



## **Analyzing the Effect of Fuel Prices Increase on Travel Behavior**

**Mohammed Aljoufie<sup>1</sup>**

<sup>1</sup>*Department of Urban and Regional Planning, Faculty of Environmental Design, King Abdulaziz University, Jeddah, Saudi Arabia*

### **Abstract**

Saudi Arabia has increased the prices of fuel in January 2018. The increase was unprecedented and range from 82% to 126 %. Travel behavior patterns and socio-economic characteristics are unique in Saudi Arabia. High car dependency is notable in all main Saudi cities. This study attempts to analyze the effect of fuel prices increase on travel behavior change in the city of Jeddah, second largest city in Saudi Arabia. A household survey was conducted to collect travel patterns of Jeddah city population, before and after the increase of the fuel prices. Results indicate a significant effect of fuel prices increase on travel behavior in Jeddah. Further studies to explore other effects of fuel prices increase on travel behavior in Jeddah are important in both short run and long run.

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### **Keywords**

Travel behavioor; Feul prices Effet;Jeddah

### **1. Introduction**

Since the oil boom has begun, changes in fuel prices have fascinated experts and researchers from diverse fields. Theoretically it has been presumed that higher fuel cost will induce people to drive less and to increase physical activities in form of walking or bicycling; it will also lead a reduction in the obesity and other lifestyle related illnesses (Edwards 2008, Wen and Rissel 2008). Reduced driving can also be interpreted in term of frequent uses of public transit, which is negatively associated with the obesity (She et.al.2017).

Likewise, land use patterns and urban development in most of the North American cities were profoundly directed by the needs of a car dominated transportation systems (Safdie 2018); and the domination of cars made the purchase of fuel an inevitable part and parcel of American lifestyle (Graham et.al. 2010).

Car dominated cities are most often blamed for reduced physical activity for the urban residents, resultant into poor health conditions, especially the obesity is a serious issue of concern that is widespread in the US cities (Sturm 2002).

There is a growing body of literature that suggest an increase in fuel prices might produce positive synergies for the urban health scenario, mainly in palliating in diseases and health conditions related to physical inactivity and restful lifestyle (Frank et.al. 2004, Wen et.al. 2006).

Also, in a study Courtemanche (2011) observed a negative connexion between the fuel bills and the body weight deploying a mixed effect model aided by a series of substantiations, the researcher exhibited that the rising fuel prices are linked with additional walks and decrease in the rate of restaurant visits to feast. He conjectured that a simultaneous fuel price drop in the USA caused, 8 percent growth, in the cases of obesity while on the other hand,

a 1\$ rise in the fuel bills might cut down obesity cases up to 10 percent.

Similarly, Hou et.al. (2011) found that in case of 0.25\$ increase in fuel price leads to 17 minutes of additional walking per week, the study was a result of mixed samples taken from 4 cities in USA namely Chicago, Minneapolis, Oakland and Birmingham. Moreover, Sen (2012), argues that an upsurge in the fuel prices either through higher taxes or via reducing subsidies, may work as a policy instrument to mitigate the occurrence of obesity among urban residents.

There are several studies that estimates the connexion between the upsurge in fuel bills and resultant change in the driving behaviours; through Monto Carlo stimulation based partial equilibrium model in USA, Leigh and Geraghty (2008) established that a 20 percent rise in fuel prices was resultant into lesser deaths (around 2.5 thousand less from the previous year) from air pollution and vehicle crashes. Another study in USA maintains that bicycling is more frequently used by the commuters in the areas that are less sprawled and the areas where fuel prices are high (Rashad 2009). Additionally, Chi et.al. (2011) claims that higher fuel prices would lead to fewer crashes. Through a recent international study, Burke and Nishitateno (2015) submit that a 10 percent upsurge in Fuel bills might diminish incidences of road fatalities by 3 to 6 percent.

Perceived as a blockade in the way of climate change mitigation, the road transport sector is assuredly a key cause of carbon emission (Creutzig et.al.2015). Considering the importance of the Paris Agreement on Climate Change, convened to make consensus among world leaders to cut down global carbon emissions (Agreement 2015), a study prompts that a rise of 10 percent in fuel prices would cut down 1.8 percent of the global carbon emissions in a short period of time; and around 4 percent of carbon emissions could be reduced in the long term (Henriksson and Horstmann 2016).

An OECD study, to cut down fuel subsidies and to make fuel prices rationalise, prompts that doing so can reduce wasteful consumption of fuel and the subsidy reforms also offers economic and environmental benefits at the global level (Burniaux and Chateau 2011). Initial dilemma was prevalent among policy makers in several countries, including Russia, India and China (all BRICS countries) regarding fuel subsidy reforms (Dansie, et.al 2010); however, countries like Indonesia are contributing their firm efforts in energy subsidy reform sector, According to Burke et.al. (2017). The fuel subsidy reform program in Indonesia brought down the number of vehicle trips on toll roads by 10 percent. Therefore, subsidy reform in the fuel sector has virtue to ease traffic in a substantial volume.

Concurrently, many studies point out the relationship between fuel prices increase and change in travel behavior. An increase on fuel prices might encourage car commuters to ridesharing, to shift to transit, to change workplaces and housing in order to reduce travel distance (CBO, 2008). It is also noted that increases in fuel prices play an important role in encouraging transit use (Kyte et al., 1988;. Doti and Adibi, 1991; Litman, 2004; Currie and Phung, 2008; Maghelal, 2011;; Lane, 2012; Chao et al, 2015). Moreover, Fujisaki (2014) point out a relationship between higher fuel prices and car ownership, travel distance, fuel consumption and transit ridership. Other studies indicate that higher fuel prices reduce traffic levels and reduced traffic crashes (Huang and Levinson 2010; Chi et al. 2012, 2013). In fact, majority of research findings depict that increased fuel prices reduce the frequency of individual driving; and may contribute to several economic, health, environmental and social benefits

Considering the unique local context, there is a lack of studies that measures association among fuel prices and travel behaviour of urban residents in Saudi Arabian context, wherein high car dependency is notable in all main Saudi cities. Thus study slips its focus, on the impact of fuel price increase that is recently applied in the contemporary ambitious country fiscal scenario. Accordingly, this paper strives to analyze the effect of fuel prices increase on travel behaviour change in the city of Jeddah, second largest Saudi city and a high car dependent city.

## 2. Methodology

### 2.1. Study area

Saudi Arabia is one of the biggest oil producers in the world, and also one of the biggest energy consumers. To diminish the rapid growth in energy domestic consumption, Saudi Arabia has increased the prices of fuel in January 2018, in line with Saudi Arabia Vision 2030 main goals, which seeks to diversify the economy and sources of revenue.

The price of Octane 91 increased from 0.75 Saudi Riyal per litre to 1.37 SR Saudi Riyal per litre with an increase of 82.6%. Octane 95 was also increased from 0.90 Saudi Riyal per litre to 2.04 Saudi Riyal per litre with an increase of 126.6%. The increase was unprecedented, but still fuel prices in Saudi Arabia are one of the cheapest fuel prices in the world.

Road transport sector considered one of the largest energy consumers in Saudi Arabia (MEP, 2015). In fact, rising incomes have household's car ownership, whereas economic development has provided widespread road infrastructure in Saudi large cities and extensive intercity highways network (Atalla et al, 2018). However, lack of effective public transportation systems in Saudi cities has reinforced high private car dependency

Jeddah (Figure 1) the second largest city in Saudi Arabia and first commercial city is not an exception Jeddah has experienced a rapid urban growth and a notable travel pattern change over the last five decades (Aljoufie et al., 2013). Several triggering factors and different patterns of development has affected the city growth and expansion and undeniably has affected the pattern of travel in Jeddah (Aljoufie, 2016). High car dependency is noted in Jeddah wherein 96% of daily trips are commuted by car, whereas 4% represent public transport, walking and cycling trips (AECOM, 2012).

Certainly this has caused haphazard issues for urban environment in Jeddah. Jeddah streets witness a constant congestion during morning and afternoon peak hours during non-peak hours (IBI, 2007; Municipality of Jeddah, 2009). Jeddah main roads average speeds is declining and traffic safety is lessening, while traffic emissions and trip duration is increasing (Municipality of Jeddah, 2009; Aljoufie et al., 2013).

Thus, it is necessary to understand the effect of increased fuel prices on travel behavior in Jeddah. The study area covers urban area extent in Jeddah city to analyze the effect of fuel prices increase on travel behaviour change in the city of Jeddah.

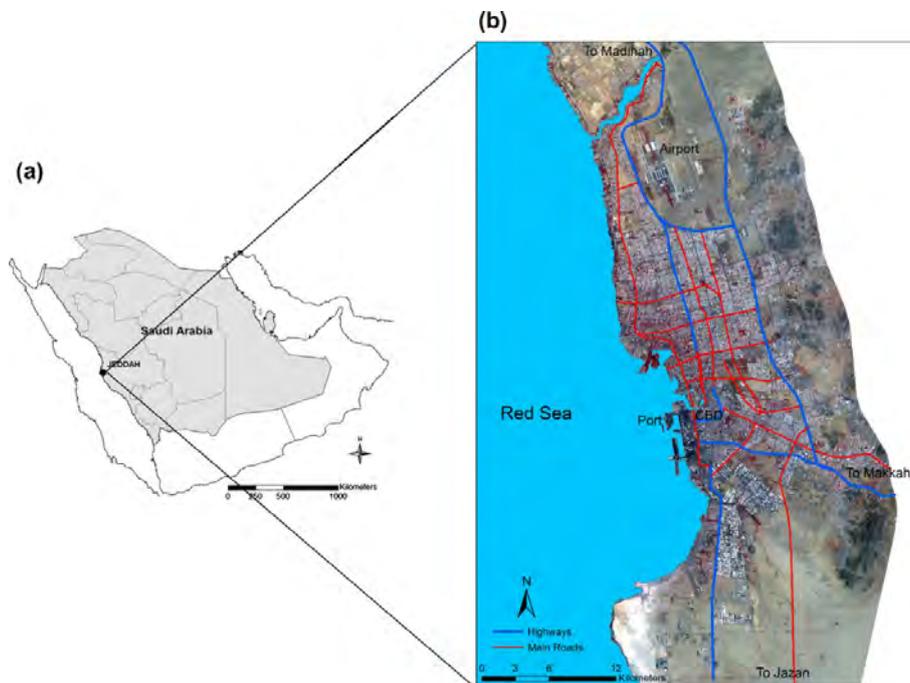


Figure 1. a) Jeddah location in Saudi Arabia; b) Jeddah urban extent

## 2.2. Household survey

To analyze the effect of fuel prices increase on travel behavior change in the city of Jeddah, an online household survey was prepared. The survey was designed in two main parts. The first part consisted of socio-economic variables, specifically: gender, age, income level and family size. These variables were formulated into closed-ended questions with multiple choices.

The second part consisted of household travel behavior before and after the increase of fuel prices. Reviewed literature on the effect of fuel increase on travel behavior pointed out several effects such as : trip frequency, transit ridership, car ownership, travel distance and car sharing (CBO, 2008; Currie and Phung, 2008; Maghelal, 2011;; Lane, 2012; Chao et al, 2015; Fujisaki 2014). Accordingly, the following effects of travel behaviour before and after fuel prices increase were considered as following:

- Total monthly expenditures on transportation (including maintenance, installments, fuel cost) before and after increase of fuel prices.
- Number of households car commuters before and after increase of fuel prices.
- Total number of household's car trips before and after increase of fuel prices.
- Total number of household's non-cars trips (public transport-walking- cycling) before and after increase of fuel prices.
- Number of households cars before and after increase of fuel prices.
- Car sharing before and after increase of fuel prices.

These effects was formulated into open-ended questions with short answers and closed-ended questions trough two choices "Yes" and "No". The household survey was designed online and considered to take about 5-8 minutes to be completed. The survey was carried out during the period between June 20th and August 20th 2018.The survey was distributed online for Jeddah residents through social networking sites and apps such as Twitter and Whatsapp.

## 3. Results

A total of 500 household surveys were distributed throughout social networking sites and apps such as Twitter and Whatsapp and a total of 312 were filled.

### 3.1. Socio-economic attributes

Table 1 shows the socio-economic attributes of the respondents wherein varied socio- economic attributes of the respondents were noticed. The majority of the respondents (about 75.9%) were male whereas about 25.1 were female. Results reveal that the respondent's ages were diverse and dominated by age group of 23 - 30 years old with about 30.8 % as shown in Table 1.

Income level information depicts variation among the respondents as depicted in Table 1. About 29.9 % of the respondents receive less than 3000 Saudi Riyals monthly, whereas about 15.4 of the respondents receive between 3000 and 6000 Saudi Riyals per month. About 12.3 % of the respondents receive monthly income between 7000 and 10000 Saudi Riyals, while about 42.4 % of the respondents earn more than 10000 Saudi Riyals per month.

Finally, the results indicate varied family size of the respondents as shown in Table 1. The majority (40.88 %) of respondents are with family size of 4-5 persons , while about 31.02 % of the respondents are with family size of 6-7 persons. Results also depict that about 6.2 % and about 10.22 % of the respondents are with family size of one person and 2-3 persons whereas about 11.68 % of the respondents are with family size of more than 7 persons.

### 3.2. Effect of fuel prices increase on travel behavior

Results reveal an effect of fuel prices increase on travel behavior in Jeddah city. The total monthly expenditures on transportation of the respondents have increased with an average of 90% as a result of fuel prices increase. Figure

2 implies that the respondents generally increased their expenditures after fuel prices increase. The majority of the respondents (about 32.69 %) have increased their total monthly expenditures more than 100%, whereas about 16.92 % of the respondents have indicated an increase of 25 % and below. Figure 2 also indicates that about 18.85 % of the respondents increased their total monthly expenditures on transportation from 26 % to 50 %, while about 31.53% of the respondents indicated an increase from 51 % to 100 %. Such an increase in total transportation expenditures seems to be related to the dramatic increase in the fuel prices gasoline prices in January 2018.

Results indicate a change in number of household's car commuters. Table 2 reveal a decrease of average household's car commuters from 3.52 before fuel prices increase to 3.33 after fuel prices increase with about -5.40% changes. Thus, it must be noted that only about 10.8 % of the respondents indicated a decrease in the number of household's car commuters. This seems to indicate a lower effect of fuel prices increase on car commuters at a glance. However, it must be noted that car is the dominant mode in Jeddah, in the absence of an efficient public transport system.

Table 2 depicts a change in the number household's car trips. A decrease of about 17.76 % is reported in the average number household's car trips before fuel prices increase with 5.63 car trips per household to 4.63 car trips per household after fuel prices increase. It is noted that about 37.2 % of the respondents indicate a decline in their number of household's car trips. This change seems to be related to the dramatic increase in the fuel prices in January 2018. However, the decline of household's car trips might be related to the decline in non-work trips such as social, shopping, and recreational trips as results of fuel prices increase.

Results also reveal a change in number of household's cars. Table 2 depict a decline of average household's cars from 2.56 before fuel prices increase to 2.44 after fuel prices increase with about -4.69% change. However, it must be noted that only about 9.2 % of the respondents indicated a decline in the number of household's cars. This seems to indicate a lower effect of fuel prices increase on the number of household's cars.

Table 1. Socio-economic characteristics of the respondents

Socio-economic attributes	Frequency	Percent
Age		
18-22 Years	50	15.9
23-30 Years	96	30.8
31-40 Years	61	19.7
41-50 Years	68	21.9
51 Years and above	37	11.7
	312	
Gender		
Female	75	24.1
Male	237	75.9
	312	
Family size		
one person	19	6.20
2 - 3 persons	32	10.22
4-5 persons	128	40.88
6-7 persons	97	31.02
more than 7 persons	36	11.68
	312	
Monthly income level		
Less than 3000 SAR	93	29.9
3000 -6000 SAR	48	15.4
7000 -10000 SAR	38	12.3

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Table 1 continued

11000-15000	57	18.4
16000-20000	37	12
more than 20000	37	12
	312	

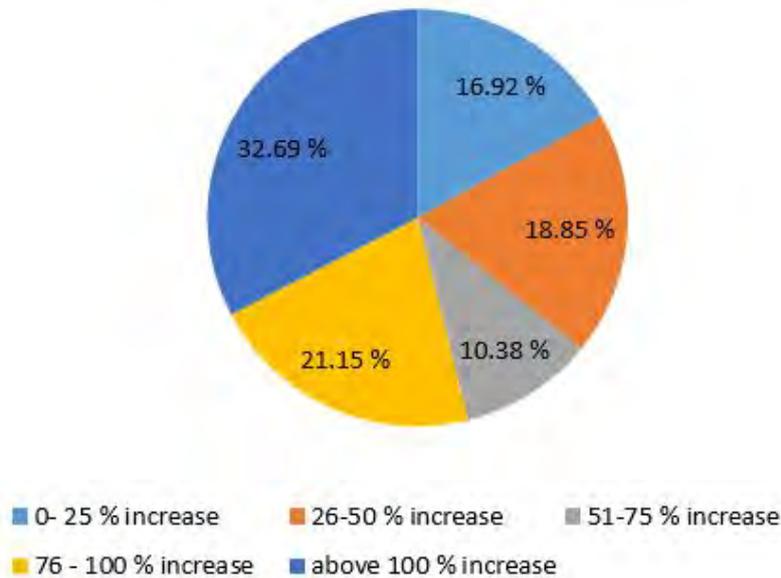


Figure 2. Increase of the monthly total expenditures on transportation

Table 2. Effects before and after the increase of fuel prices

Effects	Average before Fuel prices increase	Average after Fuel prices increase	Change %	% of Households with change
Number of households car commuters	3.52	3.33	-5.40	10.8
Number of household's car trips	5.63	4.63	-17.76	37.2
Number of households cars	2.56	2.44	-4.69	9.2
Number of household's non-cars trips	0.28	0.58	107.14	12.5

Table 2 also indicates a notable change in the number of household's non-cars trips. A notable increase of about 107.14% is reported in the average number of household's non-cars trips before fuel prices increase from 0.28 car trips per household to 0.58 car trips per household after fuel prices increase. Although, it is noted that only about 12.5 % of the respondents indicate an increase in their number of household's non-cars trips, this seems to indicate a high effect of fuel prices increase on the number of household's non-cars trips. However, in the absence of an efficient public transport system in Jeddah, the increase might be limited to walking and cycling trips.

Finally, figure 3 and figure 4 reveal the willingness of respondents for car sharing before and after fuel prices increase. It is noted that only about 18.4 % were sharing their cars with relatives or friends before fuel prices increase, while about 80.8% of the respondents were not as depicted in figure 3. On the contrary, figure 4 shows that about 35% of the respondents are willing to share their cars with relatives or friends after fuel prices increase, whereas about 65% are not willing. Although, the effect of fuel prices increase on car sharing seems to be moderate

at a glance, privacy and unique socioeconomic and cultural characteristics might play a significance role in car sharing. Accordingly, this effect might be notable and related to the dramatic increase in the fuel prices gasoline prices in January 2018.

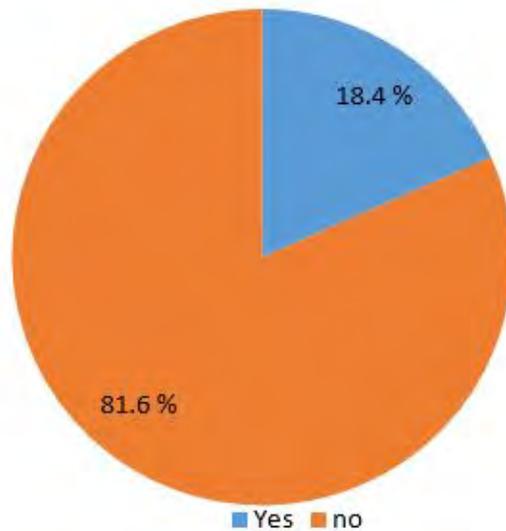


Figure 3. Carsharing of the respondents before fuel prices increase

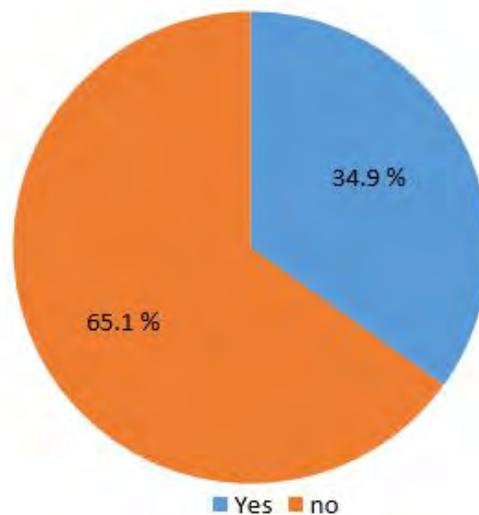


Figure 4. Willingness of the respondents' for car sharing after fuel prices increase

#### 4. Discussion and conclusion

This paper has attempted to analyze the effect of fuel prices increase on travel behavior change in the city of Jeddah, second largest Saudi city; and a high car dependent city. Generally, the results of this paper support the conclusions of other relevant research on the relationship between fuel prices increase and travel behavior. There appear to be significant effects of fuel prices increase on travel behavior in Jeddah.

Results of the household survey reveal that the dramatic increase in the fuel prices in January 2018 seem to significantly increase the monthly household total expenditures on transportation, wherein an average of 90% increase is reported. The increase was varied between different respondents at different percentages which might be associated with different income levels of the respondents. In fact, this notable increase seems to largely stimulate changes in travel behavior.

Results also indicate a decline in the average household's car commuters as result of the increase of fuel prices is noted. The average household's car commuters decrease from 3.52 before fuel prices increase to 3.33 after fuel prices increase with about -5.40% changes. Almost similarly, a decline in the average household's cars from 2.56 before fuel prices increase to 2.44 after fuel prices increase with about -4.69% changes is noted. At a glance, it seems to be that the effect of fuel prices increase on car commuters and household's cars is low. However, travel characteristics of Jeddah city must be considered wherein high car dependency is noted as 96% of daily trips are commuted by car, whereas 4% represent public transport, walking and cycling trips (AECOM, 2012).

A moderate decrease of about 17.76 % in the average number household's car trips from 5.63 car trips per household to 4.63 car trips per household after fuel prices increase is reported. In line with the current travel characteristics in Jeddah, this decrease might be related to the decline in non-work trips such as social, shopping, and recreational trips as results of fuel prices increase. In fact, it is noted that increased fuel prices reduce the frequency of individual driving and reduce the unnecessary trips (Jeihani and Sibdari, 2010; Ma et al., 2010).

Results also indicate a high effect of fuel prices increase on the number of household's non-cars trips with notable change of about 107.14%. The average number of household's non-cars trips before fuel prices increase from 0.28 car trips per household to 0.58 car trips per household after fuel prices increase. However, in the absence of an efficient public transport system in Jeddah, the increase seems to be limited to walking and cycling trips. In essence, increase fuel prices stimulate using less expensive modes of transport such walking and cycling (Hou et.al. 2011; Song et al., 2017)

On the contrary, results reveal a notable effect of car sharing related to the dramatic increase in the fuel prices gasoline prices in January 2018. About 35% of the respondents are willing to share their cars with relatives or friends after fuel prices increase whereas about 65% are not. However, privacy, unique socioeconomic and cultural characteristics seem to play a significance role in car sharing in Jeddah. In fact, family and female householders are less likely to share their ride (Zolnik, 2015).

The study findings provide implications about the short-run effects of fuel prices increase on travel behavior in Jeddah city. However, some effects are not immediate (Jeihani and Sibdari, 2010) , and need a long-run to be analyzed. Therefore, further studies to explore other effects of fuel prices increase on travel behavior in Jeddah are important in both short run and long run.

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