



IMPACT OF FUEL PRICE ON ACTIVITY PATTERN OF THRISSUR CITY

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ABSTRACT: *Transportation plays a significant role in the growth and economy of a nation. For a country like India transportation planning is becoming unavoidable due to the fast growing population and travel demand .In the transportation literature, the effects of energy price have been studied primarily in terms of their effects on aspects of travel behavior, both in the short and long term. In the short term, people may adapt their driving style, departure time, travel mode choice, route choice and/or destination choice. But in the longer run people may consider buying a new vehicle .Unfortunately, compared to other triggers of behavioral change, the impact of energy prices has received only less attention in the transportation community, perhaps due to a lack of relevant data. Most research has been conducted by economists mostly on the effect of fuel price on vehicle ownership and vehicle use. Far less attention has been paid to travel behavior especially to the dynamics of people's daily travel patterns. To gain insight into this issue, a representative sample of people residing in Thrissur Corporation was taken to know the interrelation between travel pattern and fuel price. Unrelated regression analysis was used to reveal the direct and indirect effects among dependent and independent variables. Distance traveled which is one of the measures of activity pattern is used as the dependent variable and the variables which were found very much correlated to distance were Cost Burden Ratio (CBR), mode and travel time. Model was developed both for work trips and other trips. From the model it was found that distance traveled have positive correlation with fuel price .This means that no effective change in travel pattern is observed in the area. Also people have a tendency to own a vehicle of their own with frequently varying fuel price. Unfortunately due to COVID 19 pandemic the data from 40 wards out of 52 wards could only be collected.*

1 INTRODUCTION

Energy is essential for the movement of people and objects from one place to another. Approximately one-fourth of the total energy used by humans is for transportation .As the demand for petroleum fuels continues to increase, its price also increase .For better understanding travel behaviour adaptive to increasing fuel prices, it is necessary to consider macro-level factors such as monthly energy price as well as micro-level activity-travel patterns. However, changes of income, personal circumstances, fuel prices and accessibility take place over time .Similarly, individual household travel patterns change over their life cycle and are different for different generations. Consequently, understanding the relationships between travel patterns, individual variables and economic factors is a necessary component in projecting future activity travel demand and assessing the influence of certain policy measures.

Several previous studies have observed the effect of increasing fuel price on travel behaviour of people. Bomberg & M.Kockelman (2005) conducted a survey of 500 respondents about the impact of rising oil prices on travel distances of private vehicle users. From this study, it was found that the respondents had the tendency to reduce overall or adjust their trips as a way of reducing the travel costs. Bento et al.(2013) also conducted a study of driver's reaction and carpooling attitude towards oil price changes by using data of traffic flows over eight years for 1,700 locations in Los Angeles. The results showed

that the flow of traffic in the fast lane was declining as the oil prices rose and this effect was stronger in the presence of car-sharing lane to replace the private drive. In addition, the study also found that the increase in oil prices has increased the number of commuters who shared vehicles. Sacco and Hajj (1976) analysed transportation data in Columbia, South Carolina. They found that gasoline supply greatly affected travel habits and that the effect of price appears to be reflected in the purchase of more small cars. In other words, people could not easily give up driving but rather adjusted their driving behavior to conserve gasoline. Travel was reduced by an energy saving driving style and by limiting social-recreational and shopping trips. Shifts in travel mode were moderate, although people expressed an interest in public transit. Koushki (1991) conducted a household travel survey in Riyadh. He found that as fuel prices increased, the number of daily trips decreased, especially in larger families. Dargay (2007) explored the intertemporal adjustment pattern using cross-sectional data from the annual UK family expenditure surveys. She studied the factors influencing household car travel, and specifically the effects of household income and fuel price. The estimates suggested that car use is sensitive to changes in income and its cost. Hymel et al. (2010) also found that the magnitude of the rebound effect decreases with income and increases with fuel cost.

Aswin Sivarajan et al. (2018) on studying the causes and impact of rising fuel price in Bangalore city found that Government has a role to play in the Fuel prices in the country, but that alone is not the only determinant of the Fuel Price. Bringing Petrol and diesel under GST regime is yet another long way but in the near future that also will be implemented. This would not be possible, however in the near future. The depreciating Indian Rupee and Rising Fuel Prices have an inverse relationship as already seen. Thus with the current trends, it is expected that Petrol Prices at INR 100 per liter would be normalized in the coming future. The impact of the same would also have positive and negative implications. On the long run, the increased usage of Public Transport and demand for cleaner energy would result in a better environmental friendly resources.

Bidisha Sarkar and Jain Mathew (2018) carried out a study on the Causes of Indian Basket Crude Oil Price Fluctuations and Its Impact on Indian Economy revealed that Indian basket crude oil price is influenced by Brent and OPEC crude oil price. Brent benchmark actually belongs to European zone and the political bonding of India with this region is stable. Moreover, the global oil industry did not witness much fluctuation due to this benchmark. On the other hand, OPEC has given several shocks to this industry. The organisation often come up with frequent production cut decision and leaves an adverse impact on industry. Financial year 2017-18 is an evidence of this phenomenon and the impact is visibly reflected through the 50% (approximately) crude oil price hike in last one year. Moreover, OPEC's recent battle with US provides another dimension to the issue. On the other hand, the study revealed the connection between the Indian Basket crude oil price and GDP. It infers that OPEC price shocks can eventually affect the Indian economy. Considering the frequent production cut and unfavourable political connections of OPEC, it can be suggested to reduce the import dependency on OPEC. It can not only reduce the trade deficit, but also can balance the vulnerability in Indian Oil industry.

Brons et al. (2008) found that in both the short run and long run, demand for gasoline is not very price-sensitive. The impact of a change in gasoline price on demand is mainly driven by responses in fuel efficiency and mileage per car and to a slightly lesser degree on changes in car ownership.

Similarly, Romero-Jordán et al. (2010) studying energy consumption in car travel in Spain, found evidence of low price-elasticity and high income-elasticity of the demand for transport fuel. In addition, they found that fuel tax played an important role in encouraging reductions in private transport demand and travel mode shifts.

This paper studies the impact of fuel price changes on the activity pattern of people under Thrissur corporation and also finding out the percentage change in mode shift if any.

1.1 Need for the study

Travel demand forecasting models continue to serve as the primary tools for planning future infrastructure enhancements, analysing traveller response to a wide array of policies and system conditions, and predicting changes in traveller behaviour that might arise due to external forces. For many years, fuel prices did not tend to be a major focus of transportation planning models and policy analysis. This may be because travel behaviour is highly inelastic to small fluctuations in fuel price.

The price of petrol and diesel during the year 2010 was Rs 52.91 and Rs 37.75 respectively. This gradually increased to Rs 72.38 and Rs 53.2 during the year 2014. Then it gradually decreased to Rs 60.7 and Rs 47 during the year 2015. After 2015 the graph showed an increasing trend till the year 2019

and the prices were Rs 78.3 and Rs 73 for petrol and diesel respectively. Thus it is necessary to study the effect of fuel price changes on activity pattern and analyse the percentage change in mode shift.

1.2 Objectives

The aim of the study is to:-

1. Study the effect of fuel price fluctuations on activity pattern of Thrissur city.
2. To calculate the percentage change in mode shift and to point out the probable reasons for the same

2 METHODOLOGY

The first step of doing any sort of project is making a thorough knowledge about the subject and the procedure that need to be adopted. It can be made possible by going through different journals which can give huge information regarding the subject. For this project it is mandatory to carry out the literature survey regarding how an household survey can be carried out, how sampling can be done, how the analysis of the obtained data can be done, how fuel price influence the activity pattern etc.

The study area has been fixed based on the simple criteria that it should be easily accessible and it should include the Central Business District (CBD) which is considered to be the Swaraj Round, Thrissur. Based on the data obtained from the secondary survey on the population and the total dwelling units in the premises of the CBD area, the study area has been finalized.

In the vast majority of research endeavors, the participation of an entire population of interest is not possible, so a smaller group is relied upon data collection. Sampling from the population is often more practical and allows data to be collected faster and at a lower cost than attempting to reach every member of the population.

The most important part of the project is the survey. It can be classified into two, secondary survey and primary survey. Secondary data collection include data collected from Thrissur Corporation Office, which includes data regarding the number of dwelling units, population, other buildings, maps etc. It also include the details of fuel price which was collected from various websites. The primary survey is done to collect data from primary resources. Here, the household questionnaire survey is considered to be the Primary survey. Questionnaire was prepared to collect the necessary details from the households. It includes personal data sheet, household data sheet and travel data sheet. Data was collected for the year 2016 and 2019 to understand the changes before and after fuel price hike.

Further the data was clearly interpreted to get an overview of the variables that must be included in the model. This was done using Microsoft Excel.

The principal statistical tools considered for data analysis are using the Karl Pearson's Correlation Coefficient, followed with econometric modelling of regression. Correlation means a statistical relationship between sets of variables none of which has been experimentally manipulated. Therefore, correlation means a relationship between un-manipulated variables. It measures the strength of linear association between two variables. Karl Pearson's Correlation Co-efficient is used to study correlation between the variables distance, Cost burden ratio, mode etc. Often in practice, correlation is followed by regression. The purpose of regression is also to study the model relationship between variables, describing the relationship between the explanatory and response variable. This was done using the SPSS Software. Distance which is an indicator of activity pattern is modelled both for work trips and other trips.

3 DATA COLLECTION

For any study, data is one of the unavoidable factor. Household questionnaire survey was conducted to collect the household data, personal data and travel data. The details regarding population of the study area for fixing the sample size were collected from Thrissur corporation. Household survey was done as it gives data on individual basis. Data of the year 2016 and 2019 was collected for comparison.

3.1 Study area

The study area selected is Thrissur corporation which consist of 52 wards to be surveyed.

3.2 Sampling

The sample size for the questionnaire survey was estimated to be 2383 (Krejcie and Morgan, 1970) . Based on Krejcie and Morgan’s table for determining the sample size , for a given population of 500 , A sample size of 217 would be needed to represent a cross section of population . However it is important for a research to consider whether the sample size is adequate to provide enough accuracy to base decisions on findings with confidence (Chuan and Penyelidikan , 2006) .

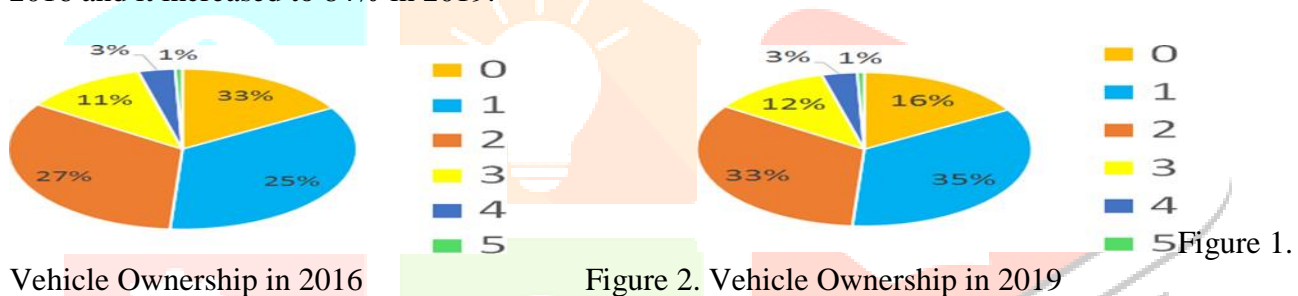
Based on this to get data from every wards, 48 individuals (or 12 houses) will be selected in random from all the 52 wards. Hence, a total sample of 2496 individuals will be obtained as sample for the survey.

4 DATA ANALYSIS

The primary analysis helps in obtaining the features of the study area. There are lots of information obtained by the help of this initial analysis. The characteristics of the sample can be easily understood by this analysis. The variables considered for analysis include vehicle ownership data, Cost Burden Ratio (CBR) and percentage mode shift , which were found very much relevant for the project.

4.1 Distribution of vehicle ownership

The Figure 1 and Figure 2 shows vehicle ownership before and after fuel price hike .From this we can see that about 67% of the people has at least one vehicle ownership before fuel price hike in the year 2016 and it increased to 84% in 2019.



4.2 Mode shift analysis

The Table 1 and Table 2 below shows the details of mode shift analysis for work trips and other trips respectively based on income groups. From the analysis it is clear that in case for both work trips and other trips the percentage number of people using own vehicle is more than percentage number of people using public transport before and after fuel price hike. Among this percentage number of people using own transport is higher in case of other trips when compared to work trips. This means that when the fuel price increases people have a tendency to own their own vehicle. Also as the income increases vehicle ownership also increases.

Table 1. Mode Shift Analysis For Work Trips

Income group		2016	2019
0 - 15000	Percentage number of work trips using own transport	46.83	53.25
	Percentage number of work trips using public transport	53.16	46.75
15000 - 30000	Percentage number of work trips using own transport	56.6	61.65
	Percentage number of work trips using public transport	43.3	38.35
30000 - 45000	Percentage number of work trips using own transport	75.86	78.56
	Percentage number of work trips using public transport	24.14	21.44
45000 - 60000	Percentage number of work trips using own transport	81	82.42
	Percentage number of work trips using public transport	19	17.58
>60000	Percentage number of work trips using own transport	85.26	86.1
	Percentage number of work trips using public transport	14.73	13.9

Table 2. Mode Shift Analysis For Other Tips

Income group		2016	2019
0 - 15000	Percentage number of other trips using own transport	65.26	72.25
	Percentage number of other trips using public transport	34.74	27.76
15000 - 30000	Percentage number of other trips using own transport	76.26	80
	Percentage number of other trips using public transport	23.74	20
30000 - 45000	Percentage number of other trips using own transport	85.26	86.55
	Percentage number of other trips using public transport	14.74	13.45
45000 - 60000	Percentage number of other trips using own transport	90	92.42
	Percentage number of other trips using public transport	10	7.58
>60000	Percentage number of other trips using own transport	96.66	96.8
	Percentage number of other trips using public transport	3.34	3.2

4.3 CBR Analysis

The most important parameter considered in the model is Cost Burden Ratio (CBR) which is the ratio of fuel cost spend to the monthly income which is expressed in percentage. It indicates the economic ability of a person to spend on fuel. The Figure 3 and Figure 4 below shows the variations in CBR for different income groups for work trips, other trips respectively. From the figure it can be seen that CBR for income group 0 - 15000 is higher for work trips and least for other trips. That is about 8 % of income is spend for work trips and about 5% for other trips. Whereas for income group greater than 60000, higher percentage of income is spend for other trips, which is about 13 %.

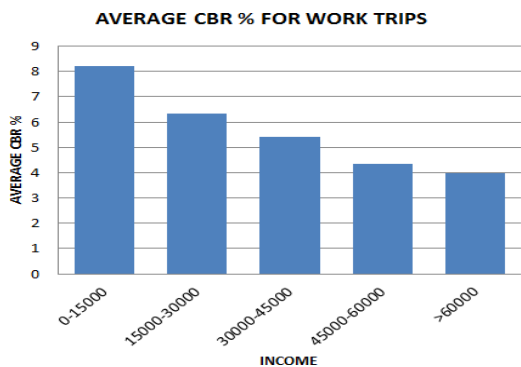


Figure 3. CBR for work trips

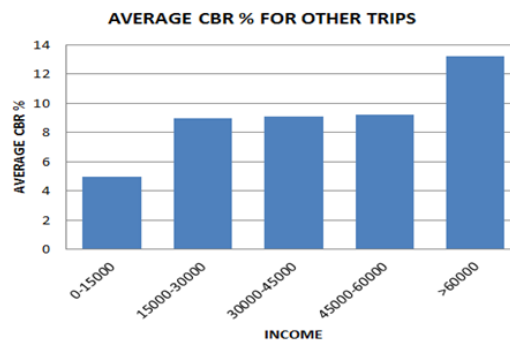


Figure 4. CBR for other trips

5 MODELING

The modeling was done using SPSS (Statistical Package for Social Science) statistical software package. The modeling approach adopted here is Linear Regression Modeling. In statistics, simple linear regression is a linear regression model with a single explanatory variable. This can be represented as shown in Eqn 1.

$$Y = a + bX \tag{1}$$

where ,

Y = Dependent variable

X = Explanatory variable

b = Co-efficient of X , which is the slope of the regression line

a = Constant , which indicates the y intercept

5.1 Correlation of variables

The model has been created by the help of 2/3rd of the whole household data. Before going for the model development the first task is to find the correlation between different variables. That has been found out by the help of SPSS by using Pearson correlation technique. Pearson's correlation coefficient is the co-variance of the two variables divided by the product of their standard deviations. The variables used for modeling are mode used, total journey time and Cost Burden Ratio (CBR). Before going for modeling it is necessary to find correlation between various variables.

Table.3 Pearson Correlation For Work Trips

Variable Name	Dependent Variable (Distance)
Distance	1
Mode	0.359**
Total journey time	0.790**
CBR	0.474**
Car share	0.103**

Table.4 Pearson Correlation For Other Trips

Variable Name	Dependent Variable (Distance)
Distance	1
Mode	-0.015
Total journey time	0.974**
CBR	0.351**

From the Table 3 and Table 4 it can be seen that the variables are very much significant at 99% confidence interval. From the correlation table for work trips, the dependent variable that need to be selected include mode used, total journey time and cost burden ratio (CBR). In case of other trips the variables selected include total journey time and CBR.

5.2 Model development

The last step of this project is model development. In this project distance modeling is done to know the impact of fuel price on activity pattern since willingness to travel longer distance will depend on amount of money spend on fuel. The parameters estimated using SPSS software.

5.2.1 Distance Model For Work Trips

The model can be illustrated as shown below in Eqn 2.

$$\text{Distance} = -213.172 + 61.502(\text{Mode}) + 0.365(\text{Total journey time}) + 26.634(\text{CBR}) \quad (2)$$

From the coefficient of the model, it is very evident that the most influencing parameter is mode used, then comes the CBR and finally travel time which has the least influence on the dependent variable distance. The model with independent variables (final model) has a significance of 0.000 which is less than the level of significance 0.050. Hence, it is concluded that the dependent variables are related to independent variables. The model is having a R^2 value of 0.692. Generally R^2 values will range from 0 to 1.0, of which 0 indicates that there is no variability of the response data around its mean. And 1 indicates that the significant variability of the response data around its mean. The accuracy of the model generated is 70%.

5.2.2 Distance Model For Other Trips

The model can be illustrated as shown below in Eqn 3.

$$\text{Distance} = -278.613 + 25.515(\text{Total journey time}) + 2.245(\text{CBR}) \quad (3)$$

Similarly in case of other trips, the coefficients reveals that the most influencing variable on dependent variable distance is travel time. Here mode used has no significance. This may be because of the reason that most people use their own transport and only few depend on public transport. The model with independent variables (final model) has a significance of 0.000 which is less than the level of significance 0.050. Hence, it is concluded that the dependent variables are related to independent variables. The model is having a R^2 value of 0.950. Generally R^2 values will range from 0 to 1.0, of which 0 indicates that there is no variability of the response data around its mean. And 1 indicates that the significant variability of the response data around its mean. The accuracy of the model generated is 85.35 %.

6 CONCLUSION AND DISCUSSION

The data regarding the year 2016 and 2019 were selected for the study. This is because only a small difference is noted in difference of petrol and diesel during those years, so that the variable can be generalised as fuel price. From the study it was found that for work trips, the distance travelled have positive correlation with the variables CBR, mode and total journey time. This means that even though the fuel price increases no effective change in travel pattern is observed.

In case of other trips the variables total journey time and CBR were found to have positive correlation. The reason behind this might be that most of the people have a tendency to own their vehicle due to the frequent fluctuation in fuel price. Which means people are giving more importance for their convenience rather than the cost they spend for fueling the vehicle. Moreover more than half of the population of the area earn an income of Rs 25000 or above. From the CBR analysis it can be seen that percentage of income people spend for other trips is greater than that spend for work trips except for low income group (0 - 15000). Other trips include mostly leisure trips, maintenance trips and so on. From this itself it is clear that no matter how much amount is spend for their trip, instead importance is given for the trip purpose. Finally from the mode shift analysis it can be seen that percentage number of trips using own transport is higher than percentage number of trips using public transport. This is again higher in case of other trips than work trips. The percentage change in mode shift from own transport to public transport for work trips is -43.34% and the percentage change in mode shift from own transport to public transport for other trips is -10.3%. This might be because of the inefficiency of the public transport system in the city especially due to the rising bus fares and lack of proper connectivity.

6.1 Limitations and future scope of the study

Data collection from household surveys were cut short due to COVID-19 pandemic. Thus the accuracy of the model is limited due to the lack of availability of larger samples. The initial aim was to collect data from 52 wards under Thrissur corporation, but 40 wards could only be completed. If we could have managed collecting larger samples, more independent variables could be accommodated and the reliability of the model can be improved.

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