has a smartphone [25]. However, this solution requires internet connection. This solution would be more practical if it worked even without the internet, however it is not possible since this solution needs use location services. In order to have an accurate and functional application, unfortunately internet is required. Also, the problem with this solution is that it requires some extra steps. Normally, people would scan their cards and then get off the public transportation when they are in desired location. With this application, they have to open up the application and scan the QR code in the public transportation. This means that they will have to do some extra steps in order to get their promotions. Finally, in terms of practicality, this solution is easy to use. Since QR usage has increased over the years, people do not have any problem and confusion when using QR codes [26]. With these assessments

in mind, practicality of this solution has two points out of four. Which is not the most practical solution among them.

2) Environmental: This solution does not require any kind of production that damages the environment. Since it is only a mobile application, this solution is not a threat to the environment in terms of increasing production of waste. Consuming causes damage to the environment too [27] This solution does not increase consuming. The promotions are only about free rides which does not increase any kind of consuming, which an advantage for the environment. Finally, this solution reduces the air pollution from vehicles. However, since public transportation is still a vehicle, they also produce gasses that causes air pollution. The key here is that, it doesn't fully reduce the air pollution but it still decreases it since it is not a private vehicle. With these aspects, this solution gets five points out of six points, which is the best environmental results among these solutions.
3) Cost: In terms of cost, different applications require different kind of price. This application is considered as medium complex application so they do not cost more than 50.000$. So in terms of costs this application does not require much in the development phase. [28] Also this application does not require any kind of extra purchase, which does not create additional problems in terms of cost. Finally, this application gives promotions to its users, which are free rides of public transportations. These promotions are effective methods, since the users will have their promotions without contacting to the manufacturer or competing in any kind of competition [21]. This solution gets three points out of three which is the best that it could get.

B. A mobile application that gives promotions for riding a bicycle

1) Practicality: This solution also does not require any high-end device since this will be a mobile application too. As mentioned before, most of the people have smartphones and since all of these solutions are mobile applications, none of these solutions require high-end device. One of the problems in terms of practicality is that this application requires internet. This application again uses location services in order to determine the distance, which decreases practicality. Another problem of this solution is that it requires extra steps. Normally people would not have to open any application to ride bicycles. With this app, in order to get the promotions, people will have to open the application and press a button in order to track their distance, which again decreases practicality. However, this solution is again easy to use. People will have to only press two buttons and they will be ready to go. Practicality gets two out of four, which is not again the best result for practicality.
2) Environmental: For environmental assessment, this solution does not increase any kind of production that may damage the environment. However, this solution increases consuming which damages the environment. It increases consuming by giving free beverages from coffee shops and giving discounts from clothing brands. This increase consuming and may be harmful to the environment. On the other hand, this solution decreases air pollution from the vehicles totally. Since people are encouraged to ride bicycles, they do not contribute to production of any gasses that damages the environment. With this assessment, environment grading gets four points out of six which is the worst among these solutions.
3) Cost: This application again is categorized as medium complex application, so again this application does not cost more than 50.000$ in the development phase. This application again

does not require any extra purchases. Like the first solution, this application gives promotions to its users too. These promotions again helps people to save money so it helps in terms of costs. This solution gets three out of three points from cost assessment, which again is the best that it could get.

C. A mobile application where all of the public transportations are accessible

1) Practicality: This solution is the most practical solution. It makes sense since it's purpose is to get rid of some steps of using public transportation. Since these solutions are all mobile applications, assessments are very similar to each other. That's why, this solution also does not require high end device to work. The only practicality problem about this solution is that it requires internet connection in order to work. The difference between this solution and the other solutions is that this solution does not require extra step. It actually gets rid of some steps. Finally, this solution is also easy to use since all people have to do is to bring their phones closer to the scanner. This solution has three points out of four in practicality. Which is the most practical solution.
2) Environmental: For environmental assessment this solution again does not increase any kind of production that may cause environment damage. The case is just the opposite. With this solution actually production of plastic cards could decrease, since there will be no need for them anymore. Also, this solution does not increase consuming. Finally, this solution reduce the air pollution by reducing the gasses that are produced by vehicles. However, public transportation still contains vehicles, it does not fully reduce the production of gasses. That's why this assessment has five points out of six, which is again one of the best environmental assessments among these solutions.
3) Cost: For this solution, this application is categorized as complex application since it requires all of the data of public transportations and it has to have some communication with these scanners. That's why the price of this application development costs more than 50.000$. The application does not contain any extra purchases and also it does not give any promotion to its users. That's why this solution has one point out three points. Which is the worst assessment in terms of costs.

VII. CONCLUSION AND RECOMMENDATIONS

The final results shows that the best solution for reducing private car usage is the mobile application that gives promotions for using public transportation. It has the most points in cost and environmental assessment. However, since all of these solutions are mobile applications, total gradings are very close to each other.

With these solutions in terms of practicality, solution three is seems to be the best. For environmental assessment solution one and three are the best ones. Finally for cost solution one and two are the best ones. In order to modify these solutions some changes should be applied in order to get rid of the extra steps for using the application. Reducing the damaging gas production should be also considered.

In order to develop the first solution, government should develop the application that gives promotions since they are in charge of the public transportations. After developing the application people could use it right away and private car usage would be reduced.

APPENDIX

TABLE 1

Practicality Grading for Solutions

	No	*Yes*
Does the solution require high-end device? (No: 1, Yes: 0)		
Does the solution require internet? (No:1, Yes:0)		
Does the solution require extra steps? (No:1, Yes:0)		
Is solution easy to use? (Yes: 1, No:0)		

TABLE 2

Environmental Grading for Solutions

	No	*Possibly*	*Yes*
Does this solution increase any production that may cause damage to the environment? (No: 2, Possibly: 1, Yes: 0)			
Does this solution increase consuming? (No:2, Yes:0)			
Does this solution reduces the air pollution from vehicles? (No:0, Possibly: 1, Yes:2)			

TABLE 3

Cost Grading for Solutions

	No	*Yes*
Does the application cost more than 50.000$? (No: 1, Yes: 0)		
Does the solution require any extra purchase? (No:1, Yes:0)		
Does the solution gives free promotions? (No:0, Yes:1)		

TABLE 4

Total Grades of Solutions

	Practicality(4)	Environmental(6)	Cost(3)	Total
Solution 1	2	5	3	10
Solution 2	2	4	3	9
Solution 3	3	5	1	9

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