Proceeding of the International Conference on Advanced Science, Engineering and Information Technology 2011

Hotel Equatorial Bangi-Putrajaya, Malaysia, 14 - 15 January 2011

ISBN 978-983-42366-4-9

Logistic Regression Models to Forecast Travelling Behaviour in Tripoli City

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***Abstract*— Transport modes are very important to Libyan's Tripoli residents for their daily trips. However, the total number of own car and private transport namely taxi and micro buses on the road increases and causes many problems such as traffic congestion, accidents, air and noise pollution. These problems then causes other related phenomena to the travel activities such as delay in trips, stress and frustration to motorists which may affect their productivity and efficiency to both workers and students. Delay may also increase travel cost as well inefficiency in trips making if compare to other public transport users in some Arabs cities. Switching to public transport (PT) modes alternatives such as buses, light rail transit and underground train could improve travel time and travel costs. A transport study has been carried out at Tripoli City Authority areas among own car users who live in areas with inadequate of private transport and poor public transportation services. Analyses about relation between factors such as travel time, travel cost, trip purpose and parking cost have been made to answer research questions. Logistic regression technique has been used to analyse these factors that influence users to switch their trips mode to public transport alternatives.**

***Keywords* --- Own car, private transport, public transport, parking cost, logistic regression.**

I. INTRODUCTION

Private cars are important for most household activities in Libyan societies. They give comfort and convenience to the users to go to different destinations without affecting other users. The personal benefits cars provide will increase the number of private cars on the road. In addition, personal car use has obvious negative effects, such as the congestion, accidents, air pollution, and noise. This problem is also related to the state of existing public transportation systems and services. They are either inadequate or unreliable. The shortage of public transportation services especially public buses in Tripoli may be the reason why commuters prefer to use private vehicles. In fact, in Tripoli city there are many areas that do not have private transportation and poor public transportation services such as stage-buses. This situation encourage residents in these areas to use own cars to make their daily trips to work and shopping. If public transportation services such as stage-buses are provided, users might shift their trip-making behaviour from travelling by own cars and different taxi types to public transportation. Also, increase in parking charges may cause own car users to think many times about their travelling behaviour and travelling choices [7]. Ultimate, the shift will save their expenditure on transportation and may also reduce travel time, travel cost and traffic congestion.

II. DATA COLLECTION

Primary data are generated by researcher who is responsible for the design of the study and the collection, analysis and reporting of the data. These data are used to answer specific research questions [4]. The data collection was done through field study i.e. observation and survey. The survey was done using questionnaires to get relevant data. The respondents for this survey are the own car users at study areas who use him / her own car to make his / her trips to work, study and shopping. The questionnaires were distributed to the private vehicle users who do not use other modes of transportation. The respondents will be selected randomly. Brief questionnaires will be formed to ensure for user's comprehension and they are in the form of open and close ended questions. The questionnaires were printed by

two languages, Arabic and English language, to provide easier understanding and answering for some respondents.

There are three sections in this survey. Section A is about respondent's personal information that will help researcher to get the respondent's basic information for this research. Section B is a section that requires respondents to fill in information about their trip characteristics and purpose such as work, study and shopping trips. Section C is a section that requires respondents to highlight their preference in mode switching in the study area. There are several questions that correspond with respondents' views, recommendation and opinions. These questions provide the opportunity for the respondents to give their opinion. The questions are formulated in such as way that could help the respondent answer the questionnaire easily and quickly. Respondents will be selected randomly from residential areas which does not have public transportation services. The selected respondents are based on private transportation vehicle and own car users who use their private vehicles as their mode of transportation to go to his/ her trips. The following section will elaborate how this selection is made.

The questionnaires were pre-tested by a pilot survey. The purpose of the pilot survey is to test whether the respondents understand the questions. Also pilot survey is purposely done to see the pattern of answers given by the respondents. Fifty application of questionnaires were distributed to twenty respondents to Libyan students who are studying in some universities in Kuala Lumpur and using own cars, and thirty applications of questionnaire were distributed in Tripoli city. These thirty respondents were selected randomly from own car and private transport vehicle users in Tripoli city.

Before determining the sample size, researcher needs to clearly define the sample frame. The sample frame of this study was calculated from own car and private transport commuters who use their car or private transport for working, studying and shopping purpose. These respondents will only be selected from area that has no public transportation system in Tripoli city. The research employs mostly primary data obtained from samples of private vehicle commuters at Tripoli city. This location was selected because the Tripoli city is capital city of Libya and lively place centre.

The number of respondents who was involved in this research was 900 people. These questionnaires were administered in the study area especially in the area which does not have public transportation services and taxi service did not cover the area. From the survey about 82% respondents answered Yes- to use public transport for question number forty nine (If have good public transport, do you intend to use public transport for your work-University or shopping trips?. And from question number forty six (If the parking cost increased by the following amount, which amount will influence you to switch from your own car to public transport? (The rate of increase price is counted as per hour). The respondents answered switch to public transportation by (0.5 LyD with 13%, 24% for 1 Ly D, 42% for 3 Ly D and 21% for 5 LyD). Where Ly D is Libyan Dinar (1USA $ = Ly D 1.25).

III. FIELD STUDY BY USING QUESTIONNAIRE

A survey using questionnaires as a tool to get information from respondent was conducted. This questionnaire has 51 questions which covered question three sections as explained above, frequency using private vehicle for work, study and shopping purposes, problems when using private vehicles and travel time and cost such as parking fees. These questions were formed based on the research questions and the hypothesis. This survey had been conducted in areas under Tripoli authority which do not have public transportation services, inadequate private transport services and shortage in parking facilities. In total, there are four zones which do not have public transportation services. This survey was done on work days (Saturday through Thursday). A total of 900 questionnaires were collected in 5 months from (25 July to 23 December 2009). The number of respondent for this survey is 600. As stated in Chapter 2, the respondents for this survey were commuters who use own car and private transport vehicles as their mode of transportation to the work, study and shopping place. Selection of respondents has been done randomly. The number of respondents was selected based on number of Tripoli population. Statistical Package for Social Science (SPSS) and Excel software were used to analysis the questionnaire and logistic regression method was used in this study.

IV. ANALYSIS RESULTS

A. *Average Monthly Income*

Most of the respondents who were employees and students earned about 150 to 750 LyD (Libyan Dinar). Fig. 1 shows the income of respondents which are 6% earned low income present 39 respondents between 150 to 300 LyD, 100 people had income from 300 to 450 LyD by 17%, 22% or 129 respondents who had good income between 450 to 600 LyD, 110 person by 19% had income from 600 to 750 LyD, 100 person had income from 750 LyD and above which of 17%, also had 20% for 122 respondents does not wish to say their income, (1 USA $ = 1.25 – 1.3 LYD).

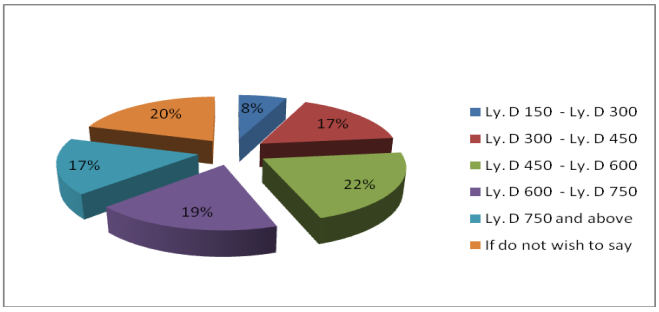

Fig. 1 Show the average monthly income

B. *Car parking Cost*

Fig. 2 shows 13% of parking cost by 0.5 LyD, 24% of parking cost 1 LyD, 42% of parking cost 3 LyD, encourage the respondents to switch to public transport (PT), and 21% of parking cost 5 LyD.

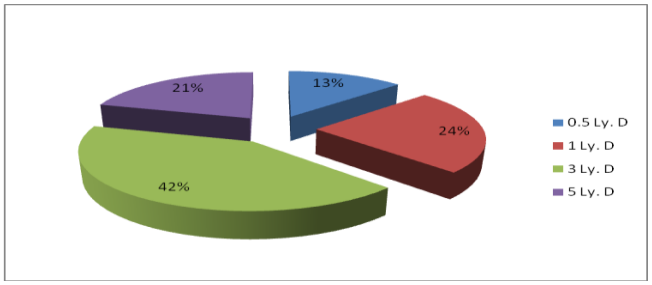

Fig. 2 Show the car parking cost percentage

Parking charges or fees or cost is another factor that may be as a hindrance for the private car users by implementing of parking fees policy. The respondents were asked if an increase in parking cost would shift them to Public Transport (PT). Parking fees of 3 LyD/h will be adequate to shift (79%) from respondents to using PT mode, while, (99%) from the respondents will prefer to use PT mode if the parking cost being 5 LyD. Fig. 3 shows PT switching percentages with parking costs.

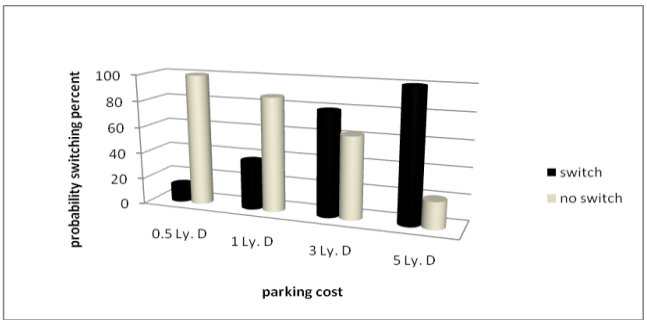

Fig. 3 Shows public transport switch for increase in parking cost

Table 1 below shows different in parking cost with respect to survey result and probability of prediction (P) values. P value is derived from Equation 1 which involve constant and alpha (α) values to verify the logistic prediction model used in this study.

$$P = 1 / 1 + De^{\alpha(\text{variable})} \quad (1)$$

Where P = Probability prediction, D = constant, α = coefficient of x_i

TABLE 1
SHOWS SURVEY RESULTS AND DATA CALIBRATION

Charging fees	Survey result	(1-p)/p	ln (1-p)/p
0.5 LyD	0.1316667	6.594934786	1.886302
1 LyD	0.2416667	3.137930464	1.143563
3 LyD	0.42	1.380952381	0.322773
5 Ly D	0.2066667	3.838708897	1.345136

The results of above table reflect the model calibration process which then uses to develop the Analysis of Variance (ANOVA) table, which is described in Appendix 1. By using the alpha (α) and (D) values from ANOVA table, our model achieved the value of P equal to 0.007421 which somehow acceptable to be significant (significant value is <0.05) as shown in Equation 2.

$L_n D = 2.490831095$
$\alpha = -5.265548985$
$D = 12.0713$

Thus,

$$P = 1 / 1 + 12.0713\, e^{-5.265548985\ (\text{variable})} \quad (2)$$

The result of the prediction models can be shown in Table 2 and Fig. 4.

TABLE 2
SHOWS SURVEY RESULTS AND LOGIT MODEL RESULTS

Charging fess	Survey result (P)	Modelling result
0.5 LyD	0.1316667	0.142151
1 LyD	0.3733334	0.370383
3 LyD	0.7933334	0.801008
5 LyD	1	0.998409

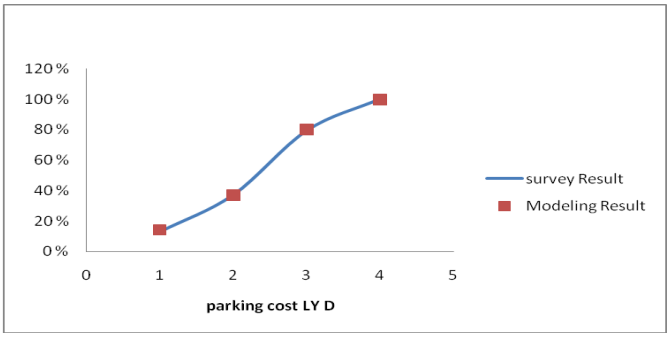

Fig. 4 Parking cost percentages

C. *Travel time in Tripoli streets represents the main factor for switching mode*

In the greater Tripoli area, travelling time has doubled since united nation lifted sanctions in 1999, due to the continuing growth in economic activities and residents are increased. Tripoli centre is old centre, modern development, but it also has a modern traffic problems. Every morning and evening, the streets are crowded with cars, taxis, micro, mini buses and vans, Fig. 5 shows the travel time between two transport mode types in Tripoli with which mode the commuter is to prefer.

Own car mode in Tripoli has brought freedom, flexibility and mobility to many people but there is increasing concern about the economic cost of road congestion and the environmental effects of pollution from congested traffic (United Kingdom Targets) [6]. Own car is the most available one mode in Tripoli. Each person has own car or more. He can transfer from place to place in safety way it and takes a few times to transport from place to other. Most the people like the car because they can feel freely to do whatever they want. The number of cars reaches to more one million car to end 2009 and cars owned by the state, Authorities and international organizations are excluded [7] on the roads is still increasing, which means: congestion, parking problems and negative environmental impacts. Adding a traffic light here and there is not enough to resolve all the traffic problems.

Private transport mode in Tripoli is the other transport type available, namely (taxi and micro buses) which reached to end of 2009 to 72827 vehicles [1]. The private transport is a very reasonable and easily available mode of transport. The first private transport is taxi. If you like to be individual

not with other people, so the best way is to take a taxi. It is cheap also, but not cheaper than the micro bus. Taxi can be owned by a person who get a driver and this driver give him money each months. The second private transport type is private the bus. A private bus is a large road vehicle designed to carry numerous passengers. If you do not have your own car you can use a micro bus to travel in short travel. It is cheap and available on a large or small scale. Also, private micro buses are provided buy by private company and the person or by bond with some commercial banks.

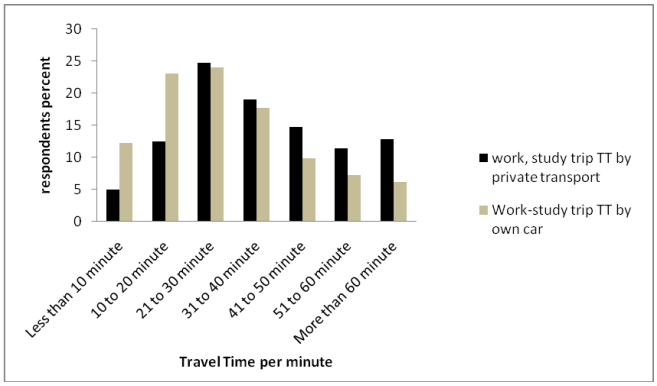

Fig. 5 Show travel time for two types of Tripoli transport mode

1. Travel time to work- study trip by own car

Table 3 below shows travel time to work and study by car with respect to survey result and probability of prediction (P) values. P value is derived from Equation 4 which involve constant and alpha (α) values to verify the logistic prediction model used in this study.

$$P = 1 / 1 + D\, e^{\alpha(\text{variable})} \quad (4)$$

Where P = Probability prediction, D = constant, α = coefficient of x_i

TABLE 3

SURVEY RESULTS AND DATA CALIBRATION

Travel time	Survey result (P)	(1-p)/p	ln(1-p)/p
Less than 10 minute	0.1216667	7.21917583	1.976741
10 to 20 minute	0.23	3.347826087	1.208311
21 to 30 minute	0.24	3.166666667	1.15268
31 to 40 minute	0.1766667	4.66037629	1.539096
41 to 50 minute	0.098333333	9.169491526	2.215882
51 to 60 minute	0.071666667	12.95348837	2.561365
More than 60 minute	0.1	9	2.197225

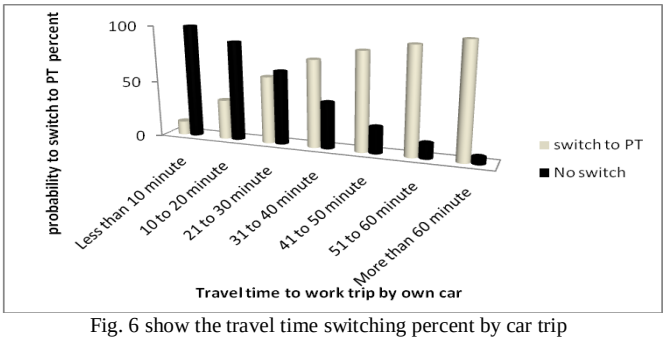

Fig. 6 show the travel time switching percent by car trip

The results of above table reflect the model calibration process which then uses to develop the Analysis of Variance (ANOVA) table, which is described in Appendix 2. By using the alpha (α) and (D) values from ANOVA table, our model achieved the value of P equal to 9.7795E-06 which somehow acceptable to be significant (significant value is <0.05) as shown in Equation5.

LN D = 3.021094
α = -7.99007
D = 20.5137177

Thus
The result of the prediction models can be shown in Table 4 and Fig. 7.

$$P = 1 / 1 + 20.5137177\, e^{-7.99007\ (\text{variable})} \quad (5)$$

TABLE 4

SHOWS SURVEY RESULTS AND LOGIT MODEL RESULTS

Travel time	Survey result (P)	Modelling result
Less than 10 minute	0.1216667	0.114156675
10 to 20 minute	0.3516667	0.348602129
21 to 30 minute	0.5916667	0.597691143
31 to 40 minute	0.7683334	0.764347192
41 to 50 minute	0.866666733	0.860963178
51 to 60 minute	0.9383334	0.940513534
More than 60 minute	1.0383334	1.038298087

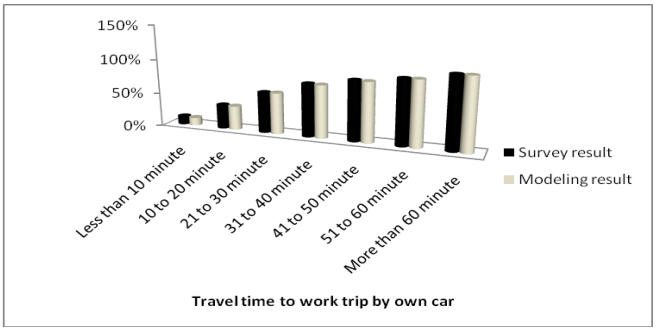

Fig. 7 Travel time to work, study trip by own car

2. Travel time to work-study by private transport

Table 5 below shows travel time to work and study by private transport with respect to survey result and probability of prediction (P) values. P value is derived from Equation 6 which involve constant and alpha (α) values to verify the logistic prediction model used in this study.

$$P = 1 / 1 + D\, e^{\alpha(\text{variable})} \quad (6)$$

TABLE 5

SHOWS SURVEY RESULTS AND DATA CALIBRATION

Travel time	P	(1-p)/p	ln(1-p)/p
Less than 10 minute	0.05	19	2.944439
10 to 20 minute	0.125	7	1.94591
21 to 30 minute	0.246666667	3.054054054	1.11647
31 to 40 minute	0.19	4.263157895	1.45001
41 to 50 minute	0.146666667	5.818181817	1.760988
51 to 60 minute	0.113333333	7.823529414	2.057136
More than 60 minute	0.128333333	6.792207794	1.915776

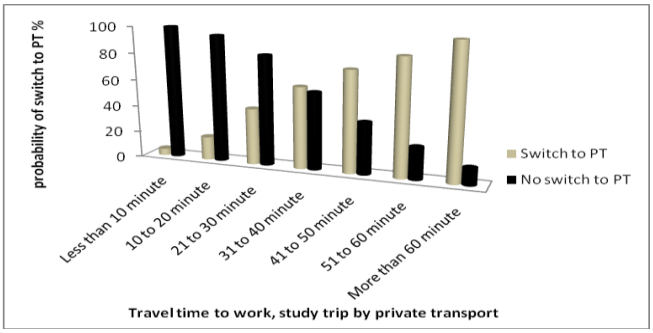

Fig. 8 Travel time to work, study trip by private transport

The results of above table reflect the model calibration process which then uses to develop the Analysis of Variance (ANOVA) table, which is described in Appendix 3. By using the alpha (α) and (D) values from ANOVA table, our model achieved the value of P equal to 0.000287751 which somehow acceptable to be significant (significant value is <0.05) as shown in Equation 7.

LN D = 3.16029
α = -8.9313
D = 23.57743279

Thus
The result of the prediction models can be shown in Table 6 and Fig. 9.

$$P = 1 / 1 + 23.5774327\, e^{-8.9313\,(\text{variable})} \quad (7)$$

TABLE 6
SHOWS SURVEY RESULTS AND LOGIT MODEL RESULTS

Travel time	Survey result (P)	Modelling result
Less than 10 minute	0.05	0.062168
10 to 20 minute	0.175	0.176841
21 to 30 minute	0.421666667	0.454273
31 to 40 minute	0.611666667	0.642229
41 to 50 minute	0.758333333	0.778059
51 to 60 minute	0.871666667	0.882571
More than 60 minute	1	1.0003

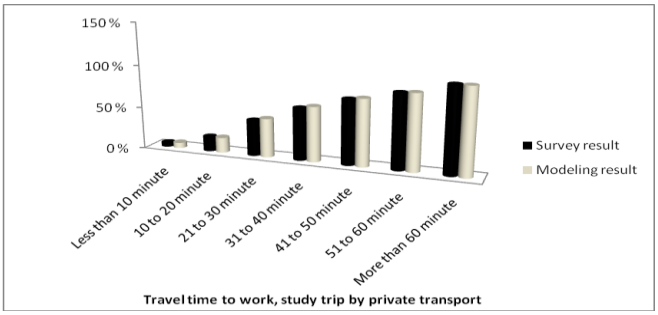

Fig. 9 Show the travel time to work, study trip by private transport

V. DISCUSSION

Traffic congestion is recognized as a major problem in urban areas, with significant effects on the economy, travel behaviour, and land use. Although traffic congestion is not a new problem for the central city, it has spread to cover suburban areas, [5]. However, the own car and private transport vehicles in Tripoli city are becoming popular among urban travellers which caused acute traffic congestions are taking place widely, especially along roads to Tripoli city centres. These cases have been causing more and more serious transportation problems with environmental issues and affect on people's quality of life.

As congestion in urban areas continues to raise it becomes increasingly difficult for drivers to find conveniently located parking spaces. This in turn brings problems for the urban economy and the environment; perceived shortages in parking can dissuade people from travelling to the city centre for work and leisure, while those that do drive in the centre spend unproductive time searching for spaces or waiting in queues, thus further exacerbating congestion [2]. Travel time to work or study trip by both own car and private transport in Tripoli at present forces the commuters to change to Public Transport, for example travel by own car in travel time (31 to 40 minute one way) encourage about 70% to switch, (41 to 50 min) encourage about 80% and travel time (51 to 60 min) encourage 98% to switch to public transport. Also the users of private transport like switch to public transport 60 % in travel time between (31to 40 min), 78% travel time (41 to 50 min) and by 98% with travel time (51 to 60 min). The result above shows the commuters like to switch to public transport when travel time increases more than 30 minutes. Other factor forces the commuter to use public transport and leave his / her own car in home is cost of parks, from the results above illustrate the commuter switch to public transport from charge fees one Libyan Dinar by 37%, 78% for fees 3 Ly D and 98% for 5 LyD. Which mean the own car drivers switch to public transport from the car parking price 3 LyD.

VI. CONCLUSION

Transportation sector is an important thing in human daily life to make their daily trips easier. But, the total of car ownership and private transport vehicle on road was increased and cause many problems such as traffic congestion, environmental impacts and else. Own car users in Tripoli city centre are suffering to transportation travel time, congestion and lack parking if compare to public transportation users in some big cities such as Cairo, Dubai, London, Paris and else. Shortage in car park places will cause several problems to private vehicle users like increasing on transportation congestion. A research has been done at Tripoli areas among own car and private transport vehicle users who live at areas with poor public transportation services in city. Analyses about relation between factors such as gender, old, number of household member, household income, travel time, travel cost, trip purpose has been done to answer the research questions. Besides that, Logistic Regression Model has been used to analyze the factor that will be influencing users to switch their travel behaviour to public transport alternatives. The lack of car parking and poor of public transportation services especially public buses at certain places in Tripoli city is a reason why travellers use private vehicle. In fact, in Tripoli there are several areas that do not have public transportation services. This situation encourage residents in these areas to use own car vehicles to make their daily trip. If public transportation services are good and adequate, the trip maker might change their trip-making behaviour from travelling by

own cars to public transportation. This will save their expenditure on transportation and reduce traffic congestion. Finally the re-establishes of public transport and provide park and ride places with suitable parking fees. All these factors encourage the commuters to switch from own cars to use public transport for all their trips to work, study and shopping.

Acknowledgement

The research was conducted in collaboration with the Sustainable Urban Transport Research Centre, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia.

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APPENDICES

Appendix 1: Car parking cost increased which amount will influence you to switch to Public Transport

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.992579
R Square	0.985214
Adjusted R Square	0.977821
Standard Error	0.096599
Observations	4

ANOVA

	Regression	Residual	Total
df	1	2	3
SS	1.243511	0.018663	1.262174
MS	1.243511	0.009331	
F	133.2608		
Significance F	0.007421		

	Intercept	X Variable 1
Coefficients	2.490831	-5.26555
Standard Error	0.123841	0.456134
t Stat	20.1132	-11.5439
P-value	0.002463	0.007421
Lower 95%	1.957988	-7.22814
Upper 95%	3.023674	-3.30296
Lower 95.0%	1.957988	-7.22814
Upper 95.0%	3.023674	-3.30296

Appendix 2: How much time do you take to arrive to your work study by car?

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.992354
R Square	0.984766
Adjusted R Square	0.981719
Standard Error	0.073433
Observations	7

ANOVA

	Regression	Residual	Total
df	1	5	6
SS	1.742866	0.026962	1.769828
MS	1.742866	0.005392	
F	323.2055787		
Significance F	9.78E-06		

	Intercept	X Variable 1
Coefficients	3.021094	-7.99007
Standard Error	0.071529	0.444438
t Stat	42.23571	-17.9779
P-value	1.40378E-07	9.7795E-06
Lower 95%	2.837222	-9.13254
Upper 95%	3.204966	-6.84761
Lower 95.0%	2.837222	-9.13254
Upper 95.0%	3.204966	-6.84761

Appendix 3: How much time do you take to arrive to your work study by Private Transport?

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.970283
R Square	0.941449
Adjusted R Square	0.929739
Standard Error	0.151187
Observations	7

ANOVA

	Regression	Residual	Total
df	1	5	6
SS	1.837643	0.114287	1.95193
MS	1.837643	0.022857	
F	80.39582139		
Significance F	0.000288		

	Intercept	X Variable 1
Coefficients	3.16029	-8.9313
Standard Error	0.153343	0.996089
t Stat	20.60924	-8.96637
P-value	4.97852E-06	0.000287751
Lower 95%	2.766108	-11.4918
Upper 95%	3.554472	-6.37077
Lower 95.0%	2.766108	-11.4918
Upper 95.0%	3.554472	-6.37077