UNDERSTANDING THE IMPACT OF RISING FUEL PRICES ON DRIVING BEHAVIOR: A SURVEY IN IZMIR

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

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Baysak, Selin

Master's Program in Sustainable Energy

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The world has entered a period of major geopolitical upheaval and is facing an unprecedented global energy crisis. This study aims to determine how people respond to rising fuel prices and if this current energy crisis has accelerated the transition to cleaner transportation behavior. The statistical analysis of data gathered in a survey of 550 people suggests that almost every car owner finds fuel prices high. Almost half of the drivers have reduced their driving and fuel consumption through various strategies and replaced it with public transportation or other more environmentally friendly methods than individual driving. Half of the respondents consider buying an alternative fuel vehicle. Therefore, it can be inferred that rising fuel prices have also accelerated the transition to cleaner transportation behavior.

Keywords: energy crisis, fuel price, change in driving behavior, alternative fuel vehicle, clean transportation

ÖZET

YÜKSELEN AKARYAKIT FİYATLARININ SÜRÜŞ DAVRANIŞINA ETKİSİNİ ANLAMAK: İZMİR İLİ ÖRNEĞİ

Baysak, Selin

Sürdürülebilir Enerji Yüksek Lisans Programı

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Dünya büyük bir jeopolitik çalkantı dönemine girdi ve benzeri görülmemiş bir küresel enerji kriziyle karşı karşıya. Bu çalışma, insanların artan akaryakıt fiyatlarına nasıl tepki verdiğini ve bu mevcut enerji krizinin daha temiz ulaşım davranışına geçişi hızlandırıp hızlandırmadığını bulmayı amaçlamaktadır. 550 kişiyle yapılan bir ankette toplanan verilerin istatistiksel analizi, hemen hemen her araç sahibinin akaryakıt fiyatlarını yüksek bulduğunu göstermektedir. Sürücülerin neredeyse yarısı, çeşitli stratejilerle araç kullanma ve yakıt tüketimlerini azaltmış ve bunun yerine toplu taşıma veya bireysel araç kullanmaya göre daha çevre dostu olan diğer ulaşım yöntemlerini tercih etmiştir. Ankete katılanların yarısı alternatif yakıtlı bir araç almayı düşünmektedir. Dolayısıyla artan akaryakıt fiyatlarının daha temiz ulaşım davranışına geçişi hızlandırdığı söylenebilir.

Anahtar Kelimeler: enerji krizi, yakıt fiyatları, sürüş davranışında değişim, alternatif yakıtlı araçlar, temiz ulaşım

In Loving Memory of My Dearest Grandpa and Grandma

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LIST OF ABBREVIATIONS

CIF: Cost, Insurance & Freight

EMRA: Energy Market Regulatory Authority

EU: European Union

EV: Electric Vehicle

ICE: Internal Combustion Engine

IEA: International Energy Agency

LNG: Liquified Natural Gas

OPEC: Organization of Petroleum Exporting Countries

PHEV: Plug-in Hybrid Electric Vehicles

SCT: Special Consumption Tax

TANAP: Trans-Anatolian Gas Pipeline

TL or TRY: Turkish Lira

US: United States

USD: United States Dollar

VMT: Vehicle Miles Traveled

CHAPTER 1: INTRODUCTION

According to the World Energy Outlook 2022; 2022 was marked as the year of global trouble; war, skyrocketing energy and food prices, inflation, and the threat of recession (IEA, 2022b). The cost of living had reached record levels for everyone worldwide. The world was just in the recovery period after the Covid-19 pandemic when another catastrophe hit it. Production pauses challenged the economy due to the closures during the pandemic and supply chain disruptions. This conjecture was topped with the conflict between two critical energy players, Ukraine and Russia, resulting in the rapid and steep rise of energy prices worldwide. Rising fossil fuel prices had a domino effect on prices of almost everything because energy is the input in every sector, from agriculture to services, from heating to industry, and transportation of goods and services as well as individuals. This ripple effect had become visible as inflation figures. Even in the most developed countries, the inflation rates hit the highest levels in decades (Rausser, Strielkowski and Mentel, 2023).

The effects of the energy crisis have been felt intensely by the Turkish population, with many individuals struggling to cope with the rising transportation and household energy consumption costs. Turkey, as a net importer and a net oil and gas importer country that is abundantly dependent on other countries to provide primary energy to its fellow citizens (Bulut and Muratoglu, 2018) has been adversely impacted by the crisis in the energy sector. The nation has also suffered from a trade deficit for consecutive years and currency fluctuations (World Bank, 2020). Combined with other stated factors, the elevated energy costs generated cost-push inflation means that the high energy prices created a spiral effect on all prices in the economy (Dunkelberg, 2022). High inflation has hauled down the purchasing power of households. Among other goods, high oil and gas prices are reflected as fuel prices to Turkish consumers. Due to the rise in the price of Brent oil, which is taken as a reference to come up with the gasoline price in Turkey, and the depreciation of the TL against the USD, there have been serious fuel cost increases, especially since the last months of 2021.

Plenty of articles study the effects of the fluctuations of fuel prices due to past energy crises (or fuel shortages due to other reasons) on consumer travel behavior. According

to the literature review done for this study, when gasoline prices are increased, people are expected to react in various ways. Reducing car usage (Corsi and Harvey, 1975), car-pooling, or public transportation (Haire and Machemehl, 2007) are a few savings strategies. In addition, some people purchase more efficient automobiles (Jeihani and Sibdari, 2010) or change theirs with alternative fuel vehicles (Brito et al., 2020). Moreover, to reduce driving, some people may relocate their residence closer to work or other needs (Eltony, 1993). Additionally, applying energy efficiency strategies, an increased tendency to use public transportation, and buying more efficient or alternative fuel cars such as hybrid and electric vehicles for financial motivations also serve another agenda of the world; energy transition for combatting the climate crisis (Florence School of Regulation EUI et al., 2022).

This topic is of special relevance today. However, due to the recency of the situation, there is no extensive research regarding the current energy crisis' effect on people's travel behavior and whether this situation has accelerated the transition to greener transportation. In order to fill this gap, by combining existing knowledge with the survey findings, the thesis contributes to addressing the current energy crisis' effects on driving behavior and explore diverse motivations and perspectives to guide efforts in transitioning to sustainable transportation alternatives. Specifically, it examines how individuals and households respond to increases in gasoline (or diesel) prices and whether higher prices have accelerated the transition to cleaner modes of transportation. To investigate the potential effects of the current energy crisis on driving behavior, a comprehensive survey was conducted in İzmir, Turkey. The study aims to provide insights into how energy prices influence transportation choices and the potential for policy interventions to promote sustainable travel behaviors.

The statistical analysis of data gathered along a survey of 550 people is performed using SPSS. The findings suggest that almost every car owner finds fuel prices high. Almost half of the drivers have reduced their driving and fuel consumption through various strategies and replaced it with public transportation or other more environmentally friendly methods than individual driving. Half of the respondents consider buying an alternative fuel vehicle. Therefore, it can be inferred that rising fuel prices have also accelerated the transition to cleaner transportation behavior.

This thesis is structured as follows;

Section 1 is the Introduction. In this section, the topic is introduced. There is a quick look at the phenomenon, literature, and the gap leading to this research's initiation. The objective of the study and the related main research question follows it. The methodology and as well as the results of the study are also briefly mentioned. Section 2 is the Literature Review. This section serves as an example of a thorough and long-range literature evaluation. Section 3 delivers the Conceptual Framework. The study's survey-based methodology and design are explained in this section. Section 4 is titled "The Current Energy Crisis". This chapter provides a general outlook on the present situation in the energy domain and identifies the concepts related to the topic to develop a more holistic understanding of the subject matter. Section 5 is the Analysis. The data gathered from the survey has been thoroughly evaluated in this section. The final section is 6; Discussion and Policy Recommendations. This chapter aims to provide insights into how the current energy crisis affects people's driving behavior and attitudes toward energy conservation, which may have important implications for the country's energy policy and conservation efforts.

CHAPTER 2: LITERATURE REVIEW

Most of the scientific materials utilized in the literature review came from the journals listed in the databases like; Elsevier / Science Direct, Scopus, Taylor and Francis, Springer, Wiley, SAGE Journals, and JSTOR. A comprehensive investigation into the effects of increasing fuel prices on driver behavior was conducted, involving a review of over 200 articles. From this exhaustive analysis, 50 to-the-point articles were selected and employed as references, ensuring a robust foundation for the research. The selected sources encompassed diverse disciplines, with a predominant focus on social sciences and humanities. The following are the primary keywords utilized in the literature review; “fuel prices”, “gasoline prices”, “rising fuel prices”, “rising gasoline prices”, “energy prices”, “energy crisis”, “fuel price elasticity”, “private transportation”, “public transportation”, “ridership”, “travel behavior”, “modal shift”, “electric vehicles (EV)”, “alternative fuel vehicles”… There is substantial research to explore how consumers respond to fluctuating or rising fuel prices. The literature research showed plenty of meta-analyses, surveys, time-series analyses, and other methods of research that have been done to look at the potential travel response to changes in energy and especially fuel prices. For example, Pitts, Willenborg, and Sherrell (1981) summarize the reaction to pump price hikes:

> "*Many adaptation alternatives exist. For example, consumers could cut back on driving, buy more efficient vehicles, seek the lowest-priced gasoline, increase relative usage of the more efficient vehicle(s) in multivehicle households, drive at reduced speeds, or do nothing at all.*”

Among others, Chi et al. (2013) also confirm that increases in gasoline prices have a distinct impact on its consumption. Reducing vehicle travel is related to reducing gasoline usage. Diminishing the number of trips, switching from private vehicles to public transportation, driving more fuel-efficiently, using more fuel-efficient vehicles, transforming frequently made short-distance trips into multi-purpose trips, and moving closer to important destinations (like workplaces) are just a few ways to accomplish it. In summary, this introduction provides a glimpse into the vast body of literature exploring the effects of increasing fuel prices on household behavior, hinting at the

insights and findings to be presented in the upcoming subsections where a more structured, comprehensive, and detailed analysis of the selected sources will be delivered.

2.1. Change in Distance Traveled

Within the literature, since the oil crises of the 70s, a wealth of studies have been devoted to examining the intricate relationship between fuel prices and consumer fuel demand, focusing on the concept of fuel price elasticity and its implications on consumer behavior.

One of the early studies made by Corsi and Harvey (1975) in the aftermath of the Arab embargo reasoned that oil crises in the US expose that only extreme increases in fuel prices modify the transport behavior of the households. Moderate and small increases do not necessarily significantly affect travel patterns. Willenborg and Pitts (1977)'s research showed that rising gasoline costs did not dissuade drivers, even during brisk and persistent price hikes. Barnaby and Reizenstein (1977)'s research in the same year confirms that fuel consumption is price inelastic for many people. According to Puller and Greening (1999), demand for gasoline tends to be somewhat resistant to change in the short term after a change in gasoline prices. However, households tend to reduce the miles they drive the following year.

On the other hand, based on numerous research and meta-analysis, the price elasticity of demand for fuel is negative, which means a price increase in fuel results in reduced demand for it (Graham and Glaister, 2002). Goodwin, Dargay and Hanly (2004)'s meta-analysis confirms the finding that the price elasticity of demand for fuel is negative. Kennedy, Wallis, and Hamilton (2007)'s report shows the highway traffic declined due to an increase in petrol prices, indicating fewer people hit the road with their cars. According to Erath and Axhausen (2010), people respond to higher fuel prices by reducing mileage. As mentioned above Chi et al. (2013) also confirms that increases in gasoline prices have a distinct impact on its consumption. Reducing vehicle travel is related to reducing gasoline usage. Gillingham (2014) also came up with a negative vehicle-miles-traveled (VMT) elasticity in the medium run.

Interestingly, although Wang and Chen's (2013) research confirms the negative price elasticity and less VMT, they, along with Hymel and Small (2015), also determine that a rebound-effect is visible when the price rises and describe the rebound-effect as;

"an increased level of VMT as the result of an improvement in fuel efficiency".

This is why higher fuel prices incentivize people to buy more fuel-efficient cars; this way, they can drive more for the same amount of money.

Overall, the literature illuminates the complex dynamics between fuel prices and driving habits, developing an understanding that people tend to drive less when fuel prices go up.

2.2. Change in Modal Behaviour

Many studies have identified rising fuel prices as a driver of rising public transportation use and other ways of transportation, such as carpooling.

According to the research conducted by Haire and Machemehl, (2007); there is a correlation between rising fuel prices and the use of public transportation; passengers using various modes of public transport grow when the fuel prices increase. Currie and Phung (2008) further explored the relationship between gasoline price increases and transit ridership growth. As stated by Chi et al. (2011) and Chi et al. (2013) as well as Molloy and Shan (2013), individuals who drive may decide to utilize alternate forms of transportation, such as public transit, carpooling (Ferguson 1997; Bento, Hughes, and Kaffine 2013), biking, or walking, as a result of increased fuel costs. Lane (2010; 2012)'s findings show a relationship between gasoline price fluctuations and ridership. When gasoline prices increase, more people may take public transportation, such as bus or train, instead of driving their cars. Creutzig (2014)'s research reveals that the way people travel changes depending on the fuel cost, and variations in fuel costs result in three distinct modal share schemes. When fuel costs are high, people are more likely to use public transportation. When fuel costs are low, people are likelier to use their

vehicles. When fuel costs are in the middle, people are more likely to use a combination of public transportation and their vehicles. Olsson, Maier and Friman (2019) concluded that gasoline costs impact mode choice, which majorly impacts people's choice to “share the use of a privately owned car for a trip”, and this tendency might be attributed to the fact that fuel prices are the biggest expense of traveling an automobile, or arguably the expense that car owners are most informed of.

On the other hand, during the in-depth interviews of Beirão and Sarsfield Cabral (2007), although the drivers associated fuel cost as the major cost of ownership and an expensive aspect to riding a car compared to public transportation, they did not intend to make a modal shift. The study of Haire and Machemehl (2007) showed that many people are willing to bear higher expenditures for fuel, concluding that financial variables, such as gasoline prices or public transportation fees, are not very effective at modifying transportation behavior. As Erdogdu (2014) demonstrated, increased fuel costs did not lead to a fall in private transportation and an increase in the propensity to use public transit in Turkey. However, it is argued that it might have prevented a further increase in the number of motor vehicles on the roads. According to Urbanek (2021) fuel costs do not significantly influence modal shift behavior.

In conclusion, among the reviewed literature, most of the studies emphasize the significant relationship between rising fuel prices, the growing utilization of public transportation, and the adoption of alternative modes of transportation.

2.3. Fuel Optimization, Vehicle, and Distance-Related Behavioural Change

Reducing the number of kilometers traveled and switching to alternative modes of transportation are not the sole approach to conserving gasoline. The literature reveals various other effective strategies to reduce fuel expenditure through various means.

Corsi and Harvey (1975) investigate individuals' adjustment strategies in response to rising gasoline prices, such as behavioral and distance-related modifications. According to Willenborg and Pitts (1977)’s research, at the time of increasing fuel prices, drivers were reluctant to cut back on driving. However, people started to buy

lower-cylinder cars due to a shift to less fuel-consuming models. Some households switched to smaller cars, while some kept larger cars and bought smaller ones. As mentioned above Pitts, Willenborg and Sherrell (1981) displays the options for adapting elevated gas prices apart from reducing their driving by purchasing more fuel-efficient cars, looking for cheaper gasoline, using the more efficient vehicle(s) more frequently in households with multiple cars, driving at lower speeds, or choosing to take no action. Eltony (1993) model shows that rising fuel prices result in behavioral changes in households, such as; driving fewer miles, purchasing fewer cars, and buying more fuel-efficient cars. An old car of the house is pushed off, and plans of acquiring a new car are either postponed or the new car is redecided as a more energy efficient model, such as diesel cars. Graham and Glaister (2002) found out that when the price of gasoline increases, the traffic jam less than gasoline consumption, which suggests that people somehow reduce gasoline consumption by rather different driving skills or using fuel-efficient technologies such as switching the car or motor type of the car etc.

On the other hand, Goodwin, Dargay, and Hanly (2004) argue that in case of an increase in fuel prices, the volume of traffic and fuel consumption will drop. Nevertheless, fuel consumption will have a slightly greater decrease than the volume of traffic, which is assumed to be related to more efficient use of fuel through possible ways such as; technical improvements in the vehicles, fuel-saving driving skills, and combinations. Jeihani and Sibdari (2010)'s time series analysis revealed that gas prices directly impact customers' choice of car. With rising gas prices, consumers seek to choose more fuel-efficient automobiles. Wang and Chen (2013) found that the rising fuel cost has caused a demand for more fuel-efficient vehicles. Chi et al. (2013) argue that drivers tend to adopt driving behaviors that conserve fuel when the price of gasoline increases. This may involve driving using less fuel, such as accelerating more slowly or maintaining a more consistent speed so that the number of car crashes increases. Gillingham (2014) states;

> "*Consumers can respond to gasoline price shocks on both intensive and extensive margins by changing driving behavior, purchasing a more fuel-efficient vehicle or scrapping an old gas guzzler*."

Jacobsen, (2015) argues that energy prices are not a big concern when purchasing home appliances, but it is when buying a car. According to Whalen (2020)'s survey report on *The State of Automotive and Mobility*, the consumer considered fuel prices when considering buying a new car.

Eltony (1993) pointed out that, in the case of higher fuel prices, households will cut on the distance traveled by various means in the short run and relocate their residences closer to work in the long run. However, Erath and Axhausen's (2010) findings suggest that people are reluctant to relocate residence in the case of fuel price rises. Molloy and Shan (2013) found a small impact of gasoline prices on the choice of house location. According to the research of Chi et al. (2013), transforming frequently made short-distance trips into multi-purpose trips and moving closer to important destinations (like workplaces) are ways to decrease fuel consumption.

To sum up, these diverse strategies provide individuals with a comprehensive toolkit for effectively reducing fuel expenditure and fostering more efficient use of gasoline.

2.4. Focused Research on Gas Prices and Alternative Fuel Vehicles (EV, hybrid, and plug-in hybrid) Relationship

The literature review explores the relationship between gas prices and alternative fuel vehicles, specifically electric vehicles (EVs), hybrids, and plug-in hybrids, shedding light on the dynamics, influences, and implications of gas price fluctuations on the adoption and consumer behavior toward these environmentally friendly transportation alternatives.

Diamond (2009) uncovered that fuel costs and the penetration of hybrid vehicles are strongly correlated. According to the research of Turrentine and Kurani (2007), fuel economy is not a factor that comes to mind first when buying an automobile for the household. However, they propose that fuel prices are not at a level that is challenging the consumer; therefore; if gasoline costs rise sufficiently (proportionally more than the rise of their income), customers will make more calculated, economically logical decisions about fuel economy. Jeihani and Sibdari (2010)'s study also confirm the

previous study. Fuel economy is an important factor in automobile shopping, along with safety, comfort, design, etc. Consumers are turning towards fuel-efficient cars as a response to fluctuations in fuel prices. The trend of fuel-efficient and alternative fuel cars have replaced the rising trend of SUVs in the automotive industry.

Moreover, Noori and Tatari (2016) added the knowledge to the literature that the upward trend in oil prices has catalyzed the growth in EV market shares. A meta-research by Leung et al. (2018) discloses; expensive petroleum fuel may promote the adoption of supplementary technologies such as electric motors, batteries, hydro-fuel cells, etc. Brito et al.'s (2020) study show that fuel price changes generated variations in alternative fuel market shares. Furthermore, today a customer that would not consider buying an EV this soon is encouraged to switch because of the unprecedented fuel prices. Rising energy prices and implementing mandatory emission standards encourage developing energy-saving technologies.

In conclusion, the broad literature review underlines the correlation between gas prices and alternative fuel vehicle adoption. These findings contribute to a better understanding of the interplay between gas prices and the transition to more sustainable transportation options.

2.5. Complementary Research on the Relationship between Energy Prices and Consumption

In addition to the literature discussing fuel prices and individual transportation relationships, the literature also heavily concentrated on the effects of electricity prices on domestic energy consumption, which is quite a parallel concept.

According to many studies on the price elasticity of energy demand, consumers cut back on usage when costs are high. Most of the studies focus on household electricity consumption. (Reyes and Quevedo, 2021; Biresselioğlu et al., 2018; Yalcintas and Kaya, 2017; Yohanis, 2012; Reiss and White, 2008) Electricity expenses are a major concern affecting people's related consumption patterns (Biresselioglu et al., 2019). Reiss and White (2008) study revealed that after a price shock in energy households,

they substantially decreased their consumption by either making behavioral changes in the frequency of utilization of appliances or changing to energy-saving options. Similar to the motivation of reducing costs in case of a price increase, saving money also has an appreciable effect on the energy-saving behaviors of urban residents. Habits regarding electricity consumption take a while. Households either decrease the number of electric appliances or buy energy-efficient appliances in the long run. (Wang et al., 2021). In other words, people modify their habits in favor of energy saving, energy efficiency, etc. According to the research done by Borozan, (2018) majority of the literature shows that energy prices have a significantly negative outturn on consumption. Singh, Mantha, and Phalle's (2018) survey results demonstrated a negative price elasticity to electricity prices.

2.6. Key Variables and Literature Review Matrix

To sum up, in addition to the extensive literature addressing the relationship between fuel prices and individual transportation, a substantial body of research also delves into the effects of electricity prices on domestic energy consumption, highlighting the parallel concept of price influences on energy behavior, thereby emphasizing the broader scope of energy pricing dynamics and their implications for sustainable energy consumption practices. Based on the literature review, the mutually changing transportation-related behaviors in response to fuel price increases can be categorized into six key variables;

1. Change in Distance Traveled
2. Change in Modal Behavior
3. Change in Fuel Optimization Behavior
4. Change in Vehicle-Related Behavior
5. Change in Distance Related Behavior
6. Intention to Buy Alternative Fuel Vehicles

These categories serve as essential indicators or measures of how individuals respond and adapt their transportation-related behaviors in the face of fuel price increases. They provide valuable insights into the changes people make in travel patterns, mode

choices, vehicle-related decisions, and overall approach to fuel consumption. Below is the literature review matrix of the study.

Table 1. Literature Review Matrix

#	Title	In-text Citation	Objective(s)	Methodo-logy	Main Themes / Keywords	Results	Key Variables
1	Motor fuel prices in Turkey	Erdogdu (2014)	to determine Turkey's elasticity of demand for motor fuel	Econo-metric analysis	Model construction and estimation, Fiscal policy, Motor fuel prices	Rising motor fuel costs did not dissuade driver's from private transportation nor had an effect of a growth in public transport use.	Change in Modal Behavior
2	Long term fuel price elasticity: Effects on mobility tool ownership and residential location choice	Erath and Axhausen (2010)	to examine how increasing gasoline prices impact the use and ownership of mobility tools as well as the decision of where to live	Survey		Reduced driving and intention to acquire smaller engines and diesel autos are the primary demand reactions to rising fuel prices. There is a resistance to leaving the existing dwelling when considering a potential influence of gasoline prices on resident location choice.	Change in Distance Travelled, Change in Vehicle Related Behaviour, Change in Distance Related Behaviour
3	Fuel price elasticities of market shares of alternative fuel vehicles in Brazil	Brito et al. (2020)	to examine how different fuel price levels affect the demand for automobiles using gasoline and other fuels (AFVs)	Market share model	Ethanol Flex vehicles Market-share Fuel price elasticity AFV	Different levels of fuel price elasticity are found in the sales various vehicle technology. Elasticity is strong when gasoline and ethanol are competing with one another. The wide availability of flex-fuel cars was considerably aided by advancements in efficiency.	Change in Vehicle Related Behaviour, Intention to buy Alternative Fuel Vehicles
4	The impact of government incentives for hybrid-electric vehicles: Evidence from US states	Diamond (2009)	to explore the effects of incentives offered by government and other measures intended to encourage the adoption of HEVs	Cross-sectional analysis of hybrid registra-tion time series data	Hybrid-electric vehicles, Public policy, Technology diffusion	Fuel prices are more effective in adoption of HEVs than government incentive policies.	Change in Vehicle Related Behaviour, Intention to buy Alternative Fuel Vehicles

Table 1. (Continued)

5	Development of an agent-based model for regional market penetration projections of electric vehicles in the United States	Noori and Tatari (2016)	to estimate potential electric vehicle market share in the US for 2030 and navigate underlying concerns	"Electric Vehicle Regional Market Penetra-tion" tool	Electric vehicle, Market penetration, Inherent uncertainty, Agent-based modeling, Exploratory modeling and analysis	EV (Electric Vehicle) market shares have greatly increased in recent years due to energy insecurity concerns, the increasing trends in oil prices, improvements in electrical power storage, and electricity's current status as the cheapest and most efficient energy source for the transportation sector in the foreseeable future.	Change in Vehicle Related Behaviour, Intention to buy Alternative Fuel Vehicles
6	Elasticities of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review	Goodwin, Dargay and Hanly (2004)	to review the research that has been conducted in the past 30 years on the effects of "price and income on fuel consumption, traffic levels, and other indicators such as fuel efficiency and car ownership"	Meta - analysis		If gasoline prices rise, both the volume of traffic and the amount of fuel consumed will fall. Nonetheless, gasoline consumption is expected to fall somewhat more than the quantity of traffic, which is attributed to more efficient consumption of gasoline via feasible means such as technological advancements in cars, fuel-saving driving skills and mixes.	Change in Energy (Fuel-focused) Related Behaviour, Change in Vehicle RElated Behaviour
7	How fuel prices determine public transport infrastructure, modal shares and urban form	Creutzig (2014)	to understand how public transport costs are affected by fuel prices and urban form and how these factors can affect the use of public transport	Modal share modeling framework	Public transit, Urban form, Modal choice, Urban economics	Variations in fuel costs result in three distinct modal share schemes. Public transportation is the only means of transportation when costs are high; vehicle transportation is the only mode of transportation when costs are low and they are co-existent in case of median fuel prices.	Change in Modal Behavior

Table 1. (Continued)

8	A tale of two tails: Commuting and the fuel price response in driving	Gillingham and Munk-Nielsen (2019)	to show the relationship between public transportation access, fuel prices, and fuel consumption in the US and EU	Rich data analysis	Distributional effects, Transportation Commuting, Urban form, Environmental taxes	Public transportation can help to increase fuel price elasticities by making it more affordable and convenient for people to travel without a car. When people have more affordable and convenient options for travel, they are more likely to change their travel behavior in response to changes in fuel prices	Change in Modal Behavior
9	The Demand for Automobile Fuel: A Survey of Elasticities	Goodwin, Dargay and Hanly (2004)	to yield a state of the art research on internation fuel demand literature	Meta - analysis		the price elasticity of demand of fuel is negative	Change in Distance Travelled
10	Transport Gasoline Demand in Canada	Eltony (1993)	to determine and differentiate between the impacts of various household reactions to a rise or drop in fuel costs	Investment-utilization model		A household that already owns an automobile can respond quickly to a price rise by traveling less kilometers. The household that is going to buy a new automobile may either delay their purchase or pick a more fuel-efficient new car, the household that has an old car may sell it in reaction to increasing gasoline prices, and households can relocate closer to work.	Change in Vehicle Related Behaviour, Change in Distance Related Behavior, Intention to buy Alternative Fuel Vehicles
11	The Impact Of Gas Price Trends On Vehicle Type Choice	Jeihani and Sibdari (2010)	explores if consumers' automotive purchasing habits have altered as a result of fuel price hikes	Regression modeling	Transportation Economics, Traveler Behavior, Gas Price, Demand Elasticity	People's car purchase decision is influenced by fuel prices. People strat to buy fuel-efficient (smaller) automobiles in the case of increased fuel prices (for two periods-long term decision).	Change in Vehicle Related Behaviour, Intention to buy Alternative Fuel Vehicles

Table 1. (Continued)

12	Identifying the elasticity of driving: Evidence from a gasoline price shock in California	Gillingham (2014)	to find out consumer reaction to fuel price fluctutations	Quantile regressions, VMT model (vehicle miles traveled)	Gasoline taxes; Heterogeneity; Urban transportation; Vehicles	10% increase in gasoline price leads to a 2% decrease in VMT in the medium term. In addition, elasticity of VMT with respect to gasoline price is heterogeneous, with wealthier households being more responsive to price changes than less wealthy households.	Change in Distance Travelled, Change in Vehicle Related Behaviour
13	Fuel price changes and their impacts on urban transport – a literature review using bibliometric and content analysis techniques, 1972–2017	Leung et al. (2018)	attention to transportation equality issues, particularly the effects of fuel prices	Meta - analysis	Automobile dependence; energy stress; transport equity; transport and society; fuel price; bibliometric analysis; content analysis	Fuel price changes can be an effective policy tool for reducing VMT, promoting public transport use, and improving air quality	Change in Distance Travelled, Change in Modal Behavior
14	Impact of Rising Fuel Prices on U.S. Transit Ridership	Haire and Machemehl (2007)	to test the hypothesis that increased fuel prices result in ridership growth	Time series analysis		There is a statistically significant correlation between ridership and gasoline prices for every mode of transportation, indicating that energy price rises have certainly played a role in boosting transit usage.	Change in Modal Behavior
15	Potential of modal shift from private cars to public transport: A survey on the commuters' attitudes and willingness to switch –	Haire and Machemehl (2007)	to determine factors influence one's decision of using a personal vehicle and what is the willingness to bear additional costs.	Survey	Private cars Public transport Travel attitudes Travel behaviour Modal shift	Economic variables, such as gasoline prices or public transportation fees, are ineffective at modifying transportation behavior.	Change in Modal Behavior

Table 1. (Continued)

16	The Influence of Socio-Economics on Travel Behavior of Public Transportation in Malaysia	Ngah et al. (2021)	to look at public transportation passengers' travel habits from a socioeconomic standpoint.	Questionnaire, Descriptive analysis	Socio-economics, travel behavior, public transport	A person's degree / educational attainment has a considerable effect on travel behavior, but gender, age, income, and job make little difference.	Demographics
17	Energy-Crisis Travel Behavior and the Transportation Planning Process	Corsi and Harvey (1975)	to explore household adaptation techniques in response to current and projected fuel shortages and price increases.	Questionnaire		Gasoline price rises that are moderate and gradual are not probable to induce major changes in household transportation habits.	Change in Modal Behavior, Change in Vehicle Related Behaviour, Change in Distance Related Behavior
18	The rebound effect for automobile travel: Asymmetric response to price changes and novel features of the 2000s	Hymel and Small (2015)	to determine if the early-2000s instability in the energy sector altered the stability of the elasticity of light-duty car travel with regard to fuel cost, known as the "rebound effect."	Simultaneous equations methodology	Rebound effect, VMT elasticity, Gasoline demand, Asymmetric response	The findings are consistent with previous findings of a rebound effect that decreases in magnitude with wealth. The rebound effect is substantially stronger in times when fuel prices rise than in years when they decline. It is also stronger during periods of press coverage and volatility in the market.	Change in Distance Travelled, Change in Distance Related Behavior
19	The State of Automotive and Mobility	Whalen (2022)	to see the way individuals buy and operate cars after the pandemic and look at important developments in vehicle commerce, electrification,	Survey		Gas costs have continuously risen, worsened by the Ukrainian war context, consequently, people have begun making alterations in their driving habits. When thinking of the acquisition of next car, the cost of fuel is an important factor.	Change in Vehicle Related Behavior

Table 1. (Continued)

20	A time-series analysis of gasoline prices and public transportation in US metropolitan areas	Lane (2012)	to investigate the seasonal nature of the link between using mass transit and fuel costs.	Time-series analyses	Travel cost, Time-series analysis, Mass transit, Fuel cost, Travel behavior	Fuel costs cause a minor but constant amount of variation in public transportation usage.	Change in Modal Behavior
21	Understanding attitudes towards public transport and private car: A qualitative study	Beirão and Sarsfield Cabral (2007)	to get a clearer picture of people's attitudes about transportation and to investigate assessments of the quality of public transportation services.	In-depth interview	Service quality; Travel attitudes; Public transport; Private car; Qualitative research; Portugal	Many things impact transportation preference, including one's personality and way of life, the nature of travel, the alleged performance of each kind of transportation, and contextual circumstances.	Change in Modal Behavior
22	Domestic energy use and householders' energy behaviour	Yohanis (2012)	to examine residential energy usage and energy behavior, thus the impacts of electricity costs and habits on the use of electricity behavior, that is important in determining the basis of electricity consumption patterns.	Question-naire	Household energy efficiency, Appliances, Interventions	Although good practices in the use of electricity in homes are being implemented, real usage is increasing. Cost is the most important factor in energy-related considerations when buying appliances for the home. Energy behavior continues to evolve, but awareness requires more work.	

Table 1. (Continued)

23	Electricity price and habits: Which would affect household electricity consumption?	Wang et al. (2021)	to investigate the impact of energy costs and habits on energy use.	Economic statistics and question-naire	Electricity consumption Electricity price Habits Household	Because habits about energy usage cannot be altered instantly, home power consumption does not change immediately once the price of electricity increases. Residents' power use habits are gradually changing. This lagging adjustment process may also represent limited rational decision-making behavior; that is, inhabitants get knowledge but are constrained by their habits in making judgments. However, people may maximize their household utility in the long run by modifying their behaviors, such as reducing the number of household appliances or using energy-saving products.	
24	What are the preferences of household energy use in Pakistan?: Findings from a national survey	Biresselioglu et al. (2019)	to understand Pakistani home consumers' attitudes and awareness associated with electricity consumption, as well as the extent of relationship between this awareness and their actual preferences and behavior.	Survey	Household consumers Energy-related preferences Pakistan Survey Developing country	The findings indicate considerable disparities in Pakistani families' understanding of energy-related concerns such as energy efficiency and conservation, as well as their opinions of the necessity to take action on these issues.	

Table 1. (Continued)

25	Regional-level household energy consumption determinants: The European perspective	Borozan (2018)	to discover the factors that influence home use of power.	Panel data are collected from the Eurostat database data are annual, covering the period from 2005 to 2013, for 12 EU Member States	Energy consumption Households EU regions Panel analysis	The literature on the influence of energy costs on home energy usage is likewise equivocal. Some studies found a considerable negative effect, while others found that, at least in the short run, power consumption is not highly sensitive to price fluctuations, owing to electricity-related subsidies and their gradual growth trend. There is a little indication that power costs influence consumers' inclination to buy high-efficiency products. Electricity costs and the recession appear to be key drivers of energy use in developing countries. All else being equal, the data demonstrate that greater utility costs or an increasingly severe economic crisis lead to decreased energy consumption.	
26	Do energy prices influence investment in energy efficiency? Evidence from energy star appliances	Jacobsen (2015)	to find the link between energy costs and investment in energy efficiency, consider if customers respond to price changes by seeking out higher-efficiency items	State-year level panel data on electricity prices and appliance sales patterns	Energy efficiency Energy Star Appliances Electricity prices Energy efficiency gap Energy efficiency paradox	Consumer purchasing of Energy Star appliances is unaffected by energy costs.	

Table 1. (Continued)

27	Comparative Assessment Report on European Energy Lifestyles Report	Biresselioğlu et al. (2018)	to give a more methodical viewpoint on decisions and behavioral choices related to energy, made by the people who are members of communities (meso-perspective).	Survey and data analysis			
28	An Exploratory Analysis for Household Energy Consumption and Conservation	Reyes and Quevedo (2021)	To statistically determine which of the limited and impacted factors has an impact on the electricity bill.	Survey	Energy Consumption; Energy Conservation; Filipino Household; Philippine Electricity; Behavioral Attribute	The demographics and the use of appliances account for a quarter of the variation in electricity bill, while the type of dwelling and behavioral characteristics of the occupants account for very small fraction, of the variation in electricity bills.	
29	Roles of income, price and household size on residential electricity consumption: Comparison of Hawaii with similar climate zone states	Yalcintas and Kaya (2017)	to look at what influences how much power is used at home.	Data from Hawaii Data Book linear regression	Residential electricity consumption Income Price Household size	A key factor influencing domestic power consumption is the proportion of per capita electricity bills to per capita income. This is due to the fact that the impact of installed energy efficient technology and regulations is overshadowed by a decline in the buying power of home electricity.	

Table 1. (Continued)

30	Characterizing domestic electricity consumption in the Indian urban household sector	Singh, Mantha and Phalle (2018)	to look at how much electricity is used in metropolitan houses due to big power users like air conditioners, refrigerators, and electric water heaters	Questionnaire, regression analysis	India, Residential electricity consumption, Dwelling factors, Home appliance, Energy efficiency	Demographic factors and electricity use have a positive weak correlation. There is a responsiveness to electricity prices; price elasticity of (-0.72) and further boost in the pricing can encourage the use of additional power-saving measures.	
31	What changes energy consumption? Prices and public pressures	Reiss and White (2008)	to present proof of how energy use reacts to price shocks as well as public pressure.	consumer's monthly bill: total electricity consumption, billing period dates, line-item charges, taxes, any special discounts or rebates,		Regulators prevent significant and relatively immediate modifications in consumers' use of electricity behavior when they restrict price rises after disruptions in supply.	
32	Gasoline Prices: Their Effect on Consumer Behavior and Attitudes	Willenborg and Pitts (1977)	to assess the effectiveness of the pricing mechanism in decreasing fuel use.	Questionnaire		Even during a period of extremely fast and consistent price rises, the price mechanism was unable to dissuade consumers.	Change in Distance Travelled, Change in Vehicle Related Behavior
33	Gasoline prices and their relationship to drunk-driving crashes	Chi et al. (2011)	to find out the relationship between fuel prices and accidents related to driving with alcohol consumed.	Regression analyses	Drunk-driving crashes, Gasoline prices, Alcohol consumption	When gasoline prices are higher, there are fewer drunk-driving crashes.	
34	The Effect of Gasoline Prices on Household Location	Molloy and Shan (2013)	to find out the relationship between fuel prices and real estate market.	Difference in difference approach		A hike in fuel prices decrease the demand for housing in locations that is far away from business relative to locations closer to jobs, but this is a small effect.	Change in Distance Related Behavior

Table 1. (Continued)

35	Understanding Links between Transit Ridership and Gasoline Prices: Evidence from the United States and Australia	Currie and Phung (2008)	to find out the factors affecting public transport usage.	Disaggre-gate analysis		There is a relationship between guel price increases and the demand for public transportation.	Change in Modal Behavior
36	Transit Ridership, Auto Gas Prices, and World Events: New Drivers of Change?	Currie and Phung (2007)	to provide a review of the published studies on the impact of fuel prices on public transportation demand across modal markets.	Constant elasticity model and World events model		1.2% more people use public transportation when fuel prices rise by 10%.	Change in Modal Behavior
37	Carpooling and driver responses to fuel price changes: Evidence from traffic flows in Los Angeles	Bento, Hughes and Kaffine (2013)	to find out if people react to changes in gasoline prices by carpooling and other responses related to driving	Simple theoretical model	Gasoline prices, Traffic congestion, Carpooling	Increasing gasoline prices cause flows in high occupancy vehicle lanes to rise while decreasing the number of vehicles in regular lanes.	Change in Modal Behavior
38	Why Do They Ride with Others? Meta-Analysis of Factors Influencing Travelers to Carpool	Olsson, Maier and Friman (2019)	to examine consumer attributes, motivations, and demotivations towards carpooling	Meta-analysis	behavior; carpool; effect size; intervention; motivation; meta-analysis	The demographic and socioeconomic factors that influence carpooling are only slightly correlated, and mental factors including cost- and time-saving advantages, mitigating traffic, and ecological worries are starting to take center stage. The expenses for gasoline have an impact on mode selection.	Change in Modal Behavior

Table 1. (Continued)

39	The rise and fall of the American carpool: 1970–1990	Ferguson (1997)	to examine the factors associated to downturn trend in carpooling among commuters.	Data analysis	carpools, education, family income, fuel economy, gasoline prices, vehicle availability	The most important factors associated with recent declines in carpooling to and from work include increasing household vehicle availability, falling real marginal fuel costs, and higher average educational attainments among commuters.	Change in Modal Behavior
40	Impact of fuel price on vehicle miles traveled (VMT): do the poor respond in the same way as the rich?	Wang and Chen (2013)	to find out if the fluctutations in gasoline prices effect different households among different income groups by looking at the differences of fuel price elasticity of VMT.	Structural equations	Vehicle miles travelled (VMT), Fuel efficiency, Fuel (gasoline) price, Income, Structural equations	Compared to lower income families, households with greater earnings have larger fuel price elasticity.	Change in Distance Travelled
41	Impacts of fuel price changes on New Zealand transport	Kennedy, Wallis and Hamilton (2007)	to measure the effect of fluctutation in energy prices on its demand, the trafic density and ridership	Econo-metric analysis	bus services, carless days, diesel, econometric, elasticity, fuel, GDP per capita, international fuel consumption, modelling, petrol, price, public transport	Energy price fluctutations effect on highwat traffic density is distinguishable in the long-run (after the first year)	Change in Distance Travelled
42	Car buyers and fuel economy?	Turrentine and Kurani (2007)	to find out people's perceptions and behaviours towards fuel economy.	Semi-structured interviews	Fuel economy, Fuel efficiency, Automobiles, Car buyers	In the near past, consumer's car purchase decisions didn't need much involvement. But, if the energy prices were to increase, then the consumers are expected to consider fuel economy.	Change in Vehicle Related Behavior

Table 1. (Continued)

43	Gasoline demand and car choice: estimating gasoline demand using household information	Kayser (2000)	to develop calculations on demand and its elasticies regarding fuel	Joint decision model	Gasoline consumption; Energy; Price elasticity	There is not much difference of price elasticity (in short-run) for fuel use across individuals.	Change in Distance Travelled
44	Consumer Adaptation to Gasoline Price Increases	Pitts, Willenborg and Sherrell (1981)	to extend the knowledge on people's reaction to increased fuel prices in case of its supply dicrepancy.	Adaptive behavior framework		Fuel price hikes and vehşcle shortages resulted in adaptive consumer behavior.	Change in Distance Travelled, Change in Vehicle Related Behavior
45	Consumer Attitudes and Approaches to Gasoline Conservation	Barnaby and Reizenstein (1977)	to investigate the potential impact of rising gasoline prices on consumer behavior	Survey		The study's findings suggest that people are more likely to reduce their gasoline consumption when the price of gasoline increases. However, a significant number of people are not price-sensitive and will not reduce their gasoline consumption, even if the price increases significantly. This information can be helpful for businesses and policymakers who are trying to understand how changes in gasoline prices will affect consumer behavior.	

Table 1. (Continued)

46	Household adjustment to gasoline price change: an analysis using 9 years of US survey data	Puller and Greening (1999)	to examine the dynamics and composition of household adjustment to changes in the real price of gasoline to look at how households adjust their driving behavior, vehicle ownership, and other transportation related expenses in response to changes in gasoline prices and how different household 26haracteristic, such as income, wealth, and location, affect it	Model of gasoline demand	Energy; Gasoline demand; Consumer behavior	Gasoline demand is slow to change in response to price changes (relatively inelastic in short-run). However, in the year after a price change, households reduce the amount of driving (VMT) they do and the fuel efficiency of their vehicles. This can be done by altering driving and maintenance behavior or by changing household vehicle stock driving habits, such as buying more fuel-efficient vehicles or by selling older, less fuel-efficient vehicles.	Change in Distance Travelled, Change in Fuel Optimization Behavor, Change in Vehicle Related Behavior
47	The impact of gasoline price changes on traffic safety: a time geography explanation	Chi et al. (2013)	to explain the impact of gasoline price changes on traffic safety	Time geography theory	Time geography, Gasoline prices, Traffic safety, Traffic crashes, Fatal crashes, Space–time path	Gasoline price increases can lead to a decrease in the number of all types of traffic crashes. However, the decrease is more pronounced for less severe crashes than for fatal crashes(neglagible).	Change in Distance Travelled, Change in Modal Behavior, Change in Fuel Optimization Behavor, Change in Vehicle Related Behavior, Change in Distance Related Behvaior

Table 1. (Continued)

48	The relationship between recent gasoline price fluctuations and transit ridership in major US cities	Lane (2010)	to look at how changes in gasoline prices affect the number of people who use public transportation.	Regression analysis	Public transportation, FuelCost, Mode choice, Urban areas	Even though the change is small, there is a significant relationship between changes in gasoline prices and public transportation ridership.	Change in Modal Behavior
49	Investigating the Effect of Gasoline Prices on Transit Ridership and Unobserved Heterogeneity	Jung, Yu and Kwon (2016)	to determine how gasoline prices affect people's decisions about whether to drive their own car or take public transportation.	Empirical analyses	Public transit ridership, private vehicle use, gasoline prices, heterogeneity	During a period of rising gasoline prices, low-income group reduced their gasoline consumption and increased their use of public transportation. High-income group, who are more likely to be committed to driving, maintained relatively inelastic demand for gasoline and public transportation.	Change in Modal Behavior
50	Automobile Fuel Economy: What is it worth?	Espey and Nair (2005)	to find out if consumers consider fuel economy importantly.	Hedonic price analysis model		People have willingness to pay more for cars with better fuel economy, indicating that they value the savings on fuel costs.	Change in Vehicle Related Behavior

CHAPTER 3: CONCEPTUAL FRAMEWORK

A thorough review of the literature is conducted on changing fuel prices, transportation behavior, and the transition to cleaner modes of transportation. Theories, key concepts, and models that can help to develop a conceptual framework are identified.

3.1. Theoretical Model & Key variables & Propositions and Research Questions

What makes the price of petrol exert such a strong influence over us? Fuel is a unique consumer good that one is exposed to its price tag all the time, even when she is not even shopping. Fuel prices constantly stare the consumer in the face while passing through a gas station. Basic economic theory assumes that demand is expected to fall as prices for commodities increase. (Wang and Chen, 2013) By either spending less, buying different items, or putting off their purchasing. However, fuel is one of the goods that does not have many alternatives, making it difficult to replace. People are dependent on fuel in many daily routines. For instance, it is impossible to work from home until the gas price decreases if your job is on-site or drop-off the children to school just three days a week. Therefore, she is bound by constraints even if one wants to reduce consumption. Accordingly, in the case of rising fuel prices, it might be expected for people to reduce driving and use alternative ways of transportation such as using public transportation or maintain their driving through various strategies to buy less fuel such as buying more fuel-efficient automobiles etc.

Based on this study's research questions and literature review, the key variables that will be studied are identified. These include rising fuel prices, changing transportation behavior, and cleaner modes of transportation, as well as demographic factors that may influence these variables. Building on the work of Corsi and Harvey (1975), the mutually changing transportation-related behaviors as a response to fuel price increases that appeared through the literature review are categorized into different types. These behavioral change categories include;

- "**Change in Distance Traveled (Vehicle Miles Traveled (VMT))**" corresponds to a change in kilometers driven or driving frequency that resulted from increased fuel prices.
- "**Change in Modal Behavior**" corresponds to a shift from private transportation to public transportation and alternative modes of transportation.
- "**Change in Fuel Optimization Behavior**" corresponds to acts of driving associated with cost-saving and energy efficiency related to fuel consumption.
- "**Change in Vehicle Related Behavior**" corresponds to decisions related to ownership, purchase/sell, and type of the car/fleet etc.
- "**Change in Distance Related Behavior**" corresponds to living adjustments related to minimizing driving.
- "**Intention to Buy Alternative Fuel Vehicles**" corresponds to individuals' willingness or plans to purchase vehicles that run on alternative fuel to diminish reliance on (fossil) fuel.

After the key variables are identified, a conceptual framework is constructed inspired by the conceptual framework model of Chi et al. (2013). By creating a conceptual framework, the literature determines and inspires assumptions. The steps followed when using the conceptual framework to identify assumptions are as follows; key concepts are identified in the conceptual framework, and their relationships are reviewed. Based on the information obtained from the literature review, the expected relationships between these key concepts are determined. Based on the relationships identified, assumptions are made.

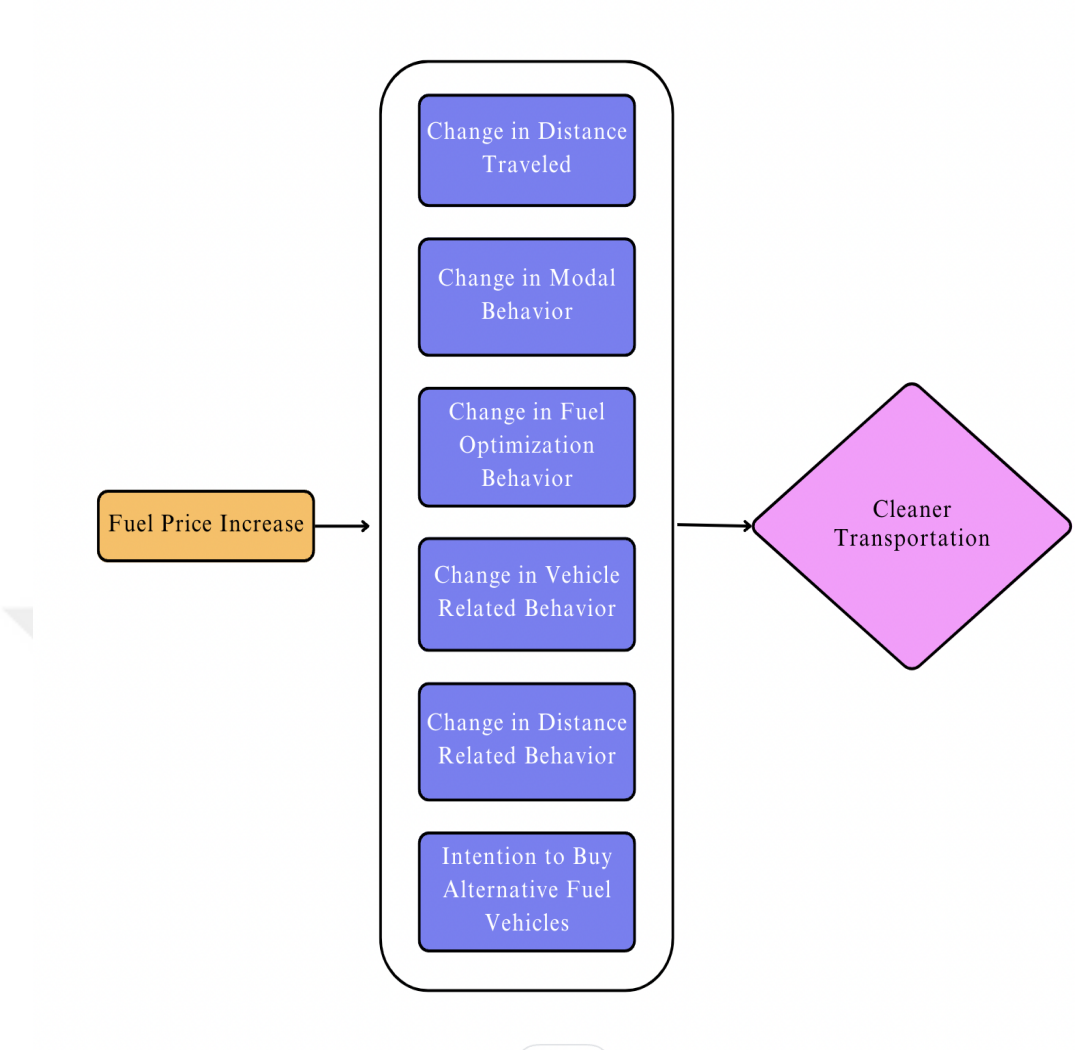

Figure 1. Conceptual Framework

Inspired by the research design of the studies in the literature (such as Biresselioglu et al., 2017 and Ye et al., 2021); certain propositions related to the identified vital variables are made. In this context, the assumption is that the findings in the literature will also be valid in this study.

Table 2. Key Variables and Propositions

Key Variables	**Propositions**
Change in Distance Traveled	P1: People are expected to drive less when gas prices are higher.
Change in Modal Behaviour	P2: To save money on fuel prices, some people may switch from driving the vehicle to public transportation and other modes.
Change in Fuel Optimization Behavior	P3: Drivers may change their driving habits to maximize fuel efficiency.
Change in Vehicle-Related Behaviour	P4: People might change their vehicle-related behavior in response to higher fuel prices.
Change in Distance Related Behaviour	P5: When fuel prices rise, many people may reduce driving via distance-related strategies.
Intention to Buy Alternative Fuel Vehicles	P6: Higher fuel prices may push people's alternative vehicle purchase intention.

3.2. Methodology

Based on the literature review, it was observed that a survey was conducted to collect primary data in similar studies. Therefore survey methodology is a suitable choice for the research (Corsi and Harvey, 1975; Willenborg and Pitts, 1977; Barnaby and Reizenstein, 1977; Erath and Axhausen, 2010; Yohanis, 2012; Wang et al., 2021; Biresselioğlu et al., 2018; Biresselioglu et al., 2019; Reyes and Quevedo, 2021; Singh, Mantha and Phalle, 2018; Urbanek, 2021; Ngah et al., 2021). Social scientists back in

the 1930s and 40s consulted a sample of the universe to collect data for social inquiry. The survey became a tool for empirical research starting from that time and today is practiced in many related disciplines as well (Bennett and Charles Young Glock, 1967). Surveys can measure attitudes and behaviors, providing a comprehensive understanding of how rising fuel prices have affected people's modal behavior and their transition to cleaner transportation. Among other reasons for choosing the survey method, there are advantages in terms of being well-suited for digitizing and analyzing data and in terms of reaching a large sample in the universe in a short time and from a distance that is easy to administer (i.e., remotely) and cheap (de Leeuw, 2005). Surveys use standardized questionnaires that allow for systematic and consistent data collection, improving the results' reliability and validity (Tourangeau and Smith, 1996).

It is unachievable to ask questions to every universe member; therefore, selecting a representative population subgroup is very important (Fowler, 2014). The study sample was determined as convenience sampling as it can be undertaken in less time, achieved without great effort, and cost less (Stolovitch, Keeps and For, 1992). According to Etikan, Musa and Alkassim (2016),

> "*Convenience sampling methods place primary emphasis on generalizability (i.e., ensuring that the knowledge gained is representative of the population from which the sample was drawn)*".

Within the scope of convenience sampling, opinions of citizens representing different age, gender, socio-economic, etc. groups were consulted. İzmir, Turkey, is worth applying a survey on how people respond to rising fuel prices and whether they have switched to more sustainable modes of transport because; İzmir is the third biggest metropolitan city in Turkey with a diverse population in terms of demographics. The city has a well-developed, integrated public transportation network (bus-ferry-subway-suburban train-tram) and a wide range of roads and highways, facilitating studying the effect of rising fuel prices on transportation behaviors. Moreover, İzmir is famous for having environmental consciousness, and its municipal policies encourage a greener lifestyle and sustainable transportation through promoting and building upon public transportation; trams, electric buses, bike lanes (scenic cycling

routes), EV charging stations, transforming the municipal fleet to Electric Vehicles etc. (İzmir Metropolitan Municipality Department of Climate Change and Environmental Protection, Control Directorate of Climate Change and Clean Energy et al., 2020) This makes İzmir a suitable choice to investigate transition to cleaner transportation. (Egercioğlu and Doğan, 2016)

To confirm content and face validity, a pretest was conveyed with five researchers in the same field and five respondents that matched the sample criteria. Multiple channels were employed to reach a diverse range of participants to distribute the research survey. The link to the final version of the survey, created using Google Forms, was sent through: email, WhatsApp, and LinkedIn. A list of relevant contacts, including colleagues, professionals in the field, and various WhatsApp groups, including academic groups, professional networks, etc. were reached. Additionally, to achieve a larger number of participants, a snowball technique was employed during the survey distribution. This technique involved leveraging existing participants to expand the survey's reach to a broader audience. A certain group of respondents who received the link via the abovementioned mediums were asked to complete the survey and forward the link to others who fit the sampling criteria and might be interested in participating. By employing a multi-faceted approach involving email, WhatsApp, and LinkedIn, as well as the snowball technique, it was aimed to ensure a high response rate and a diverse pool of participants. This distribution strategy facilitated easy access to the survey and enabled engaging individuals from different backgrounds and professional spheres, thereby enhancing the overall quality and breadth of the research findings. This survey was applied to participants between January 1st and 31st of January. Also, during this monthly period, USD/TRY average was 18.8 (TCMB, 2023), and the average fuel price was TRY 20 for gasoline and TRY 22.6 for diesel (EPDK, 2023).

Over 750 citizens aimed to participate in the study achieving a very satisfactory 73% response rate (Urbanek, 2021). As a result, 550 citizens from İzmir participated in the study. The high response rate enhanced the statistical validity of the study, allowing for a more comprehensive analysis and justified sound conclusions to be drawn (Biresselioglu et al., 2019). According to the demographic results, the age and gender composition of the sample is very representative of İzmir (see Figure 19). However, it is skewed toward high income-and high educational attainment. This bias is attributed

to the survey's aim of investigating the effect of fuel prices on driving behavior and the transition to cleaner modes of transport, therefore targeting people who own cars. With further investigation of the relationship between demographic variables, it is found that high income is correlated to high education (see Table 6), and high education is correlated to car ownership (see Table 7) in this study. In other words, car ownership is therefore associated with high income and education. In addition, the method used to deliver the survey, which is the snowball technique (distributing the survey to a relatively small group of people proposing them to share with their surroundings) could also have led to this outcome as people who referred to participate in the survey were also people like them, reinforcing the bias towards high income and education. While this skewed demographic composition may limit the generalizability of the survey findings to the broader population of İzmir, it is important to restate that the focus of the study was primarily on car owners and their driving behavior. Moreover, it is worth noting that it was expected that the survey also could have reached individuals without cars. Therefore, questions addressed their transportation behavior not to exclude them from the population and include them in the analysis.

During the data analysis and interpretation phase of the survey, IBM SPSS (Version 28) was used as the statistical software. This software package provided the tools and functions to perform comprehensive data analysis and derive meaningful insights from the collected survey data. Different statistical techniques and tests were applied to explore the relationships, patterns, and trends within the data. Descriptive statistics were applied to summarize the main characteristics of the survey responses. Additionally, the software program facilitated the generation of visualizations, such as graphs, to present the findings. These visuals assisted the interpretation of the data, enabling a better understanding of the survey results.

3.3. Survey Design

Questions are the measures of the survey research (Fowler, 2014). Multiple existing research surveys influenced the design and structure of the survey used in this study. While creating the survey, some questions in the literature review were adapted, and the researcher added new questions. (Corsi and Harvey, 1975; Willenborg and Pitts,

1977; Haire and Machemehl, 2007; Whalen, 2022) These works provided valuable insights and ideas incorporated into the new survey. Drawing inspiration from these previous studies enabled me to adopt, modify, or add questions based on their methodologies, concepts, and findings. This approach helped build upon existing knowledge and contributed to the overall quality of the research.

Corsi and Harvey (1975) grouped some key strategies under two types of changes as behavior and distance. The behavior type of change is divided into 3 subgroups;

> "*journey to work, shopping and recreation*". Under journey to work, there are; "*change mode, purchase additional smaller automobiles, trade in larger for smaller automobiles, sell automobiles and do not replace them, postpone the purchase of a second automobile and purchase a motorcycle*".

Under shopping there are;

> "*combining shopping trips and combining shopping with other trips*".

Under recreation there is;

> "*using public transportation for vacation and other recreation*".

Households were asked about which change strategies they had adopted. In the research survey of Willenborg and Pitts (1977) to determine if the price is a potent tool to reduce fuel consumption, respondents were asked whether there was an increase, decrease, or no change in mileage they have driven. A further inquiry in the survey examines if the quantity and content of their household car inventories have changed. The following questions pertain to inventory changes; the number of automobiles, the kind of car replaced (if the fleet mix changed but the overall number of cars per household remained the same), and the number of cylinders.

Moreover, the sample was asked about the necessary price level increase in fuel to cut back on driving. Barnaby and Reizenstein (1977)'s survey is composed of questions about the hypothetical amounts of fuel price increases and consumers' reactions. Haire

and Machemehl (2007)'s survey had questions about demographic features, age, gender, and education. They also questioned what level of monthly expenditure on fuel would make the respondent switch from private transportation to an alternative. People were also asked about the alternative ways of commuting in case of switching from private cars. They also explored the relationship of such choices to demographics, such as income, by Kruskal–Wallis test by ranks, also known as one-way ANOVA in SPSS. Whalen (2022)'s broad survey was particularly interested in the reasons for individual's interest in EVs and their disinterest. In the survey, the motivating factors were listed as,

> "*environmental sustainability, price, quality/reliability, availability of charging stations, vehicle range, cost of maintenance, performance, ease of maintenance, cost of ownership, lack of availability of new gas-powered vehicles"*.

The demotivating factors were listed as;

> "*price, vehicle range, cost of ownership, lack of charging infrastructure, quality/reliability, lack of performance, lack of selection, lack of racing pedigree/heritage"*.

Inspired by the references mentioned above and other survey studies in the literature review, demographic questions are added to the survey to measure the sample validity and any other significant relationship. As mentioned above, building on the work of Corsi and Harvey (1975), the change strategies are categorized into behavior types in the survey. Participants were asked about the specific change strategies they had adopted within these subgroups. Furthermore, in line with Barnaby and Reizenstein's (1977) thus Haire and Machemehl's (2007) surveys, a question regarding the fuel price threshold to quit driving or decrease kilometers driven was added. Drawing from Whalen (2022)'s broad survey, questions related to interest and lack of interest in EV adoption are added. These choices include sustainability, price, quality, trust, range, maintenance, charging station availability, etc.

Table 3. Key Variables, Propositions and Corresponding Questions

Key Variables	Propositions	Questions
Change in Distance Traveled	P1	Q15 & Q16
Change in Modal Behaviour	P2	Q18 & Q20
Change in Fuel Optimization Behavior	P3	Q21
Change in Vehicle-Related Behaviour	P4	Q22
Change in Distance Related Behaviour	P5	Q23
Intention to Buy Alternative Fuel Vehicles	P6	Q24

The survey starts with a brief introductory section outlining the objectives of the study, how the data would be used, and how the responses would remain anonymous. The survey uses two types of questions: multiple-choice questions (some questions allowed multiple responses) and Likert-scale questions (respondents were presented with further price increases regarding the fuel price and asked to rank their likelihood to change driving behavior). The user-friendly interface of Google Forms, the short completion time of the survey (it could potentially be finished in around five minutes), and the method of distribution selected to reach the respondents all contributed to a satisfactory response rate. The survey has various layers meaning that different answers lead participants to different questions. The structure is as follows;

- The first 9 questions regarding demographics which are (Q1) gender, (Q2) age, (Q3) educational level, (Q4) employment characteristics, (Q5) household income, (Q6) community type, (Q7) household size, (Q9) automobile ownership (number) is completed by every single participant who begins the survey.

- (Q9)Automobile ownership (number) is the first parting of the ways of the respondents;

- If the respondent's households do not own a car, they are presented with the question (Q10)Public transportation usage.

    - If the answer to (Q10) is "yes", they continue to (Q11)Which public transportation methods they use. Afterward (Q12)Alternative transportation methods used by the respondent.
    - If the answer (Q10) is "no" they directly skip to (Q12).

- The next question for non-car owners is (Q24)Planning to buy an EV, hybrid, or plug-in hybrid, which is a mutual question for everyone taking the survey.

- If the respondent's household owns a car or more, they are directed to (Q13) the type of car owned. It is followed by (Q14)Monthly fuel expenditure. Then comes (Q15)Perception regarding the level of fuel prices. Next question (Q16)Change in driving frequency is another fork that directs the respondents to different paths

    - If the answer to (Q16) is "not affected" or "increased," then comes (Q17)Amount of price increase required to impact driving habits.
    - If the answer to (Q16) is "decreased", you are skipped to (Q18)Complementary public transportation usage.

        - If the answer to (Q18) is "yes", they continue to (Q19)Which public transportation methods they use. Afterward (Q20), Alternative transportation methods were used by the respondent.
        - If the answer (Q18) is "no" they directly skip to (Q20).

    - Afterward, respondents with decreased driving fill the consecutive questions; (Q21) Fuel-related energy saving and

efficiency strategies, (Q22) Vehicle-related energy saving and efficiency strategies and (Q23) Distance-related energy saving and efficiency strategies.

- The next question that appears for all one or more car owners, regardless of the change in driving habits is (Q24) Planning to buy an EV, hybrid, or plug-in hybrid, which is a mutual question for all people taking the survey. (Q24) again divides the sample into 2 different groups.

    - If the answer to question (24) is “yes” for EV, hybrid, or plug-in hybrid, the respondent fills (25)Factors for considering and (26)Car brand. (Q26) is the least question for them.
    - If the answer to question (24) is “no” or “undecided”; one is skipped to (Q27)Factors for not considering, which is the last question for this group.

CHAPTER 4: CURRENT ENERGY CRISIS

Major milestones in energy distinguish the 21st century. According to The Intergovernmental Panel on Climate Change (IPCC), the world needs to limit anthropogenic global warming by 1.5 degrees celsius urgently. At the 21st Conference of the Parties (COP21) in December 2015, by adopting the first authoritative international instrument, the Paris Agreement, many states committed to reducing greenhouse gas emissions in order to stay well below the 2°C limit of pre-industrial levels (Connors, Pidcock and IPCC, 2018). Many countries who ratified the accord submitted their pledges and declared their roadmaps either through reducing the sources of CO2 emissions or removing them to get to zero-emissions targets by the year 2050.

A recognizable event that will leave a mark in 21st-century energy history is the US Shale Revolution (as renewables were the hit of the 20th century). After shale, the US became the largest oil and gas producer, changing the country's position remarkably on the energy map. US and China engagement has turned into a strategic rivalry, and energy's role is beyond dispute in the newly developing cold war between US vs. Russia and China. Even 30 years after the dissolution of the Soviet Union, the borders are unsettled. The protracted president of Russia, Vladimir Putin came up with the slogan to restore Russian Great Power. Russia is an energy superpower as long as it has customers. Russia and Ukraine have been the center of the natural gas conflict for years, and this conflict has turned into a warship. China and Russia are politically united against US "hegemony." The US and China have been economically interdependent, but after the Covid-19 pandemic, they are slowly decoupling. The Sino-Russian relationship also lies heavily on energy trading, while China needs energy and Russia needs markets. The ever-evolving Chinese order in world politics raises whether the Belt and Road Initiative is economic or geopolitics. The Middle East has been a major world energy supplier, providing one-third of the world's oil. The Middle Eastern oil reserves were challenged with extinction, but now there is a different obstacle: the climate crisis (Yergin, 2021).

A mobility revolution challenges the familiar ecosystem of automobiles; the electric vehicles. Today the focus shifts from peak oil consumption to peak demand, from supply concern to demand concern. In other words, the question has evolved from when will the resources run out to how long the demand will continue to grow. Middle Eastern countries revitalize their economies as they can no longer depend on oil. Climate concerns reshape the energy map, thus the energy transition from fossil fuels to renewables. The automobile and all transportation industries had been a guaranteed market for oil, but climate policies and the automobile technologies such as EVs, mobility as a service, ride sharing/hailing, autonomous cars etc. challenge the world's energy order. In addition, Covid19 has changed energy markets and the future roles of oil dominators such as the US, Saudi Arabia, and Russia.

4.1. The Role of Energy in Global Issues

Energy is a globally interconnected industry. According to the World Bank (2022),

> "*Energy is at the heart of development. Energy makes possible the investments, innovations, and new industries that are the engines of jobs, inclusive growth, and shared prosperity for entire economies.*".

Daniel Yergin's (2021) basic definition of energy security is;

> "*protection of the energy supply chain*".

From 1915 to 1945, while the World passed through wartime, energy security meant national security and fueling the armies. Until the 1970s, energy security was the physical availability of energy, especially oil. Energy security had become a primary concern on the policy agenda following the two oil crises with the understanding of its importance for the entire economy. Regarding resources, international energy security was still basically synonymous with oil security. It was mentioned regarding price level in either "affordable" or "fair" contexts. While Sir Winston Churchill focused on a single resource and many suppliers (early understanding of diversification) from a military perspective during World War 1; after the crises, concerns expanded beyond

oil supply; thus the concept of diversification evolved to resources, suppliers, routes, etc. And more recently, new issues have been discussed regarding sustainability, global warming, energy poverty, and energy transition etc. (Cherp and Jewell, 2014)

During world war, the US was the largest producer and consumer of oil and supplied cheap oil for the world in a relatively stable manner. However, other oil-exporting countries were not content with the pricing and formed the Organization of Petroleum Exporting Countries (OPEC) in 1960 as a counterweight to the concentration of political and economic power of Western oil majors (Demir, 2008). OPEC comprised five major oil-producing countries: Iran, Kuwait, Saudi Arabia, Venezuela, and Iraq (Lorasdağı, 2020).

The period of 50 years marked by energy insecurity began in 1970. Past energy crises were predominantly oil crises, and the Middle East was the mainspring of two oil crises (Energy Charter Secretariat, 2015). Yom Kippur 1973 united the Arab Nations against Israel and its allies. Because nations like the US supported Israel, the Arabs cut production and ceased exporting petroleum to opposing nations. Even though OPEC only controlled half (53%) of the global oil market, shortages led to high prices and impacted the whole oil market. The oil embargo caused shocking increases in prices. As oil was a significant industry input, the inflation rate rose dramatically. The fact that oil-importing countries borrowed from banks and industrialized countries increased interest rates in order to control inflation caused the economic crisis known as the "1973 Oil Crisis". After that, in 1979, workers' protests in Iran caused a halt to oil production, resulting in another price boost. The consequences of the oil shocks were spread out across the world map far wider than the Middle Eastern region where it had primarily sprouted. The crises hit the global economy, the trans-Atlantic and the European domestic relationships etc. No matter petroleum producers or consumers, the two price hikes directly impacted every nation’s domestic economy (Venn, 2002).

> *“We are in the middle of the first global energy crisis. In the Seventies, it was the oil crisis, and now we have an oil crisis, a natural gas crisis, a coal crisis – all prices are skyrocketing, and energy security is a priority for many governments if not all,”*

said the president of the International Energy Agency Dr. Fatih Birol in his speech in Davos in 2022. The Russian Federation's invasion of Ukraine in February 2022 has given birth to many detrimental consequences for the world energy system. It has damaged the supply, routes, and well-established relationship between the trading countries, leading to an immense increase in world energy prices, especially natural gas, and oil. Price increases hurt countries, industries, and households hard (IEA, 2022b).

President Joe Biden quickly announced several sanctions on Russia as the Russian armed forces crossed the Ukrainian borders. However, annoying and turning against president Vladimir Putin has not been a big concern for the United States of America, as their imports from Russia constitute a very small portion of their energy pie. On the other hand, another big player, the European Union (EU), is at the center of the conflict as it heavily depends on relatively cheap and affordable Russian natural resources (Rausser, Strielkowski and Mentel, 2023). Approximately a quarter of the EU's energy needs are imported from Russia which is the principal supplier to the EU of all the key natural resources: natural gas, oil, and coal (Eurostat, 2022).

Table 4. EU's Energy Dependency on Russia (Source: Eurostat, 2022)

Resource	EU Import from Russia Ratio
Natural Gas	41.1%
Oil	25.7%
Coal	52.7%
Total Energy	24.4%

Even so, the EU has positioned itself alongside the USA; against Russia in this "war" and declared that they would decrease their import quantities of natural gas despite the long-term agreements, thus banning Russian oil and coal. This unilateral position, unfortunately, brought the EU extra trouble, as they also had a previous dispute regarding putting the additional Russian-German natural gas pipeline North Stream 2 in use. Russia had already been reducing the gas stream from the pipeline, taking it further in the disguise of technical problems in early summer. Although the demand

was low because of seasonality, summertime gas flow is very strategic for Europe as it is that time of the year to store cheaper gas in favor of supply security and peak demand times in winter for the EU. The obstacle of the gas shortage was overcome for Europe through American LNG cargoes destined to go to Asia. Europe was lucky. Asian demand was lower compared to the previous year due to moderate economic growth and Covid-19 lockdowns, but they were not so lucky regarding the steep price (IEA, 2022b). Where it is just a price crisis for the US; from an EU perspective, it is both a supply and price crisis.

Although it is envisioned as a crisis that emerged because of the invasion attempt of Russian troops in Ukraine, the Covid-19 pandemic already shook the energy sector, and it was unsettled as the Net Zero strategies to abandon fossil fuels to combat climate change were unclear. Fossil fuel companies were demonized because they were held responsible for global warming; therefore, investors and shareholders were disinvesting in carbon-intensive energy resources. On the other hand, renewable energy was a rising trend. Of course, every new investment in cleaning energy was serving a greater good -mitigation of climate change- may be the world was under-planned for the abrupt switch from fossil fuels, which had been the main elements of global production and the economy ever since World War II. Therefore, it is unclear if the pandemic or the Russian-Ukrainian war is the sole proprietor of the current energy crisis. The closures and disrupted supply chains starting with the pandemic, food shortage due to the war in Ukraine, and high inflation, etc., distinguish the current crisis from any time of oil price highs.

Notwithstanding, at where we come today, the risks the energy sector is facing have begun to negatively impact many domains of the world, from big or small economies to financial markets to the future of governments and, most importantly, the daily lives of ordinary people, especially in developing countries with which citizens can least afford it.

4.1.1. Energy Crisis Reflection on Oil Prices

The oil price function has many variables, such as the dynamics of supply and demand, geopolitical and economic events, speculation by investors and traders, and production quotas.

- Supply & Demand: General supply and demand principles are an important factor in the formation of oil prices. (Arezki et al., 2017)

- Geopolitical and Economic Factors: The price of oil reacts to political instability, wars, sanctions, and conflicts in major oil-producing regions. A short history of oil prices is;

  The price was stable until the Arab Oil Embargo in 1972. The unprecedented price increase was protracted with the Iranian Revolution. The price peaked with the major oil producers of the time, Iran and Iraq. In the aftermath, the price had a falling action as the Middle East quit the "swing producer role," which means that they no longer adjusted their production capacity to stabilize the oil price but let the market determine it. The steep fall lasted until the oil-rich neighbor Kuwait was invaded by Iraq in 1990. The numbers fluctuated until the Asian financial crisis, which caused a drop. OPEC reacted by cutting production. Limited supply, in return, started to increase prices, but the 9/11 attacks gave a little break to the revival of the prices. In the consecutive years following, the price spiked due to low spare capacity, scoring an all-time high.

  Nevertheless, the 2007–2008 financial crisis collapsed the oil prices and the global economy. OPEC again put a quota, limiting the production to increase the oil prices. After a while, OPEC did not cut the production, and the total oil inventory grew (also expanding US production), decreasing the prices. Furthermore, due to the Covid-19 lockdowns, oil prices visited record lows of the millennium. However, the recovery from the pandemic was higher-speed than the production capacity's revival. Thus, it was garnished with the war of one of the biggest players in the petroleum market, causing a stark elevation in oil prices like never before. (U.S. Energy Information Administration, 2023)

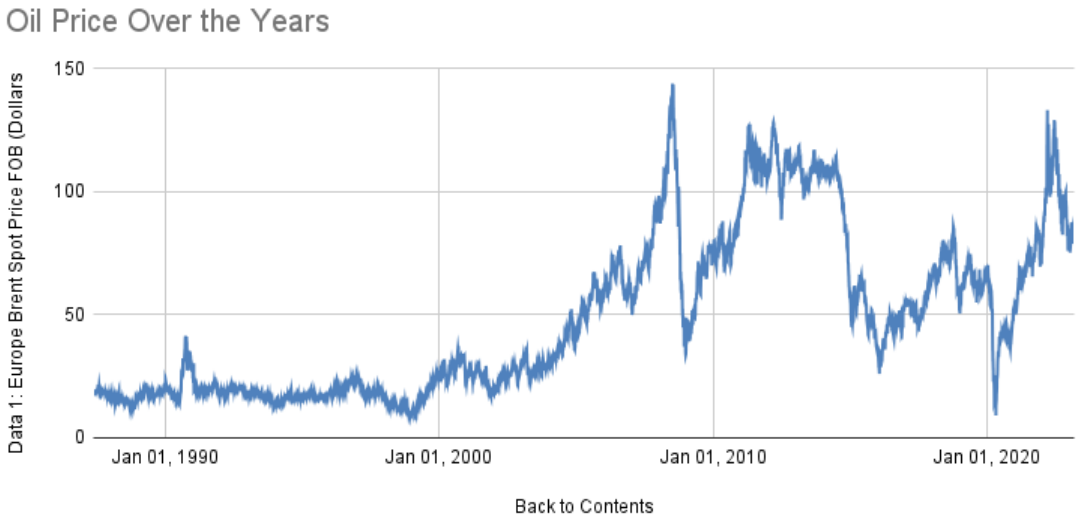

Figure 2. Oil Price Over the Years (Source: EIA, n.d.)

- Speculations: Investors' and traders' prediction of price and related trades affect the fluctuation in price. Different oil markets (WTI, Brent, Mars, Dubai, Tapis) show a similar trend due to arbitrage. (U.S. Energy Information Administration, 2023)

- Production: OPEC and non-OPEC production decisions shape the oil price. (U.S. Energy Information Administration, 2023)

Brent oil, which is priced in USD, rose 60% throughout 2021. In the first months of 2022, the price of a barrel of crude oil exceeded $100 for the first time since 2014.

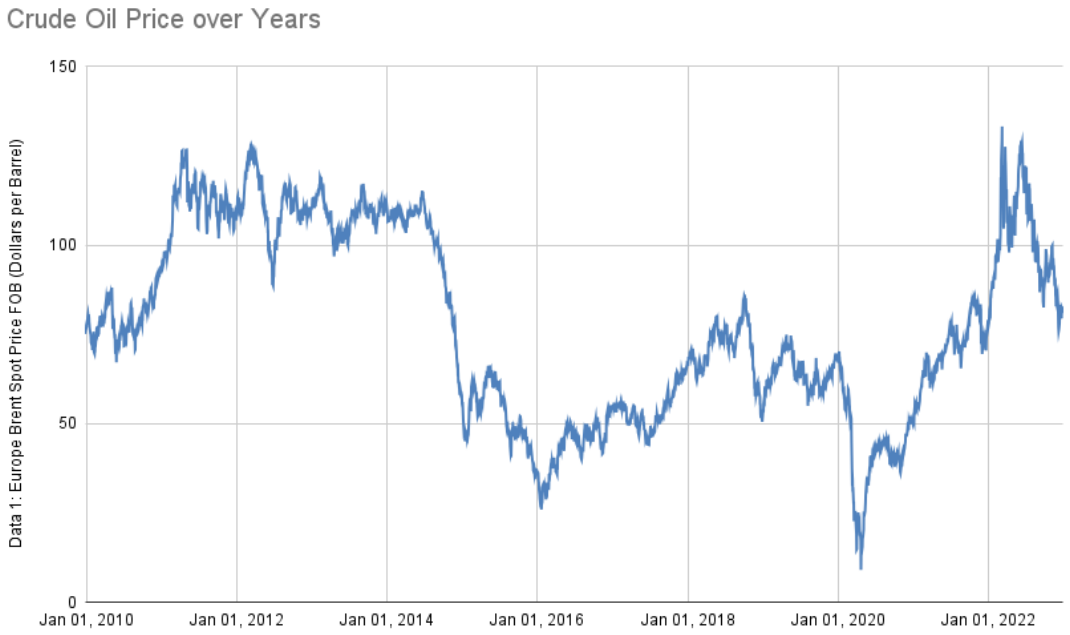

Figure 3. Crude Oil Price Over the Recent Years (Source: EIA, n.d.)

Fuel price is largely composed of the price of crude oil therefore, reacts to the same factors as oil prices, and there are some additional determinants such as refining as well as distribution and transportation costs, taxes, competition, seasonal demand etc. (EIA, 2021)

- Refining Costs: The crude oil needs to go through a process called refining before it is used in vehicles. Refining costs are associated with labor, energy, equipment, and refinery capacity and efficiency.

- Transportation and Distribution Costs: Refined oil - from then on, fuel is transported to hubs and gas stations. The cost of transporting and storing is the combination of distance, mode of transport, and related fees and taxes.

- Taxes: Fuel is a commonly used commodity globally taxed as a way for governments to raise funds and incentivize environmental policies.

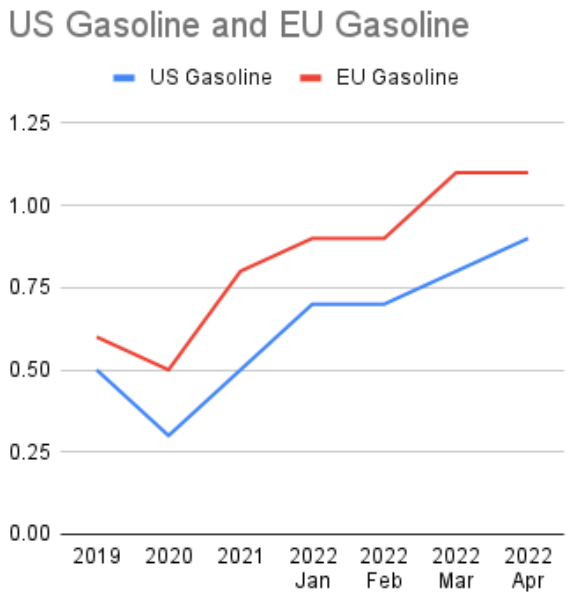

Figure 4. Oil Price Over the Years (Source: IEA, 2022a)

4.1.2. Alternative Fuel Vehicles Deployment (Electric Vehicles)

Unlike their fuel-powered predecessors, internal combustion engines, vehicles that are fully run by electricity are called electric vehicles. EVs can be defined and categorized as below.

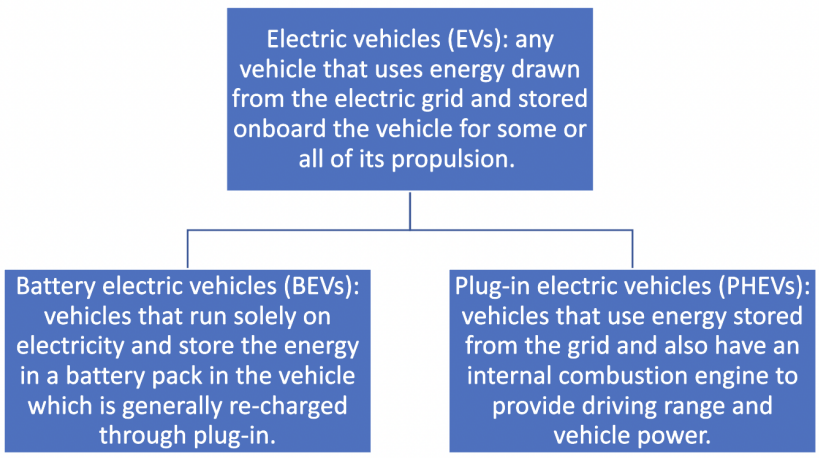

Figure 5. EV Categorization (Source: She et. al., 2017)

Compared to conventional cars, EVs offer environmental benefits to the user. These vehicles are known for not contributing to air pollution and being warriors against the enemy of climate change - zero emission options in mobility. Because of their batteries, EVs do not burn fossil fuels to power the engine. Consequently, no greenhouse gas (especially carbon dioxide) emission occurs.

> "*Electric vehicles are the key technology to decarbonise road transport, a sector that accounts for 16% of global emissions*."

stated the IEA's Report on Electric Vehicles (2022).

EVs offer many other advantages, such as; lower fuel costs, lower maintenance costs, being able to charge at home without going to a station, being the latest technology, performance, silence, brands, design, status etc. (Hardman and Tal, 2016).

Electric vehicles have been around since automobile production began. Robert Davidson built the first practical electric vehicle in Scotland in 1837, producing a truck powered by electro-magnetic motors. This was decades before the internal combustion engine (ICE) was invented. In 1881, electric battery buses were in service in Paris. In the early 20th century, electric vehicle manufacturers competed head-to-head with their emerging fossil-fuel rivals. For example, in 1914, Detroit Taxicab and Transfer Company implemented and operated a fleet of approximately 100 electric taxis. However, the EV was not initially favored as the technology was limited. The ICE cars offered a shorter range and less speed and power than their internal combustion latter. In addition, the growing oil industry and economy influenced the proliferation of the ICEs. Big investments in gasoline infrastructure secured the development of gasoline-powered cars (TAYSAD, 2022).

However, from time to time, the concept of EVs was regenerated. Moreover, these times had common characteristics. These times were the time of the resource crises. In 1973 after the oil crisis, auto manufacturers started to produce cars with smaller ICE engines, and the US federal government established a lowered speed limit. The mentioned actions served the same idea, lowering fuel consumption. At the same time, an electric car named "Citicar" was launched as another response to the 1970s oil

crisis. Citicar had been a best seller until Tesla's Model S. Later, beat it up in the 1990s with the Gulf Crisis, EVs were again brought to the automotive industry's agenda. This time GM designed and prototyped the model "EV1". Despite the high demand in the aftermath of mass production, the distribution was silently sustained, and the cars vanished. The reason for GM stopped the production and destruction of the cars remained a mystery, but of course, there are speculations such as; the oil lobby, the killing of the car care industry, etc. (Who Killed the Electric Car?, 2006)

Over time, advancements in battery technology, environmental concerns, and the desire for sustainable transportation have led to a renewed interest in electric cars. The magical component of EVs is the battery. The lithium-ion batteries are now the solution for the long quest for a lighter and smaller material by scientists and auto manufacturers. In addition, environmental emergencies forced the governments to come together and agree on limiting the atmospheric temperature increase and signed the Paris Agreement in 2016; despite the technological impossibilities, the oil lobbies and habits. In order to reach the climatic targets, one of the primary countermeasures is supporting the proliferation of EVs and promoting cleaner transportation methods. Today, governments are ambitious; the EU has declared 0 emission target with the Green Deal by the year 2030, and the law supports EVs. As a response, this time, the whole automotive industry has entered a new direction called "electrification".

It appears that EVs are now approaching their prime time. Tighter laws aimed at ICEs are causing a genuine change in the era of the climate crisis. Consumer preference for EVs in this century is outpacing the conventional automobile's century-long supremacy due to the EV's superior sustainability advantages. EVs were a long-term concept, not a new one. In order to dominate the future and be sustainable, it is now upgrading itself.

4.2. Turkey's Energy Outlook

Turkey's population has accounted for 84,775,404 people in 2021. The country's GDP was $819.04 billion in 2021 and the GDP per capita was 9,661.2 USD. Turkey ranks as the 19th largest economy in the world (World Bank, n.d.). Turkey is overly reliant

on fossil fuels. According to the Ministry of Energy and Natural Resources data, 28.66% of Turkey's total energy supply in 2020 is petroleum, 27.67% is coal, and 27.05% is natural gas. It is followed by renewables (geothermal, wind and solar) with a share of 9.85%; hydro with a share of 4.56%; and bioenergy, waste and other resources with 2.31% (2022).

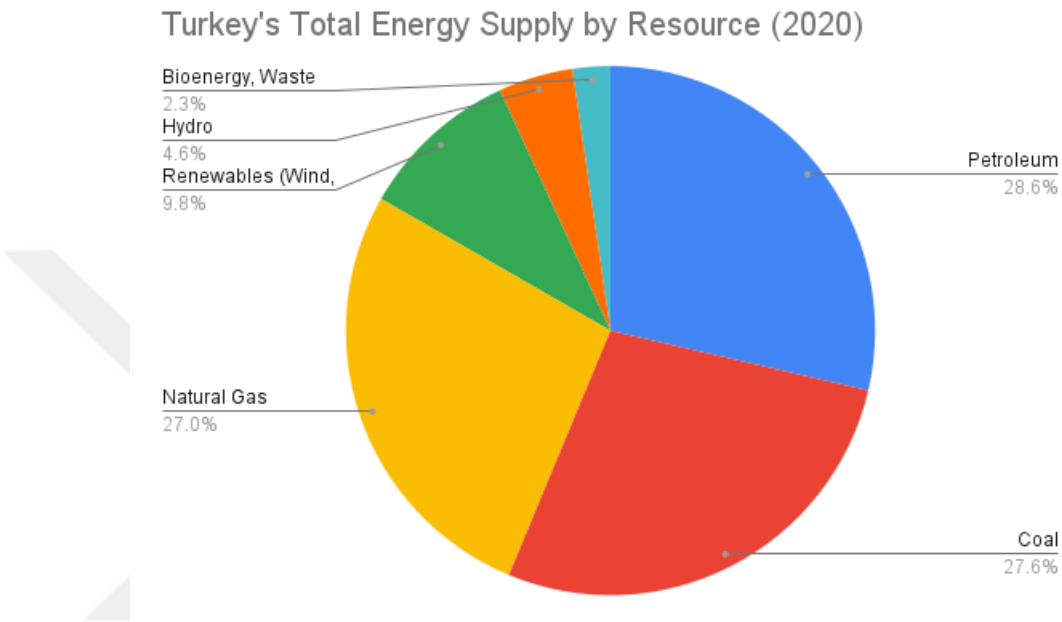

Figure 6. Turkey's Total Energy Supply by Resource 2020 (Source: Ministry of Energy and Natural Resources, 2022)

The industry is the most energy-consuming sector, and it mainly consumes oil. The second energy-intensive sector is transport which is also mostly characterized by oil. Residential and services sectors, on the other hand, predominantly use natural gas and electricity (IEA, 2022c).

In 2021, the primary energy production in Turkey was obtained through coal, geothermal, hydraulic, bioenergy and wastes, oil, wind, wastes, sun, firewood, natural gas and biofuel by 35%, 22%, 10%, 8%,7%, 5%, 5%, 4%, 2%, 1% and 1% respectively.

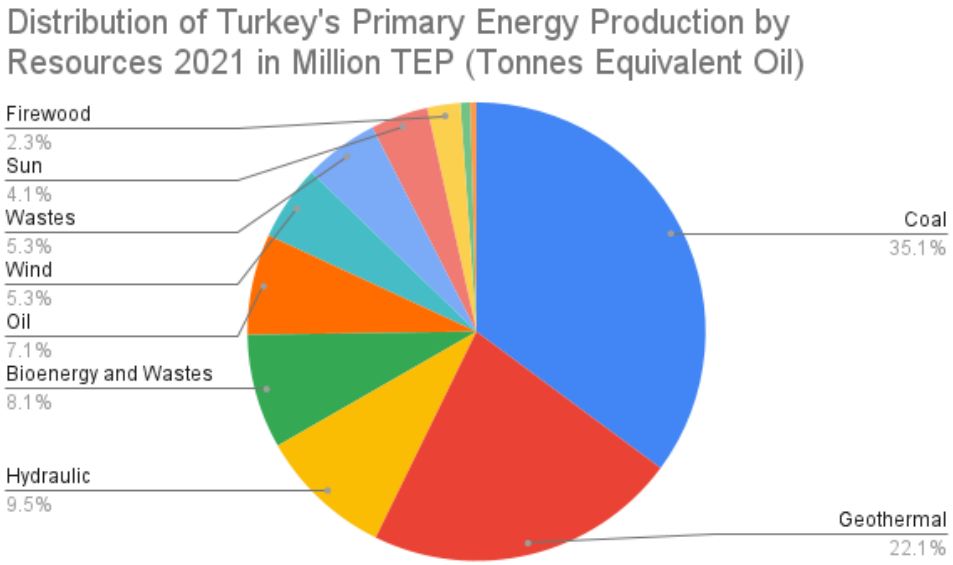

Figure 7. Distribution of Turkey's Primary Energy Production by Resources 2021 in Million Tonnes Equivalent Oil (TEP) (Source: Ministry of Energy and Natural Resources, 2022)

In addition, in 2021, coal accounted for 30.9% of Turkey's electricity output, followed by natural gas at 33.2%, hydraulic energy at 16.7%, wind and solar power at 9.4% and 4.2%, geothermal energy at 3%, and other sources at 2.4% (Republic of Türkiye Ministry of Energy and Natural Resources, 2022).

Turkey's population and economy have proliferated in the past twenty years, triggering a robust increase in energy demand parallel with an increase in import dependency as it is dependent on foreign oil and gas to a large extent. Consequently, the Turkish energy system initiated reorganization to adapt to market conditions, rationalizing the rise in energy consumption, bringing down consumer energy costs, and reducing the rate of import increase. Some initiatives included; increasing local production capacity, actions aimed at modernization, liberalization, and greater private and international investment (IEA, 2021).

The present-day Turkish energy policy is focused on market reform and energy security. A significant concern, market reform, aims to liberalize the energy markets to improve predictability and transparency in pricing. Turkey has net energy imports and is a thoroughly dependent country, especially in oil and gas. The country makes

remarkable efforts on domestic oil and gas exploration and extraction, diversifies the energy mix in terms of resources and the related infrastructure, and encourages energy efficiency by lowering the energy use in order to secure the supply of energy, which is the priority of its energy strategy (IEA, 2021).

Turkey has a small amount of domestic crude oil production, while almost all of the natural gas supply is brought from abroad. 93% of oil and 99% of natural gas is imported (IEA, 2021). However, Turkey is working steadily on achieving resilience in gas supply. This includes alternating both the country of origin, thus, the routes of the gas provided. To illustrate, Turkey is engaging in new pipeline projects, building LNG terminals and more storage etc. Once a unique supplier, Russian gas is complemented by Azeri and Iranian gas. The supply is strengthened by new pipeline projects such as TANAP, Turkish Stream, and extra LNG regasification terminals. In addition, recent gas discoveries in the Black sea look promising. Energy-saving building regulations are an alternative instrument for achieving gas supply security by regulating its consumption.

Last but not least, Turkey further diversifies its energy mix by expanding renewable energy and plans to open its first nuclear power plant. Wind, solar and geothermal are the main drivers of the development of the Turkish renewable energy system (IEA, 2021). This is an important pillar of energy security as these energy resources are low carbon, sustainable, and produced domestically. It is beneficial for Turkey to concentrate its efforts on the sustainability of its energy industry and its long-term carbon impact to develop a modern, competitive economy. Equally crucial is directing economic plans toward the following stage of the transition to clean energy. In order to do this, it will be crucial to implement policies that encourage innovation in fields like digital technology, energy storage, and electric cars.

4.2.1. Energy Crisis Reflection on Fuel Prices in Turkey

Crude oil prices worldwide are the main driver of retail fuel prices in the long run. In the short run, exchange rates, tax policies, regulations, supply disruptions, and

seasonal factors also play a role, but these effects are minor compared to crude oil (Ertekin, 2018).

According to Petroleum Market Law Part 4, Price Formation, Expropriation, Access and Coordination, Price formation Article 10; prices in oil trading are formed according to the conditions of the closest accessible world free market.

The final pump price in the domestic fuel market consists of 3 components. The first of these; is product price in international markets (refineries follow the port entrance price of CIF Akdeniz, the closest and largest market to the country) (KPMG Türkiye, 2022). The second; are the margins of refiners, distributors, and dealers, and the third is tax. The tax is the sum of VAT and Special Consumption Tax (SCT). The product's price is formed in international markets and is constantly changing. Another variable used to analyze the effect of product prices on domestic prices is the dollar rate. Prices in Platts European MarketScan, followed by Turkey, are published daily. In Turkey, on the other hand, prices are not updated daily, and the changes in these prices are reflected in the final prices according to a certain methodology, considering the changes in the USD/TL exchange rate (EPDK, 2022c). For Turkey, a crude oil importer, as a result of the depreciation of the TL, the increase in crude oil and product prices in national currency may be higher than the increases in dollars, so the decreases in fuel prices are not reflected in the market, but remain high when exchange rate increases and taxes are added (Ertekin, 2018). While the margin of refiners varies over time, the margins of distributors and dealers are more constant. Overall, prices in the fuel market are formed in an environment of free competition and are not determined by the Energy Market Regulatory Authority (EMRA a.k.a EPDK). EMRA reserves the right to regulate the maximum price.

As mentioned in the previous section, Brent oil has seen its highest levels since 2014, and it is reflected in the CIF Mediterranean price, which Turkey takes as a reference. The cost increases experienced throughout 2021, combined with the depreciation of the Turkish lira, increased the country's fossil fuel prices.

Due to the rise in the price of Brent oil, which is taken as a reference, and the depreciation of the TL against the USD, there have been severe cost increases, especially since the last months of 2021.

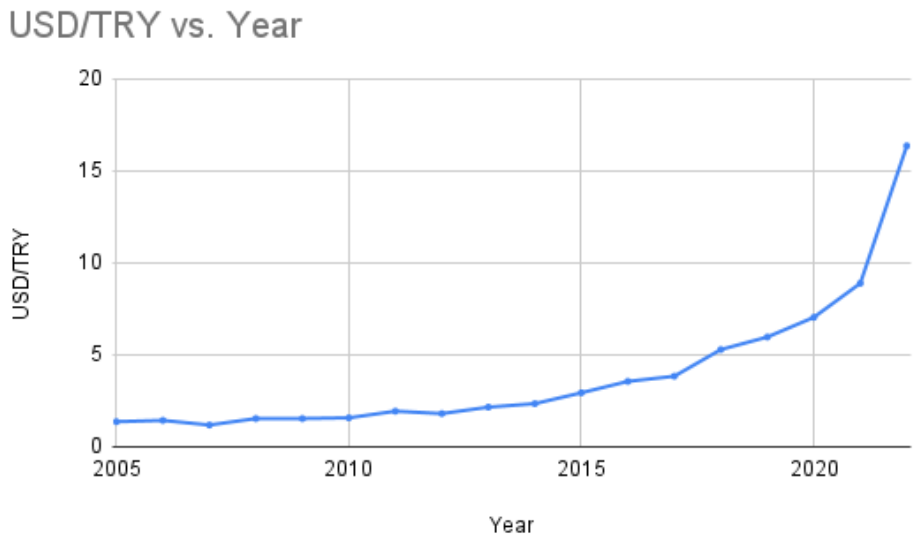

Figure 8. US Dollars to Turkish Lira Exchange Rate over the Years (Source: Ministry of Treasury and Finance and Central Bank of the Republic of Türkiye, 2022)

When the 2020 and 2021 year USD/TL averages are compared, TL depreciated by 20.88% against the US Dollar. Moreover, when the 2021 year average and the 2022 year USD/TL average are compared, the TL depreciated by 45.74% against the US Dollar. It can be said that a small part of the depreciation of the TL against the Dollar is caused by the appreciation of the Dollar against all currencies, that is, from external events. The remaining significant depreciation is due to internal reasons.

Taking the retail sale price in the province of Izmir as an example, while the pump prices, including tax, were 7.86 TL/lt for gasoline and 7.37 TL/lt for diesel on 7th of October 2021, they became 20.74 and 27.25 TL/lt respectively as of 7th of October 2022 (EPDK, 2022a). Besides, diesel fuel's pump price surpassed gasoline's at the beginning of 2022. The pump's gasoline and diesel cost rose by 1 TL per liter, almost every 10 days in the first two months of 2022.

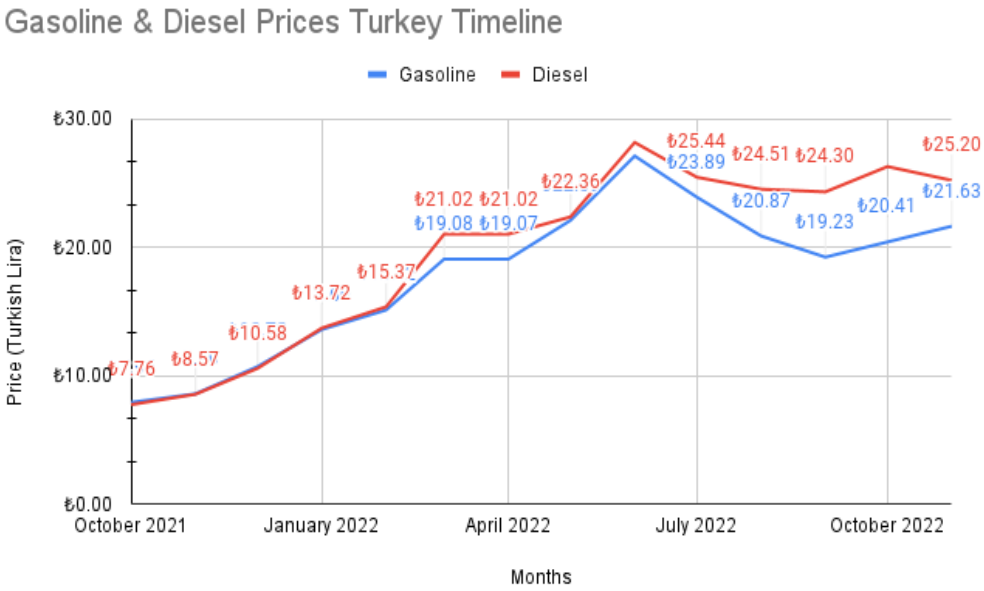

Figure 9. Timeline of Gasoline and Diesel Prices in Turkey (Source: EPDK, 2022b)

Although the gas prices fluctuated over time and sometimes displayed a decreasing trend, due to the depreciation of the TL, the decreases in fuel prices were not reflected in the market; prices remained high as the exchange rates increased, thus taxes added.

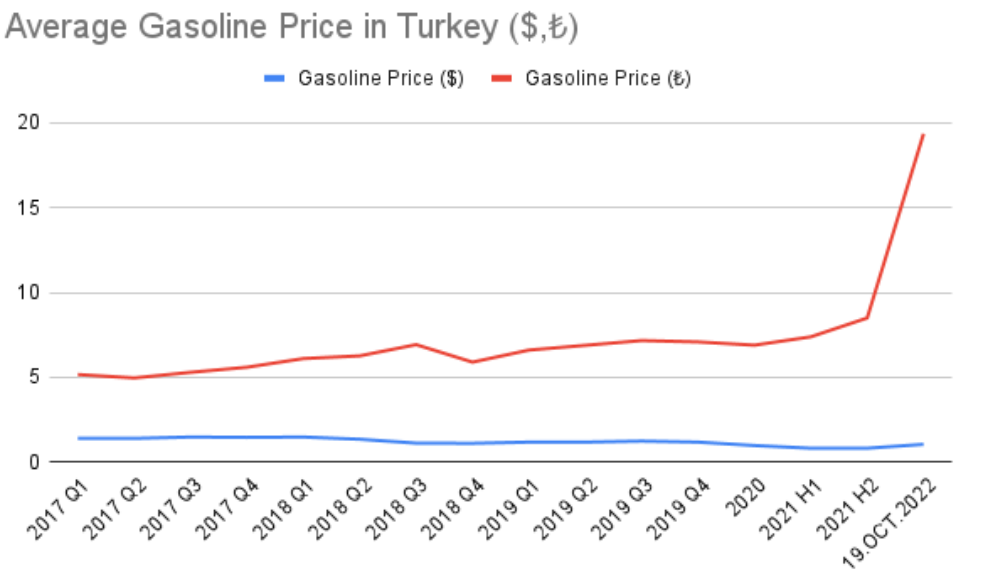

Figure 10. Average of Gasoline Price in Turkey (Source: EPDK, 2022a)

4.2.2. EV in Turkey

The number of passenger cars in Turkey is 18,274,609, while alternative fuel passenger cars constitute 4,905,620 (European Alternative Fuels Observatory, 2022).

Today the auto market has reshaped and has a different mix of fuel types compared to 2018 due to demand fluctuations because of supply shortages, foreign exchange rates, pandemic, and perhaps climate concerns. While diesel cars constituted 60% of car sales in 2018, by 2020, it had decreased to 40% and 17% by 2022, according to the data of the Automotive Distributors Association. In addition, hybrid cars also increased their piece in the car pie, from 8.7% in 2021 to 10.2% in 2022. In terms of electric cars, the size of the Turkish EV market quadrupled from 2019 to 2020 and tripled from 2020 to 2021. In 2021 sales of EVs only constituted 0.5% of total car sales, with 2.415 electric cars sold. Moreover, EV sales have increased by 157.3% as of 2022, and now the share of EVs is 1.2%, with 6.214 electric cars sold as of November 2022 (ODMD, 2022.) The total fleet of electric cars is 11217 EVs and 2246 PHEVs today.

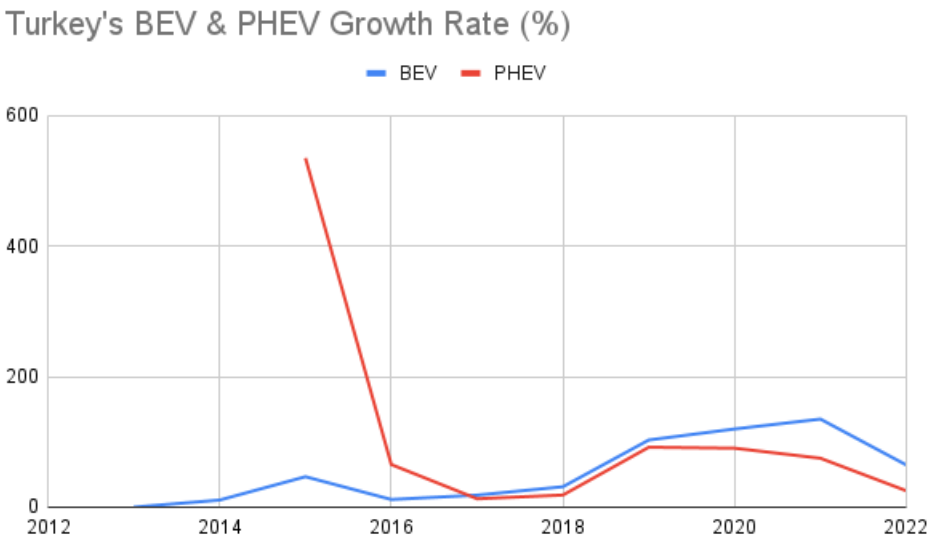

Figure 11. Turkey's BEV & PHEV Growth Rate (%) (Source: ODMD, 2022)

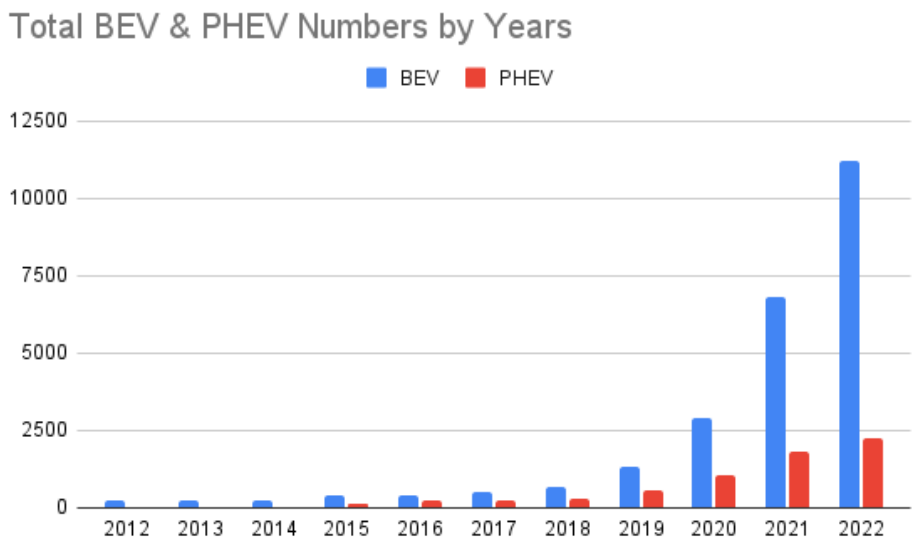

Figure 12. BEV & PHEV Numbers by Years in Turkey (Source: European Alternative Fuels Observatory, 2022)

The taxation policy for EVs and alternative fuel vehicles changes over time. EVs were included in the taxation system 2011 (Revenue Administration, 2011). The special consumption tax (SCT), a tax imposed on the sale of cars and other vehicles, was lower than internal combustion engine vehicles. However, in 2021, the government imposed higher taxes for fully electric vehicles in a policy strategy that contrasts with most of the rest of the world (Revenue Administration, 2021). By 2022, a slight tax reduction will be applied. (Presidency of Administrative Affairs General Directorate of Law and Legislation, 2022)

Table 5. Rate of Engine vs. Special Consumption Tax

Rate of Engine / SCT	2011	2021	Rate of Engine / SCT	2022
Below 85 kW	3%	10%	Below 160 kW & SCT base not exceeding 700.000 ₺	10%
85 - 120 kW	7%	25%	Above 160 kW & Exceeding SCT base of 700.000 ₺	40%
Above 120 kW	15%	60%	Below 160 kW & SCT base not exceeding 750.000 ₺	50%
			Above 160 kW & Exceeding SCT base of 750.000 ₺	60%

Infrastructure is the complementary issue in the case of EVs. One of the main barriers to the major adoption of EVs is the lack of recharging points in residences, streets, and highways. From 2021, the total number of AC and DC charging stations in Turkey has risen above 2000. Government support has accelerated this trend. However, the charger network does not display a homogeneous distribution but concentrates on specific metropolitan districts (European Alternative Fuels Observatory, 2022).

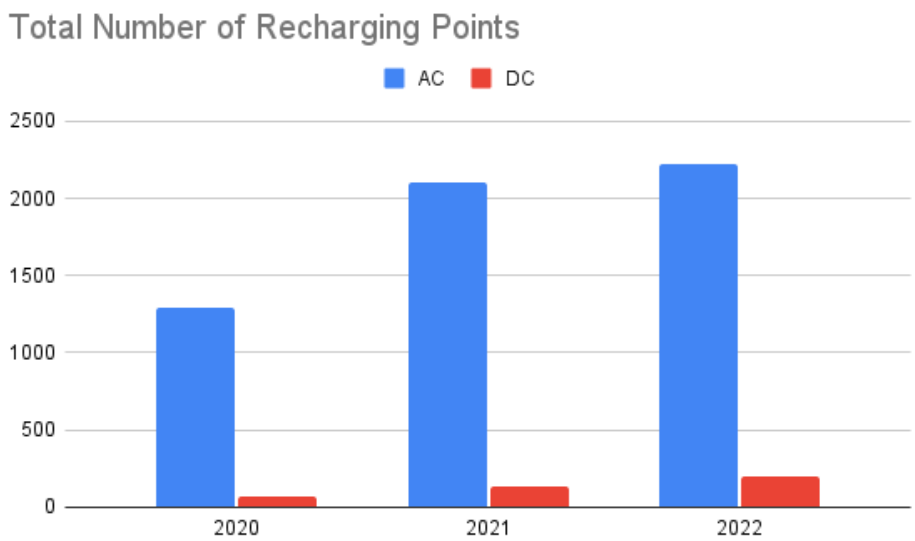

Figure 13. AC & DC Recharging Points by Years (Source: European Alternative Fuels Observatory, 2022)

CHAPTER 5: ANALYSIS RESULTS

Total of 550 people participated in the survey. A meticulous descriptive analysis of the results of the survey is established.

5.1. Demographics

290 (52.7%) of the respondents were male, and 260 (47.3%) were female, reasonably representative of the general population. The age distribution of the sample was almost the same as the population of the city of İzmir (TÜİK, 2022). The range 42-57 years old was the most populated, with 210 respondents corresponding to 38% of the total. The second and third densely populated group is 28-41 and 18-27 years old, with 117 and 115 people cumulatively accounting for almost 42% of the sample group. The 58-70 age interval comprises 87 people (16%). The least dense age group is 70+, 21 people (4%). Age and gender distribution is almost equal.

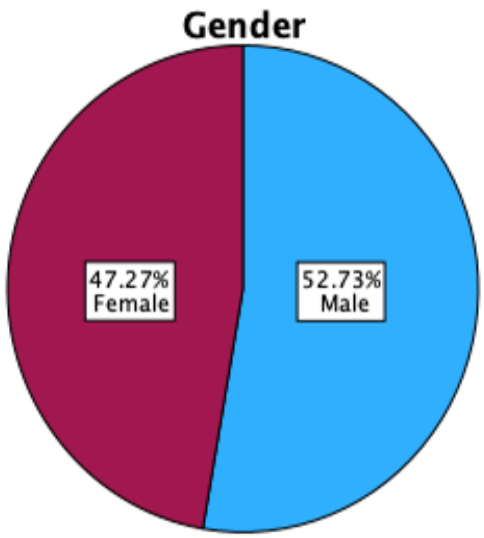

Figure 14. Gender Distribution

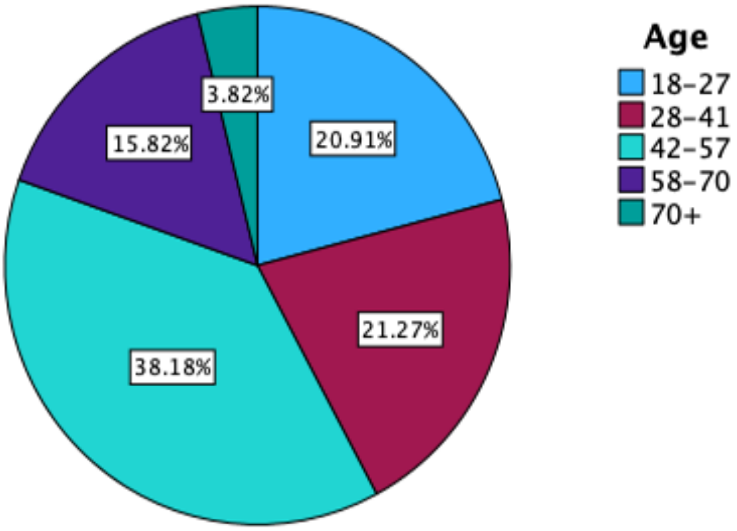

Figure 15. Age Distribution

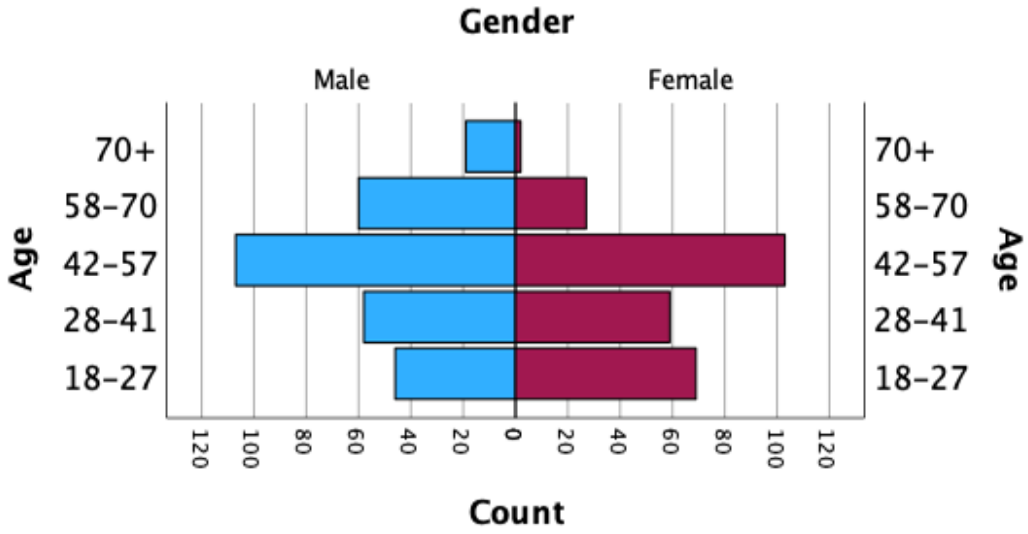

Figure 16. Gender Distribution by Age

The educational level of the sample is quite high. Only 15% of the respondents hold an educational status less than Undergraduate Degree. The proportion of the respondents that hold an undergraduate degree or master's degree are 58% and 23%; 317 and 125 persons, respectively, and high school graduates are 9%, 51 persons, which make up the majority of the educational structure of the group.

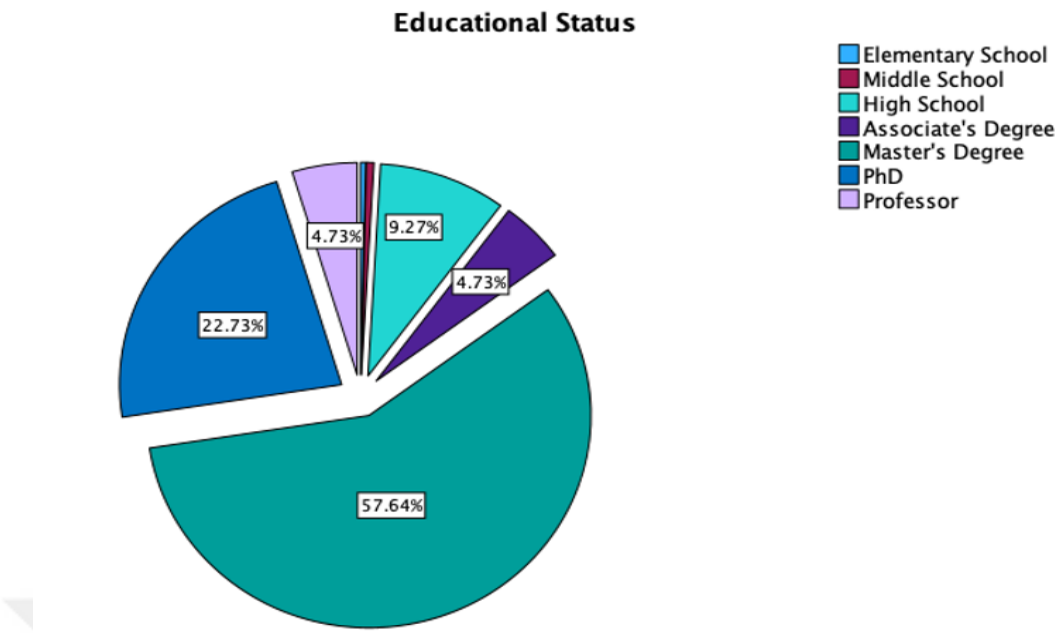

Figure 17. Educational Level Distribution

This skewness is attributed to the survey's focus on people that possess cars and the snowball technique distribution method. Since the survey's main objective was to investigate the impact of fuel price increases on people's driving behavior, it was crucial to target respondents with car(s). Owning a car in this study is found to be significantly correlated with high income (Table 7), and income is significantly correlated to high educational status ($p<0.05$, rejecting the null hypothesis that these two variables are independent of each other (Urbanek, 2021)) according to the chi-square test conducted with a sample size of 550 cases.

Table 6. Chi-Square Test Results Table of Education and Income

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	77.809	24	0.000
Likelihood Ratio	77.946	24	0.000
Linear-by-Linear Association	60.563	1	0.000
N of Valid Cases	550		0.000

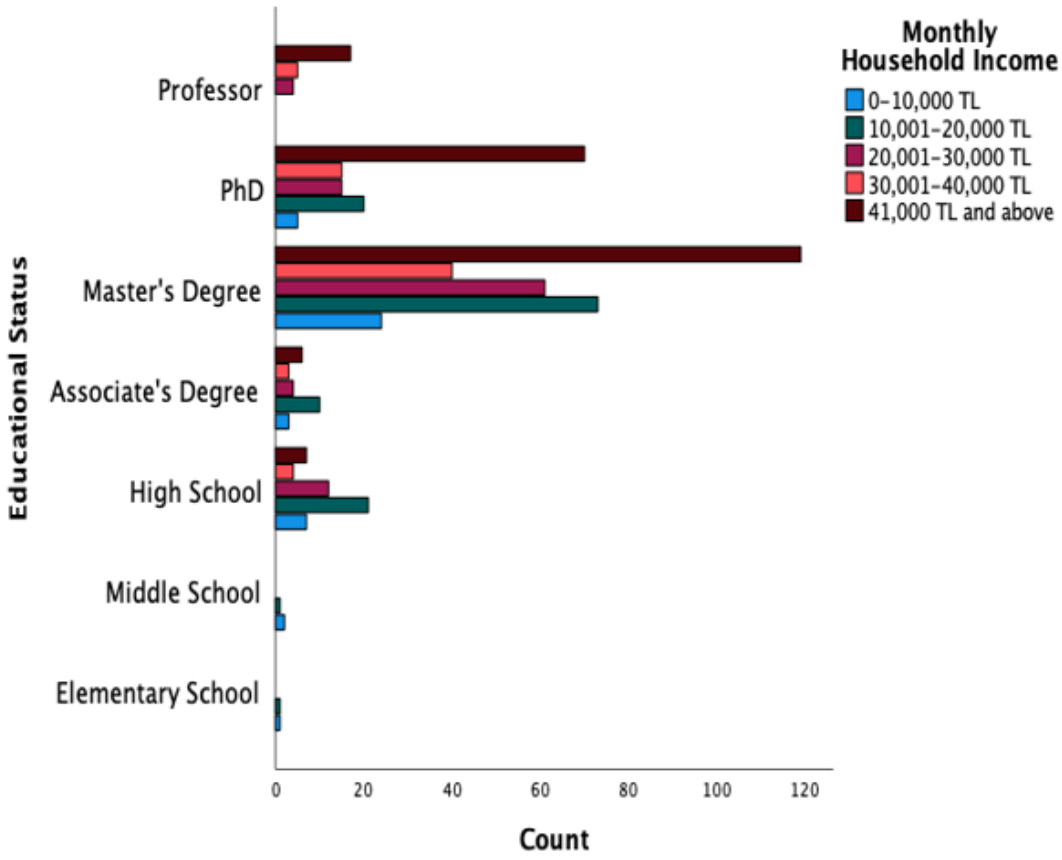

Figure 18. Distribution of Monthly Income by Educational Status

Respondents were asked about their employment status. More than half are working on-site, 10% have a flexible workplace (hybrid), and 6% work from anywhere. 11% of the population is studying, 14% is retired, and 6% is unemployed. Employment

status is important as working in the office requires more commuting than other forms of work, and not working, being retired, or being a student are determining factors (Corsi and Harvey, 1975).

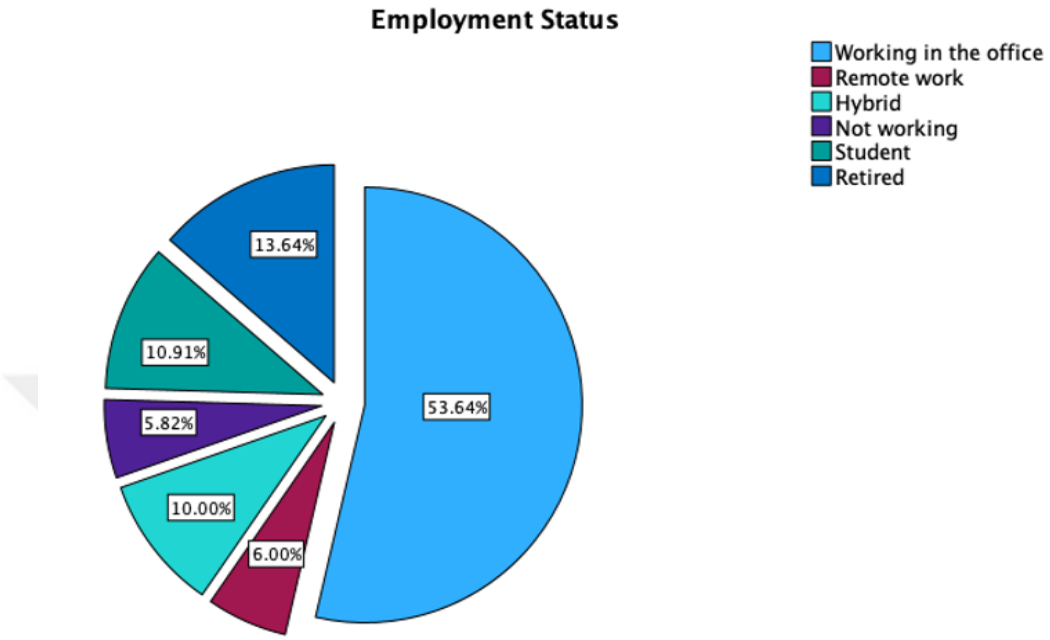

Figure 19. Employment Status Distribution

İzmir is one of the leading provinces of Turkey in terms of socio-economic status. As introduced above, there is a wealthy sample. The most frequent monthly household income level among the responding individuals is TRY 41,000 and above, with 40%. The second highest proportion (23%) belongs to people who earn between TRY 10,001 - 20,000. The third highest proportion (17%) belongs to people who earn between TRY 20,001 - 30,000. The next is the households earning between TRY 30,001 - 40,000, which is the 12% of the group. The least populous income level is no income to TRY 10,000 with 8%. More than half of the households in the sample earn more than 30,000 TL in a month.

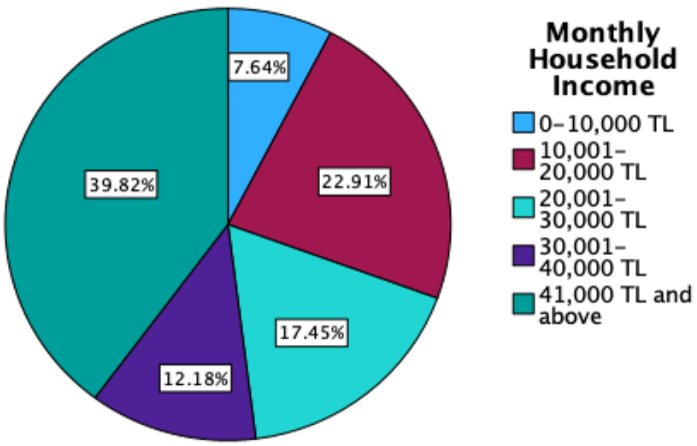

Figure 20. Monthly Household Income Distribution

This skewness is again the result of the reason that in order to serve the aim of the study, which is investigating the impact of fuel price increases on people's driving behavior and the potential acceleration of the transition to cleaner modes of transportation, it was crucial to target individuals who owned cars. Car ownership in this study is significantly correlated to high income ($p<0.05$, rejecting the null hypothesis that these two variables are independent of each other (Urbanek, 2021)) according to the chi-square test conducted with a sample size of 550 cases.

Table 7. Chi-Square Test Results Table of Income and Car Ownership

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	75.540	4	0.000
Likelihood Ratio	70.373	4	0.000
Linear-by-Linear Association	66.830	1	0.000
N of Valid Cases	550		0.000

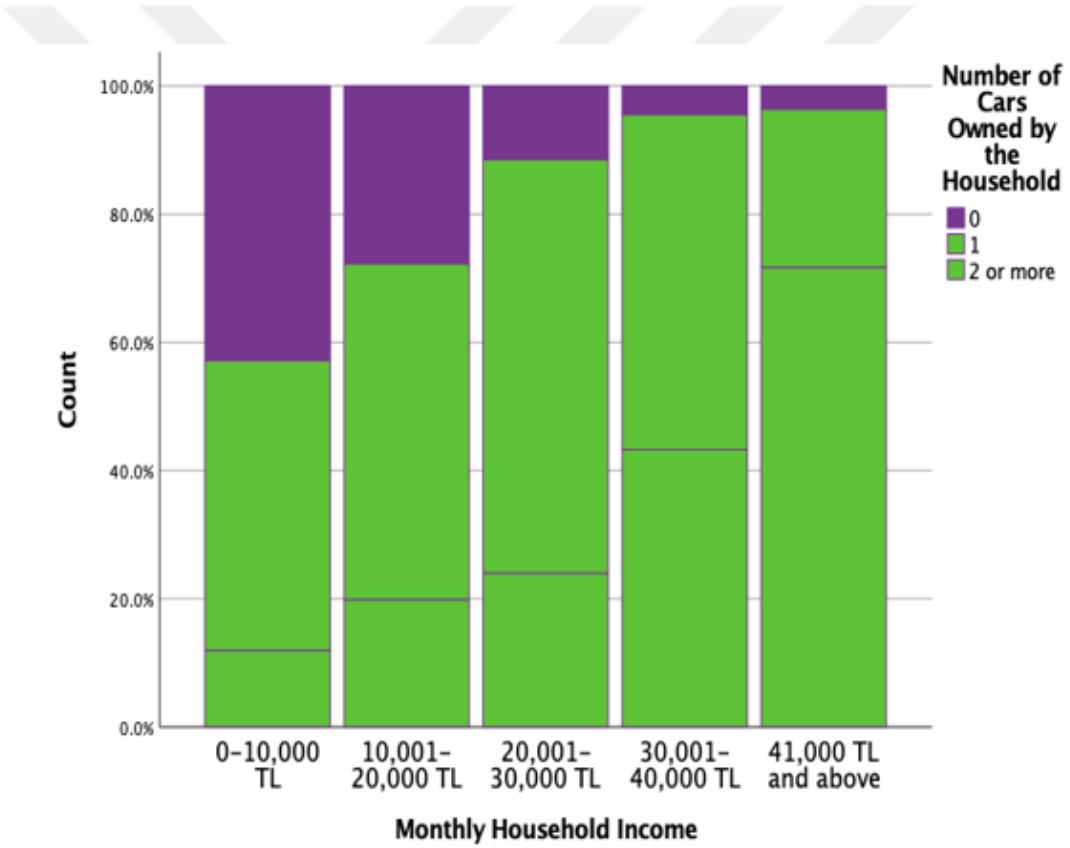

Figure 21. Distribution of Car Ownership by Monthly Household Income

People were asked whether they owned a car or not, or possessed 2 or more cars. Majority of the sample owned at least one car. The number of households who own 1 car is more or less the same as that of households that own two or more cars. They make up 475 people. Approximately 14%, the remaining 75 people said they don't have a car. Regarding the automobile classification, gasoline and diesel cars rank the highest and cumulatively, alternative fuel vehicles almost rank the same with LPG. Among alternative fuel vehicles, the line up is as follows; hybrid comes first and is succeeded by EVs and plug-in hybrid cars.

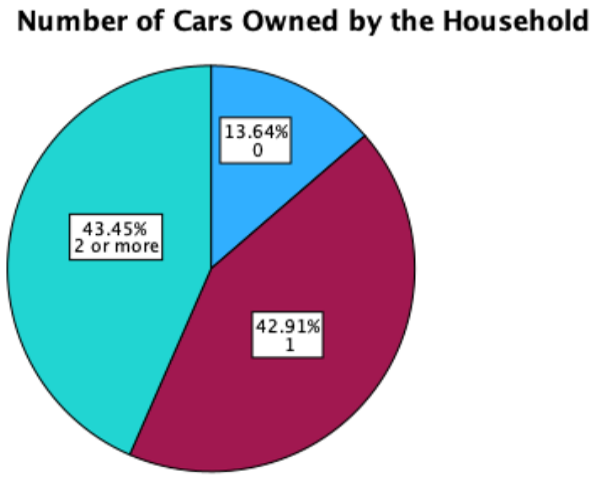

Figure 22. Distribution of Number of Cars Owned by the Household

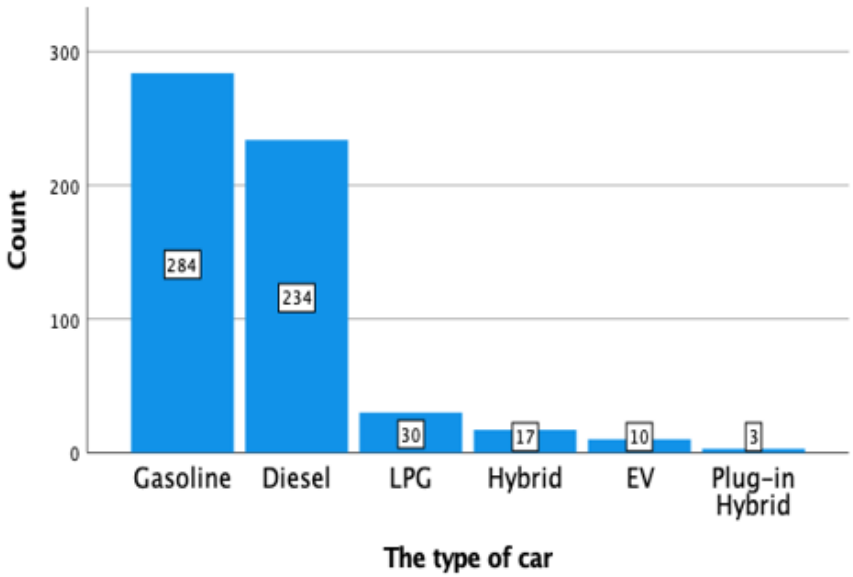

Figure 23. Distribution of the Types of Car Owned

Respondents who do not own an automobile are asked if they use public transportation. Out of 75 respondents, 89% (67 people) said “yes” and 11% (8 people) said “no”. It can be said that most people who do not have a car use public transportation.

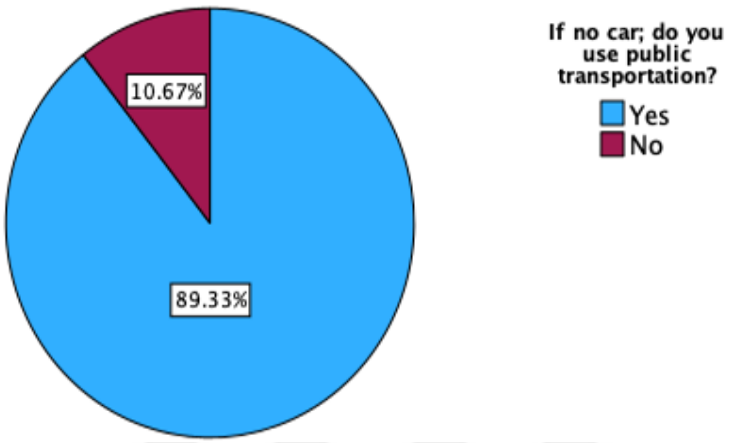

Figure 24. Distribution of the Public Transport Use of People Without a Car

Respondents are then asked about which public and alternative transportation methods they use. Walking is the most preferred form of transport and is almost performed by everyone who does not possess a car (67 people, 16% of responses, 89% of all cases). Public transportation methods, metro, and bus come next (58, 49 people; 14%, 12% of responses; 77% 65% of all cases respectively). Taxi is another highly preferred method (48 people, 12% of responses, 64% of all cases). It is followed by public transit modes; İzban, tram, ferry, and minibus (40, 34, 29 people; 10%, 8%, 7% of responses; 53% 45% 39% of all cases, respectively). 19 people (5% of responses, 25% of all cases) use the service for going to their jobs, airports, malls etc. 11 (3% of responses, 15% of all cases) is the number of people who prefer to pedal instead of riding motor vehicles. Carpooling is applied by 9 (2% of responses, 12% of all cases). 7 people (2% of responses, 9% of all cases) who don't have a car use a motorbike instead.

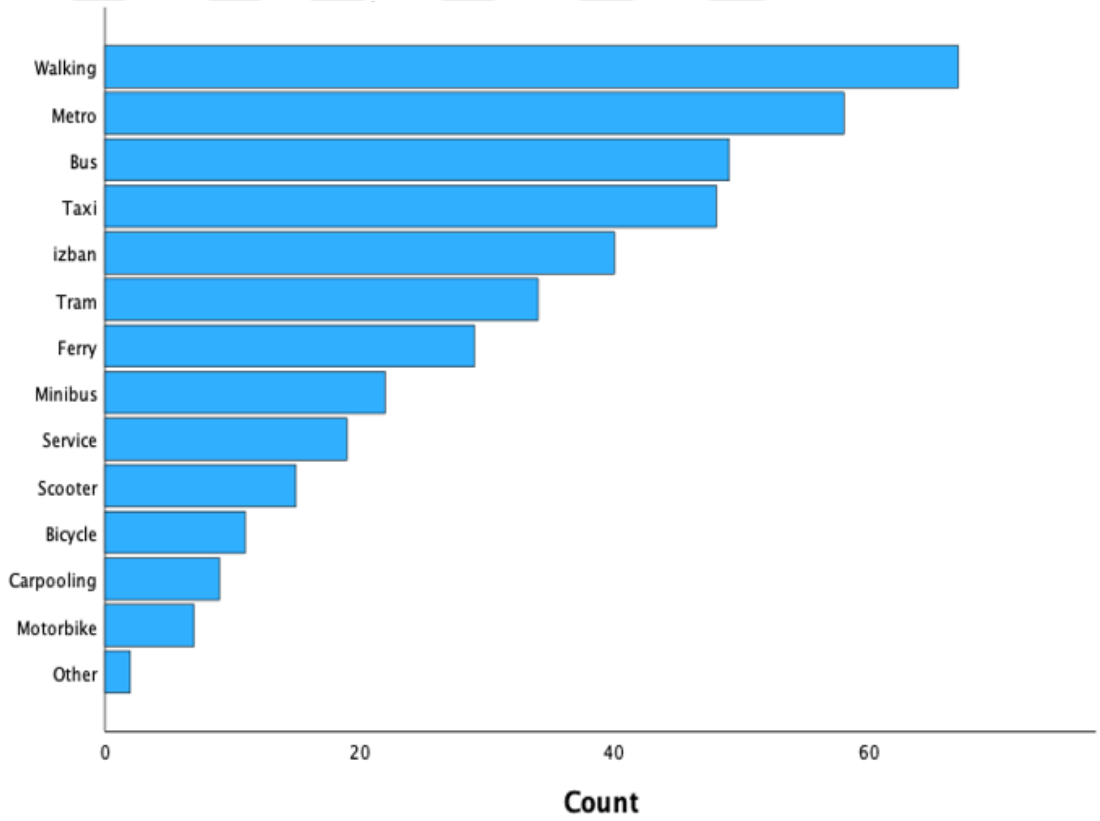

Figure 25. Distribution of the Transportation Methods Used by People Without a Car

5.2. Empirical Results

5.2.1. P1: Higher Fuel Price and Driving Behavior

Respondents who own a car were asked whether they find fuel prices high. Almost all of the respondents, 98%, 464, said "yes" and only 2%, 11, said "no". The results indicate that rising fuel prices indeed affect people's perception of how pricey it is (probably compared to the near past). The respondents were then expected to state whether they are driving less, more, or the same as before due to rising fuel prices. The number of respondents who said that their driving frequency has decreased (49%) is equal to those who are unaffected (49%). Only 7 people reported an increase in driving habits. It is figured that approximately half of the sample who own a car have decreased driving due to increased fuel prices. The findings are consistent with Eltony (1993); Graham and Glaister (2002); Goodwin, Dargay and Hanly (2004); Kennedy, Wallis, and Hamilton (2007); Erath and Axhausen (2010); Chi et al. (2013) and Gillingham (2014)., who had revealed that rising fuel prices result in behavioral changes in households such as; driving fewer miles and accordingly less VMT. In addition, the minority respondents who reported increased driving could be explained by the rebound effect ("an increased level of VMT as the result of an improvement in fuel efficiency") proposed by Wang and Chen's (2013) and Hymel and Small (2015).

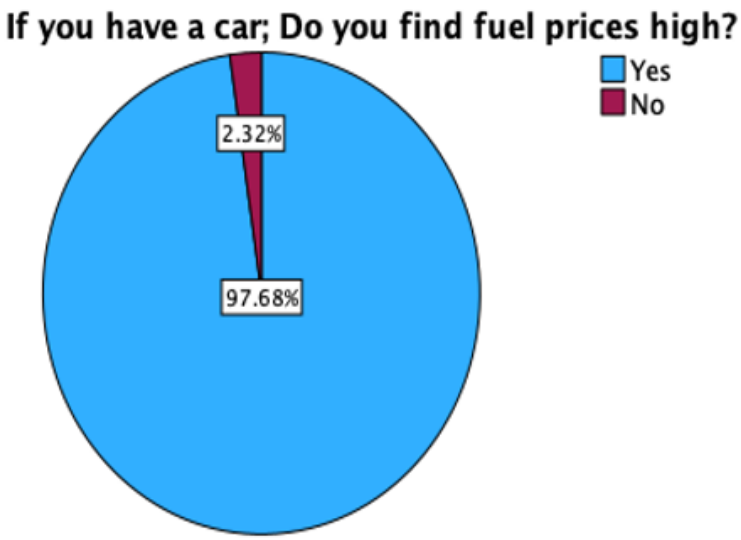

Figure 26. Distribution of People According to Perception on the Level of Fuel Prices

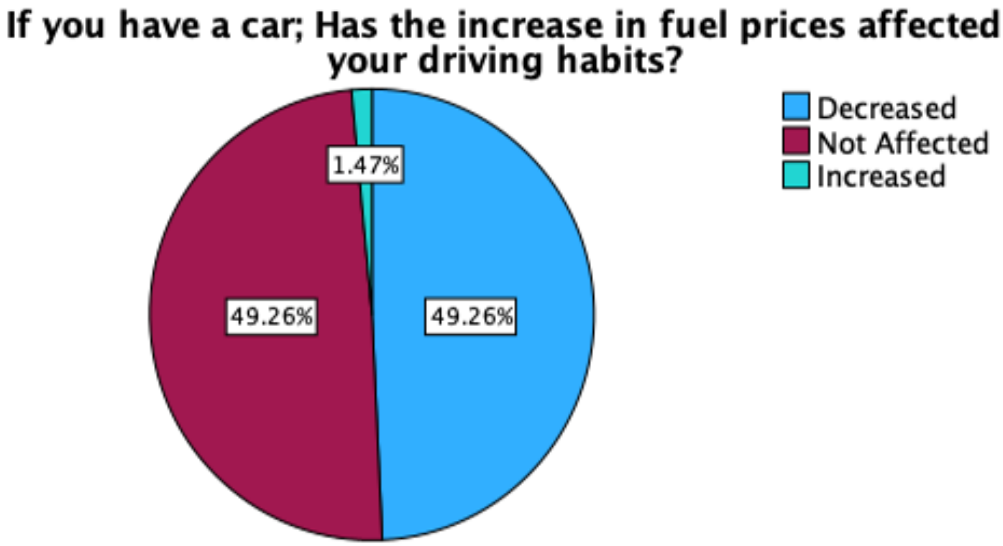

Figure 27. Distribution of People According to Change in Driving

P1 proposes that people are expected to drive less when gasoline prices increase. This is due to the cost of driving rising due to higher gasoline costs, making it more expensive for people to travel by automobile. Among people who said fuel prices are high, 233 reported their driving has decreased, and 224 said it is unaffected. Among people who don't think fuel prices are high, 1 still reported decreased driving, and 10 said it is unaffected. Looking at the table we can conclude that if someone thinks the fuel prices are high, they either downshifted driving or remained driving as usual.

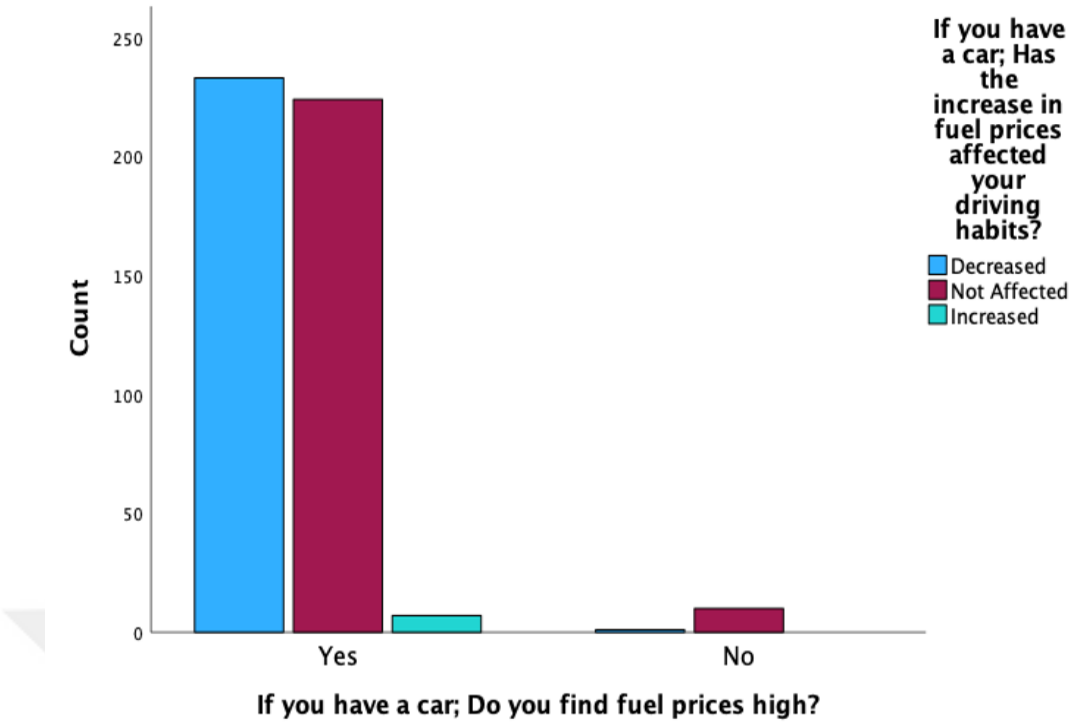

Figure 28. Distribution of Change in Driving by Perception on the Level of Fuel Prices

P1 is tested to determine whether a statistically significant association exists between the perception of fuel prices and a change in driving rate. A chi-square test is performed to determine whether there is a significant association between these two categorical variables. However, a footnote appears in the output indicating that one cell in the contingency table has an expected count of less than 5, and the minimum expected count is 0.16. This warning message is displayed to warn that the assumptions of the chi-square test may be violated, in this case, the assumption of expected cell frequencies. Fisher's exact test (Bal, Er and Sönmez, 2009; Borozan, 2018) is an alternative to the chi-square test and does not rely on expected cell frequencies. The exact test results are interpreted in the same way as the chi-square test by examining the contingency table and p-value to determine whether there is evidence of a significant association between the two variables. Accordingly, as the p-values are less than the significance level of 0.05, the null hypothesis is rejected and concluded that there is a significant relationship.

Table 8. Fisher's Exact Test Results Table of Perception on Fuel Prices and Change in Driving Rate

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	7.819[a]	2	0.020	0.034		
Likelihood Ratio	9.055	2	0.011	0.014		
Fisher-Freeman-Halton Exact Test	8.145			0.022		
Linear-by-Linear Association	6.032[b]	1	0.014	0.019	0.015	0.012
N of Valid Cases	475					

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is .16.

b. The standardized statistic is 2.456.

Moreover, in order to find out how much of a price increase from current levels is likely to have an impact on the group that has not yet made any reduction in driving, those respondents are presented with ratio levels asking them to state their intention to cut back on driving if the prices were to accelerate in the given amounts. Looking at the results, a quarterly increase in fuel prices is unlikely to cause any change in the unaffected group's driving habits. In the case of an elevation of prices by 26-75%; the respondents are still neutral. However, an increase over 75% will likely push drivers to reconsider the mileage. The results demonstrate that consumers unaffected by the

current price levels are willing to spend much more on fuel, as Haire and Machemehl (2007), where the respondents are willing to spend more than half of their salaries on gasoline. On the other hand, the results demonstrate that people's willingness to bear higher costs decreases as the price level increases. This finding is consistent with Barnaby and Reizenstein's (1977) results that suggest further price increases produced lesser projected consumption.

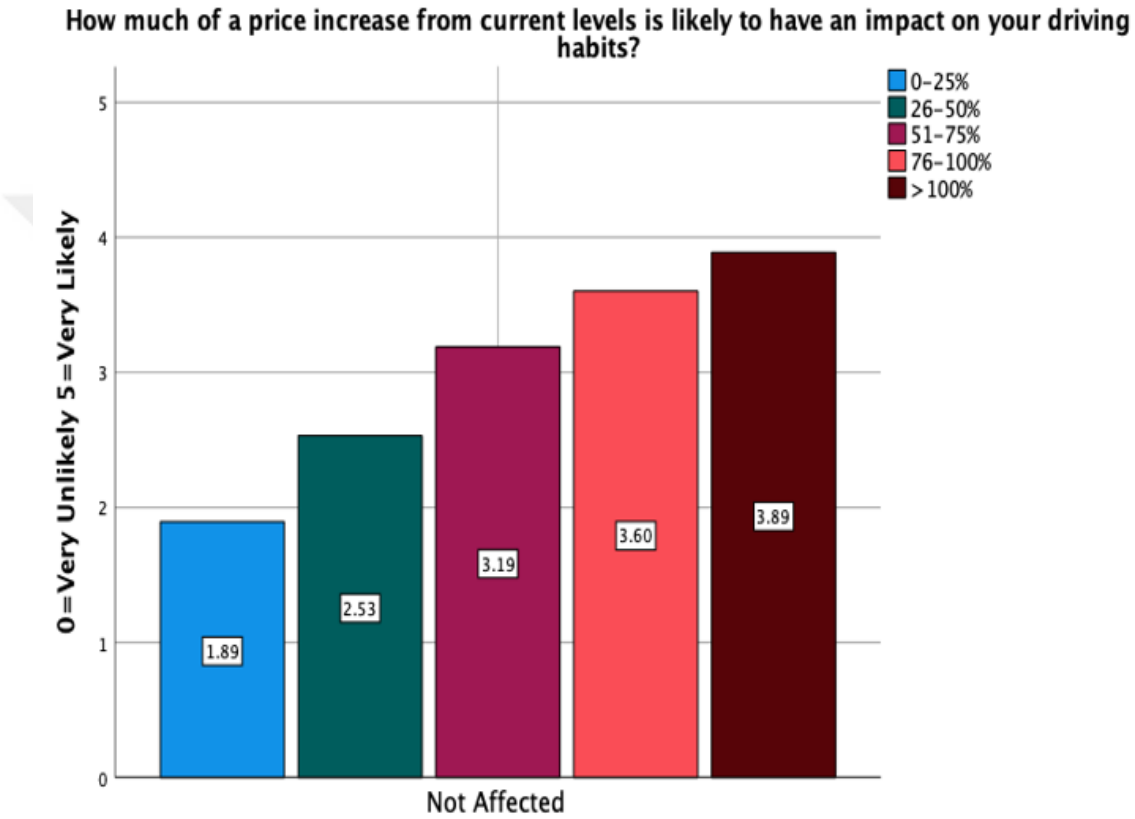

Figure 29. Level of Likelihood to Drop Driving by Percentage Increases

The results suggest a positive relationship between price and the likelihood of modifying driving meaning; as prices increase, people's likelihood of decreasing driving increases. This is also aligned with the first assumption, P1, that people are likely to cut on their driving as prices go up.

5.2.2. P2: Change in Modal Behaviour (to Public Transport or other forms of transportation)

In order to find out if people who are cutting down on individual driving move to public transportation, the participants that had stated decreased driving due to increased prices are asked, “Do you use public transportation as an alternative?” 80% (188 people) of the respondents said “yes”, 20% (46 people) said “no”. It can be inferred that most people replaced an amount of individual driving with public transportation, which is a clearer transportation method than individual driving; therefore, the assumption (P2) is supported. The findings are parallel with Lane (2012) and Creutzig (2014)'s research revealing a modal shift following a price increase. The ratio of people that engage in public transportation due to high fuel prices is high compared to Haire and Machemehl’s (2007) findings, which is about only half of the respondents.

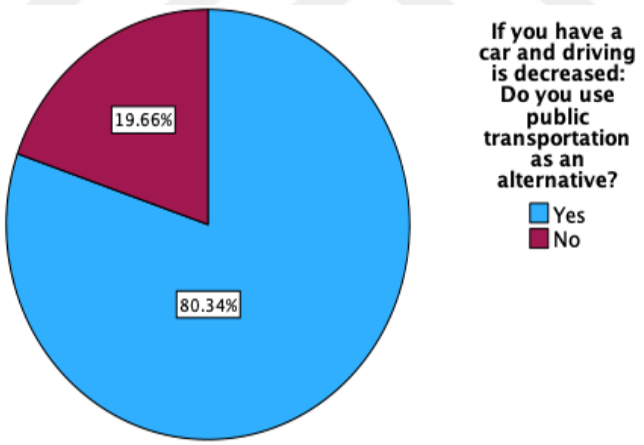

Figure 30. Distribution of People Using Public Transportation as an Alternative to Driving

In order to explore the ways of transit that mostly substitute car rides, 128 participants who have declared that they are using public transport as an alternative are asked to mention the specific modes of public transportation they use. Metro was chosen by 128, the tram was chosen by 120, a ferry was chosen by 109, İzban was chosen by 98, the bus was chosen by 80, and the minibus was chosen by 49. The substitutes' ranking differs from the non-car owner’s public transportation rankings, which are metro, bus,

İzban, tram, ferry, and minibus. The reason for the car owners not preferring the buses as much might also be to avoid traffic congestion. Since they are usually exposed to it while driving their cars, Metro, tram, and ferry use independent roads that offer more speed than (mini)bus travel.

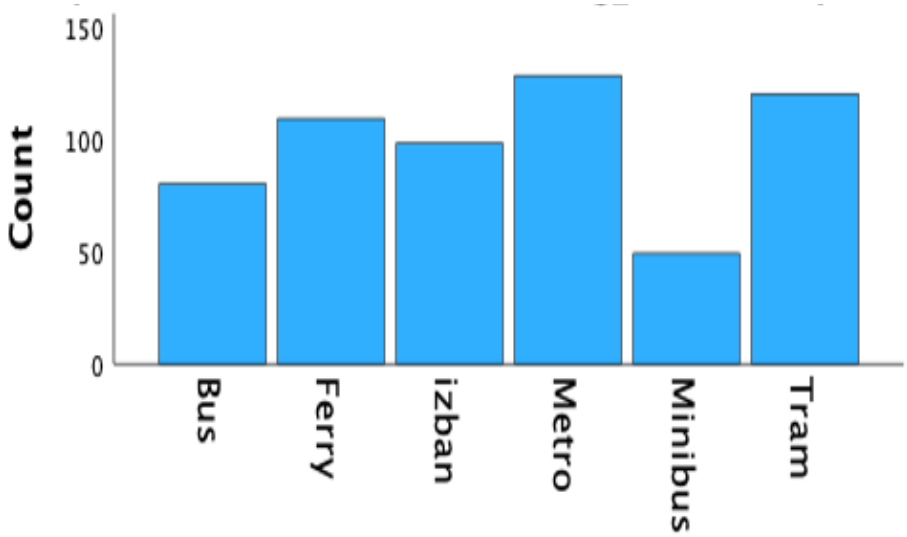

Figure 31. Distribution of Public Transport Methods Used as an Alternative to Driving

In addition, participants are asked about other ways of commuting they engage in. Going on foot is the most preferred method, as is the case with non-car owners. There were 198 responses for walking (43% of responses, 85% of all cases). Among the respondents with decreased driving habits, taking a cab comes next (88 people, 19% of responses, 38% of all cases). 44 people (10% of responses, 19% of all cases) ride their bikes. İzmir Municipality has been promoting biking by expanding the number of bicycle stations (BİSİM) and enlarging the cycling paths (to nearly 100 km) thus integrating bicycle transportation into the public transportation web. To illustrate, the decision for cyclists to benefit from the ferry within only 5 kuruş (1/20 of TRY 1), 35 free repair stations, and 50 bicycle pumps were placed on the bike paths. In 2021, 1,477 bicycle parking lots were put into service at 104 points etc. These incentives and developments might be driving factors for individuals to use bicycles. 32 respondents (7.0% of responses, 13.7% of all cases) mentioned carpooling. Using a service bus to go to work, school, the airport, the shopping center etc. is practiced by 30 respondents (7% of responses, 13% of all cases). Scooters and other forms are used by 26 and 25 people (6% of responses, 11% of all cases), respectively. 11 people (2% of responses, 5% of all cases) chose to go on 2 wheels instead of 4. Compared to the outcomes of

Haire and Machemehl's (2007) survey, there is a big contrast in the findings related to the walking option. While walking appears as the most preferred substitute for private transportation in this survey, in Haire and Machemehl's findings, only 3.5% of respondents had chosen this method. Both studies include biking and carpooling as preferred alternative methods of transportation. The percentages are exactly alike for biking. However, carpooling was preferred by 38% in Haire and Machemehl's research. Considering everything, participants take part in various modes of transportation for their daily needs, and there is an enormous potential for a modal shift in case of high fuel prices.

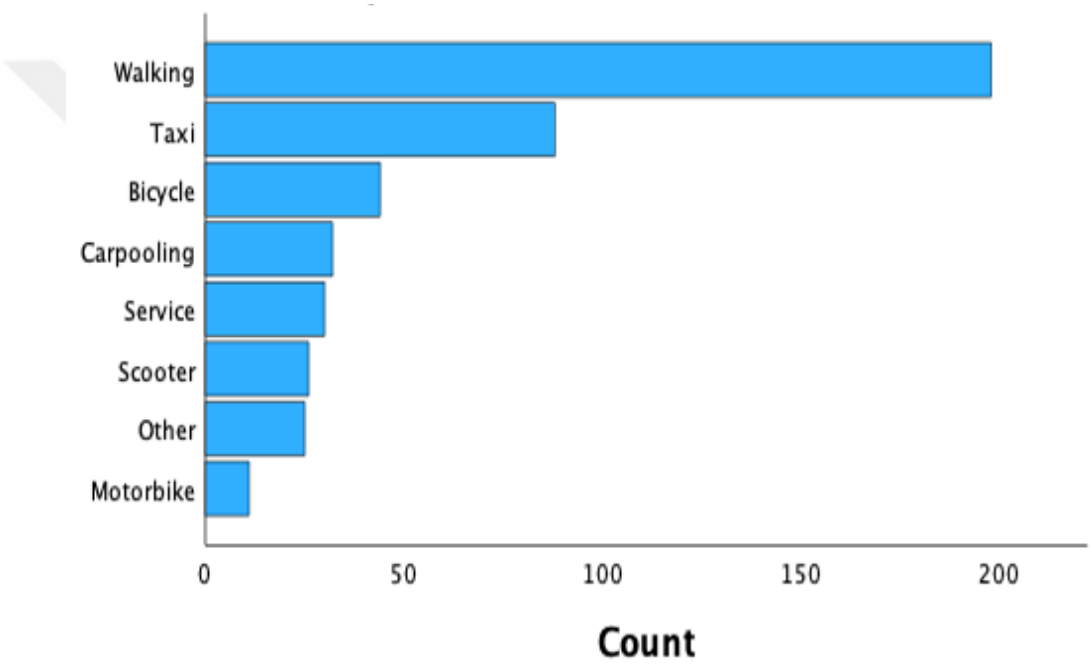

Figure 32. Distribution of Alternative Methods to Driving Used

It is important to emphasize that the outcomes show that individuals and households responding to energy price increases support the transition to cleaner modes of transportation. Rising gasoline prices can accelerate the adoption of sustainable transportation methods, encouraging people to look towards environmentally friendly alternatives compared to private driving.

5.2.3. P3: Fuel Optimization Related Behavioural Change

People that have decreased driving habits in the wake of the increase in fuel prices are asked if they have taken any of the following cost-saving and/or energy efficiency measures regarding fuel purchase. To maximize fuel efficiency, drivers may engage in various driving strategies, such as keeping a steady speed (avoiding acceleration and braking), checking tire pressure, maintaining the vehicle properly, reducing air conditioning use, avoiding unnecessary loads, going to different gas stations to find the best price, filling the tank often but making small purchases at a time (assuming prices fluctuate). The survey results indicate that out of 234 respondents who decreased driving due to increased fuel prices, 223 of them changed their behavior to decrease fuel consumption. There is an alignment between the P3 and the survey result, providing supporting evidence for the a priori assumption. The majority of respondents who reduced their driving due to increased fuel prices also took steps to decrease fuel consumption, which suggests a connection between rising fuel prices and engagement in fuel-conservationstrategies.

People were allowed to make multiple responses, so in a total of 223 people, many reported mixed strategies; each person gave an average of 2.7 answers to this question. The strategy that comes first to the driver's mind is constantly driving. 182 participants (30% of responses, 82% of all cases) said that they avoid unnecessary acceleration as high speed puts more energy into the engine, which requires more fuel. Performing periodic maintenance (for example, to avoid fuel leaks or some old cars that have been maintained and the necessary parts replacement processes may have been completed, burn less than their peers) is another strategy in demand, chosen by 129 survey takers (21% of responses, 58% of all cases). If the tire air pressure is not set correctly, the engine will be forced, and the fuel usage will increase, so tire air control is performed by 98 participants (16% of responses, 44% of all cases). 86 people (14% of responses, 39% of all cases) pay attention to reducing air conditioning and heating system use. 51 people (8% of responses, 23% of cases) do not fill up their tanks at once but do frequent gas station visits and buy in moderate amounts, supposing the prices are unsteady. 37 (6% of responses, 17% of all cases) ensure the car is not overloaded. Finally, scouring gas stations to find the best price was chosen 27 times (4% of responses, 12% of all cases). Puller and Greening (1999); Goodwin, Dargay and Hanly

(2004) and Chi et al. (2013) also pointed out that people engaged in such fuel optimization strategies.

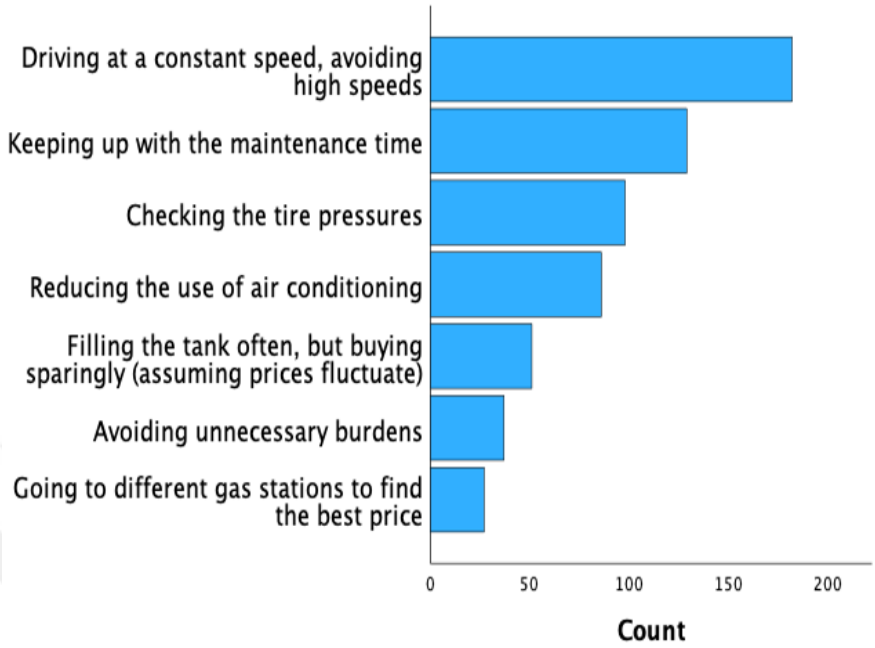

Figure 33. Distribution of Fuel Optimization Related Behavioural Changes

In short, people looked for various ways to improve fuel efficiency, prevent any extra costs, or make the best deal.

5.2.4. P4: Vehicle-Related Behavioural Change

People that have decreased driving habits in the wake of the increase in fuel prices are asked if they have taken any of the following cost-saving and/or energy-efficiency measures regarding their vehicles. People might make vehicle-related changes in response to higher fuel prices, such as replacing the existing car with a more efficient one, replacing the existing car with an electric, hybrid, or plug-in hybrid car, buying a more efficient car in addition to the one on hand, buying an electric, hybrid or plug-in hybrid car in addition to the one on hand, buy a motorcycle, selling the existing car and not buying a new one, postponing the purchase of an additional car or others. The survey results indicate that out of 234 respondents who decreased driving due to increased fuel prices, 147 of them engaged in at least one vehicle-related strategy. The fact that more than half of the respondents adopted vehicle-related behavior strategies in response to rising fuel prices, provides support for the a priori assumption P4. It suggests a connection between higher fuel prices and the adoption of specific strategies aimed at reducing fuel consumption through vehicle-related behavior change.

People were allowed to make multiple responses, so in a total of 147 people, each person gave an average of 1.2 answers to this question. The most commonly adopted strategy by 80 people (46% of responses, 54% of all cases) is delaying the purchase of an additional car, avoiding a significant additional expense. It is followed by replacing their current car with a more efficient one by 45 people (26% of responses, 31% of all cases) and 5 people (3% of responses, 3% of all cases) bought a more efficient car in addition to the one they have. 20 people (12% of responses, 14% of all cases) replaced their current car with an electric, hybrid, or plug-in hybrid car and 5 people (3% of responses, 3% of all cases) bought an electric, hybrid, or plug-in hybrid car in addition to what they already own. 9 people (5% of responses, 6% of all cases) purchased a motorcycle, and the same number of respondents sold their existing car and did not buy a new one. Replacing the current car with a more efficient one or an alternative fuel were favored strategies in line with the literature (Eltony 1993; Erath and Axhausen 2010; Gillingham, 2014), suggesting that some people may be willing to invest in a more expensive vehicle up front, in order to save on fuel costs in the long run. Being more efficient or alternative fuel, purchasing an additional car was the least

popular strategy among respondents, showing that people avoid the cost of ownership of an additional car and opt for other options.

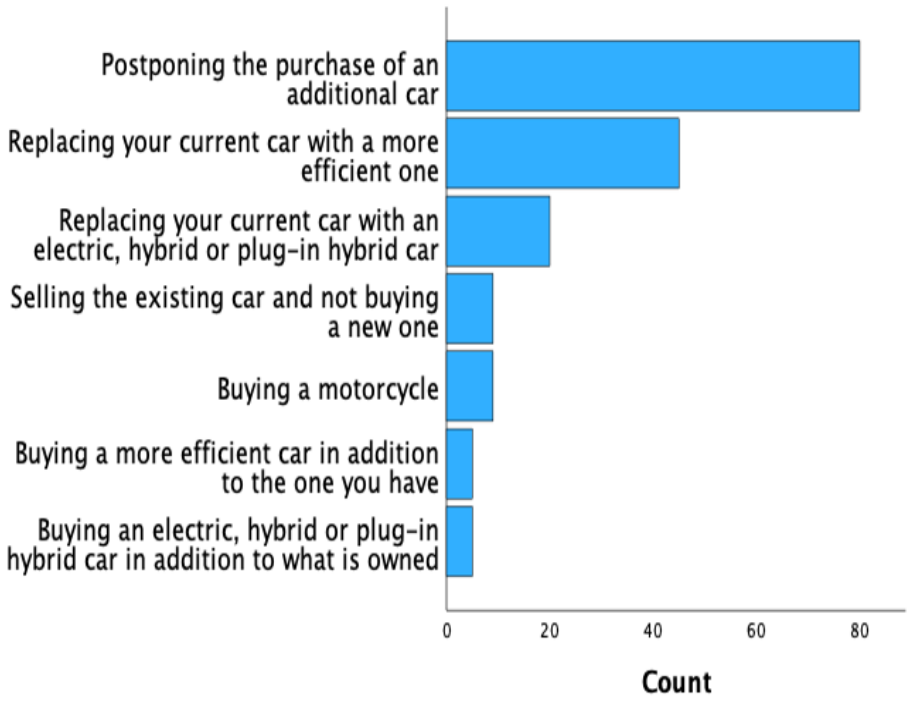

Figure 34. Distribution of Vehicle-Related Behavioural Changes

Overall, the findings suggest that people are willing to consider a range of options to save on fuel costs, and when consumers consider buying their next car, fuel costs impact their decisions.

5.2.5. P5: Distance-Related Behavioural Change

People that have decreased driving habits in the wake of the increase in fuel prices are asked if they have taken any of the following cost-saving and/or energy efficiency measures regarding distance. When fuel prices rise, many people may choose to cut back on driving via moving residence, switching to remote work, leaving the job, shopping near home, combining shopping and other outings, canceling long-distance vacations, taking shorter distance vacations, creating routes using the navigation to minimize unnecessary turns and optimize the route and others. The fact that a significant majority of the respondents 209 out of 234 adopted distance-related behavioral changes in response to rising fuel prices provides strong support for the a priori assumption. It suggests a clear connection between higher fuel prices and the adoption of cost-saving and energy-efficient measures related to distance, as indicated by the behaviors reported by the respondents. Given the large proportion of respondents who engaged in these strategies, it is reasonable to confirm P5 that people do adopt distance-related behavioral changes in response to rising fuel prices.

People were allowed to make multiple responses, so in a total of 209 people, each person gave an average of 1.9 answers to this question. 125 respondents (27.2% of responses, 51% of all cases) chose to shop around their homes without going far to meet their needs. In order to avoid unnecessary roads, entering the destination point into the navigation was the second most preferred strategy by 94 respondents (21% of responses, 38% of all cases). Another highly consulted method associated with shopping trips is going shopping while one is out for a ride was chosen 92 times (20% of responses, 38% of all cases). Canceling long-distance vacations or making shorter vacations were almost chosen equal times 57 and 56, respectively (12% of responses, 23% of all cases). Several 22 people started working from home or anywhere else. A fraction of respondents (12 people 12% of responses, 23% of all cases) left their houses for a more central one or one closer to work or public transit etc. Moreover, 1 person even left her job. Very much in parallel, in Corsi and Harvey's (1975) study, most of the participants reported mixed strategies. 70% reported doing at least one of the shopping strategies. Half of the participants changed their behavior related to their journey to work. More than 40% of the respondents made a behavior change in

recreation. A small fraction, 5%, reported relocation of residence closer to the workplace.

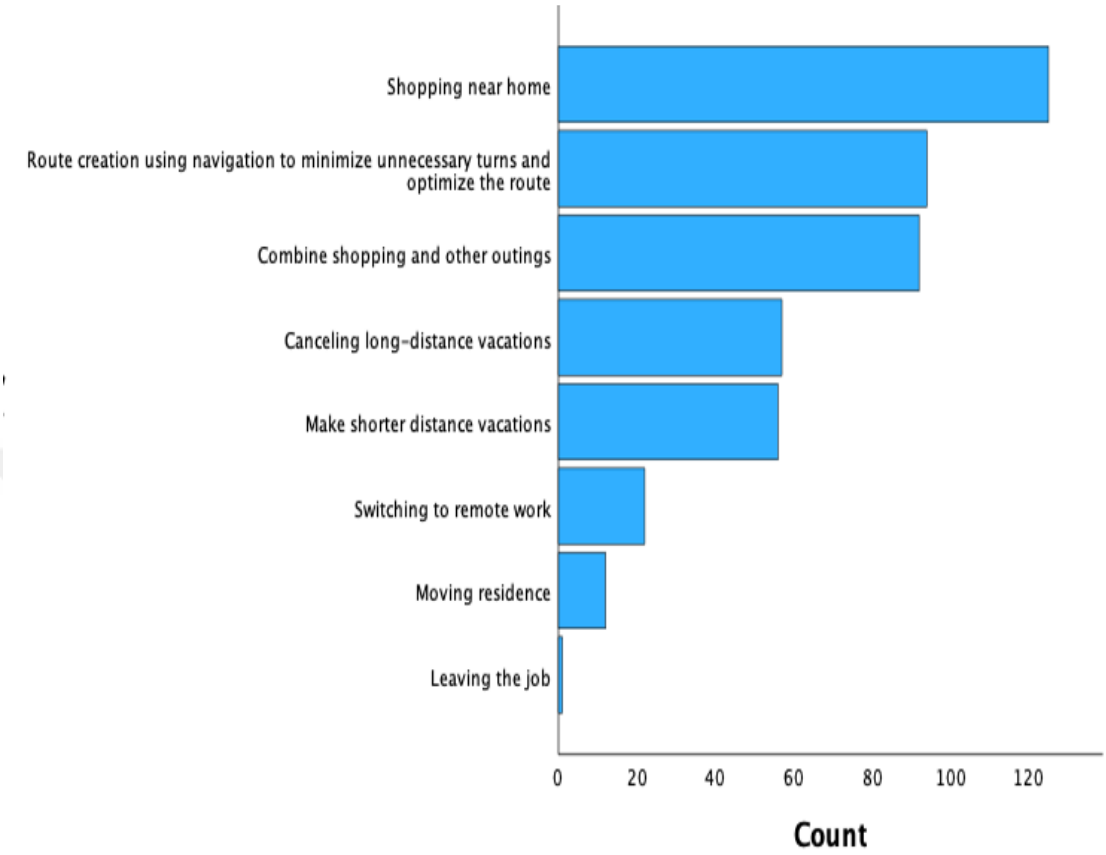

Figure 35. Distribution of Distance Related Behavioural Changes

In conclusion, rising fuel prices make people readjust their activities and ranges, decreasing the frequency or the range related to fulfilling them.

5.2.6. P6: Intention to Buy Alternative Fuel Vehicles

All participants are asked if they consider buying an EV, hybrid, or plug-in hybrid car. Higher fuel prices may push people to use alternative fuels, such as EVs, hybrid cars, or PHEVs, to reduce their dependence on gasoline.

According to survey results, approximately half of the sample consider buying an alternative fuel vehicle, and half do not. 51% of the respondents (280 people) declared that they either haven't made up their mind yet (21%, 116 people) or they are pessimistic about purchasing any type of alternative fuel car (30%, 164 people). The other 49% are enthusiastic about alternative fuel vehicles. EV is the leader of the demand with 144 potential customers (26%), hybrid cars come next with 102 potential buyers (19%) and 24 people (4%) are interested in purchasing the plug-in hybrid option. Overall, it can be inferred that out of every 2 folks, 1 is thinking of owning an electric, hybrid, or plug-in hybrid car. Based on the survey results, the assumption (P6) that higher fuel prices may push people to switch to alternative fuels is not entirely supported. It appears that there are other factors influencing the adoption of alternative vehicles.

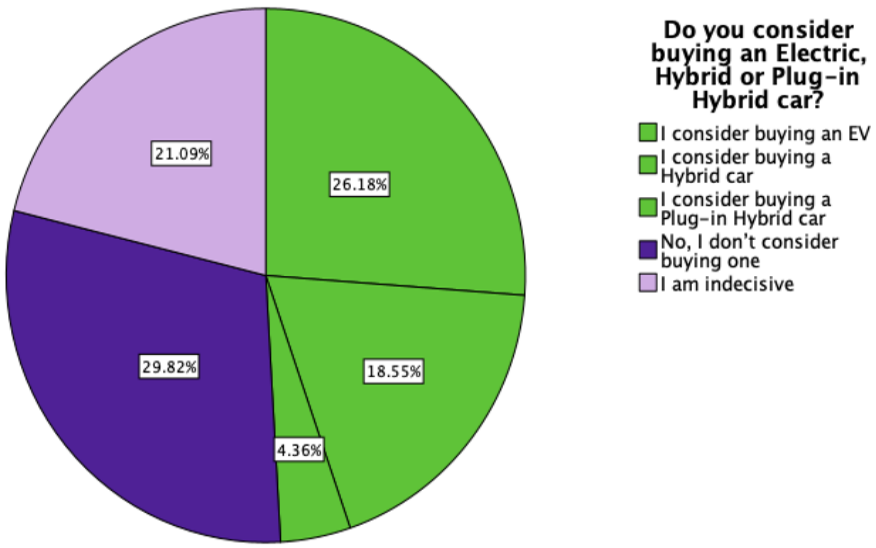

Figure 36. Distribution of Intention to Buy Alternative Fuel Vehicles

5.2.6.1. Motivating Factors to Buy Alternative Fuel Vehicles

In order to find out what are the driving factors for the participants to switch to an EV, hybrid, or plug-in hybrid car, 270 respondents are asked about them.

Respondents were allowed to make multiple choices, and each person considering buying an alternative fuel vehicle gave 3.2 answers on average. Expectedly, cheaper "fueling" cost, in this case, "charging" cost, is the top reason for interest. Most respondents are interested in EVs, hybrids and plug-in hybrids; 238 people (28% of responses, 88% of all cases) mentioned this aspect. Environmental friendliness and sustainability are key factors for people moving towards alternative fuel cars. 200 people (24% of responses, 74% of all cases) have selected it as a ground. 103 people (12% of responses, 38% of all cases) are looking forward to muting the engine's sound. Moreover, the availability of recharging at home is another factor leading 96 people (11% of responses, 36% of all cases) to consider buying one of these cars. Despite the high initial costs, lower cost of ownership seems like another essential factor in winning the consumers as 67 (8% of responses, a quarter of all cases) mentioned it. The revolutionary and disruptive technology lures 61 (7%, of responses, 23% of all cases) of the respondents. Performance, design, brand, and status are motivations relatively less frequently thought of, however, they are still considered by 47 (6% of responses, 17% of all cases), 21 (3% of responses, 8% of all cases), 12 (1% of responses, 4% of all cases), and 7 (1% of responses, 3% of all cases) people respectively. When compared to Whalen's (2022) recent broad survey, both studies clearly identify the concepts of eco-friendliness/sustainability as a significant factor influencing people's interest in alternative fuel cars. In this study, it is the second most important factor, while Whalen's findings indicate that it was the top reason for interest. It could be inferred that price/cost are important factors in both studies. In this research, it is mentioned as the top reason for interest due to cheaper charging costs, whereas in Whalen's, it appears as the second important factor. The availability of charging stations is mentioned as a factor in both studies. While this survey includes the availability of recharging at home, the other one refers to the availability of charging stations. Vehicle range, performance, and cost of ownership are factors considered by respondents in both studies, although they are ranked differently in importance. As a result, it could again be said that, when considering the purchase of

their next vehicle, consumers heavily consider gas prices, accordingly, the fuel economy of the car. It is important to emphasize that customers value more than just future fuel savings; they also feel a duty to reduce the consumption of resources, be aware that these options and greenhouse gas emissions are related, or value several other factors than financial savings on fuel costs.

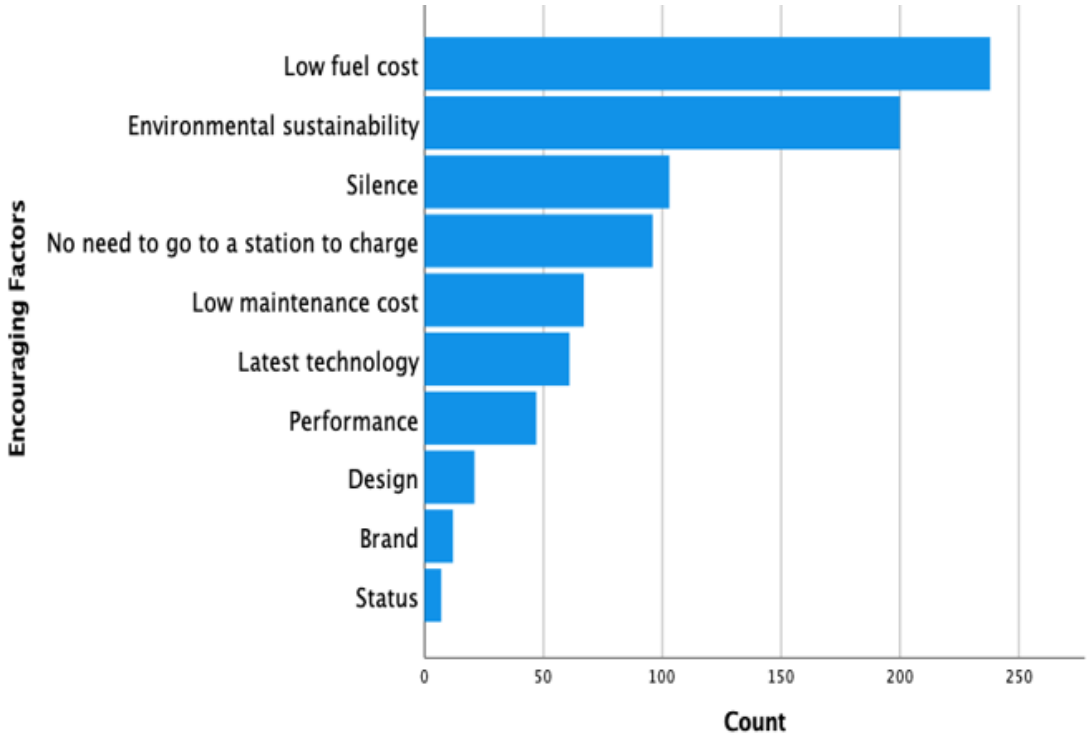

Figure 37. Distribution of Motivating Factors to buy Alternative Fuel Vehicles

5.2.6.2. Demotivating Factors to Buy Alternative Fuel Vehicles

Not all consumers are embracing electric vehicles, hybrid, and plug-in hybrid cars at the same rate. In order to find out what are the factors that draw-back the participants to switch to an EV, hybrid, or plug-in hybrid car, they are asked about them too.

Respondents were allowed to make multiple choices, and each person not considering buying an alternative fuel vehicle or having mixed feelings gave 2.9 answers on average. 175 (23% of responses, 65% of all cases) respondents stated that the initial cost of buying is the main deterrent. The availability of charging infrastructure comes next to drivers' minds. 160 people (21% of responses, 59% of all cases) think the number of AC/DC charging stations are insufficient. Many people (122 people, 16% of responses, 45% of all cases) have concerns about the battery, a main component of EVs. 97 respondents (13% of responses, 36% of all cases) think there is still time needed to advance the technology of cars. How far one can go with a single full charge is a determining factor for 80 (10% of responses, 30% of all cases). 49 people (6% of responses, 18% of all cases) do not know enough about the concept, therefore, they have a down on it. The fact that there are not as many options and quantities of EV, hybrid, and plug-in hybrid cars in the local market compared to conventional cars, 71 people (9% of responses, 26% of all cases) have chosen availability and a small number of model options as a drawback factor. Few people 18 (2% of responses, 7% of all cases) doubt the sustainability proposition of alternative fuel cars. Compared to Whalen's (2022) research, both studies identify price as the major discouraging factor for potential buyers, thus the main reason for disinterest in EVs. Lack of charging infrastructure and range are other major deterrents in both studies. Both results show a lack of availability as less important to potential buyers. To sum up, price, availability of charging stations, and vehicle range are big worries for households, making them clear of alternative fuel vehicles.

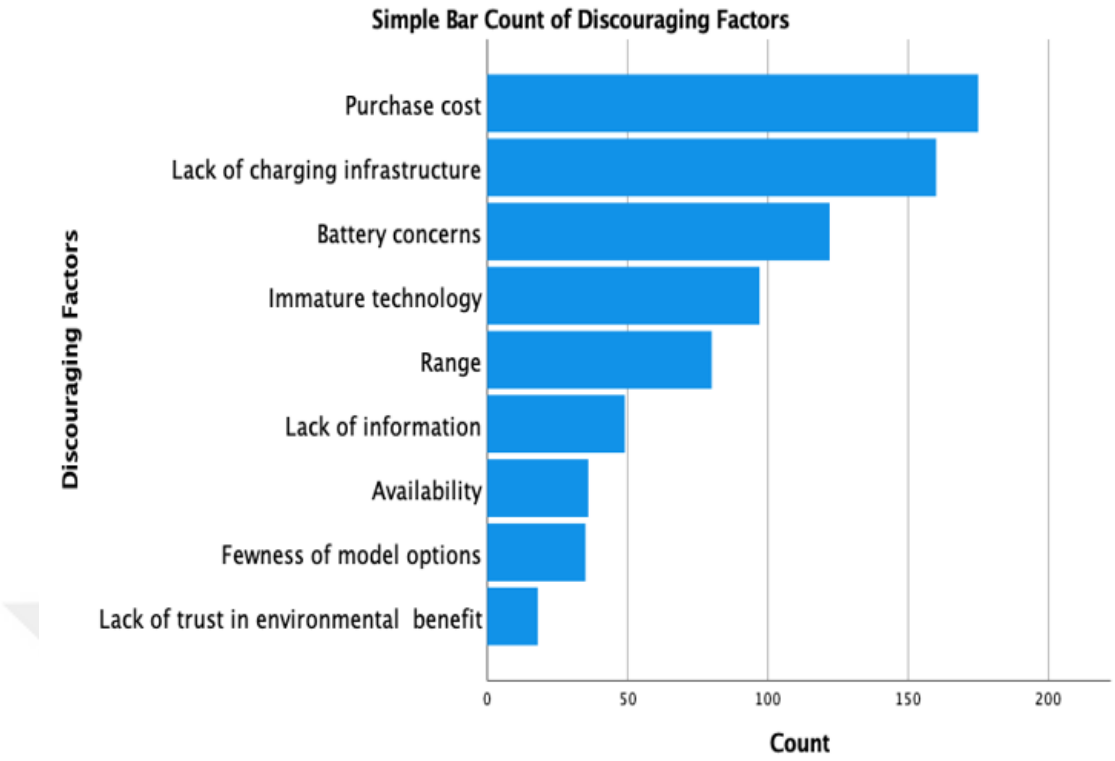

Figure 38. Distribution of Demotivating Factors to buy Alternative Fuel Vehicles

CHAPTER 6: DISCUSSION

Although the increase in fuel prices caused car owners a financial burden in many areas of life, from commuting to going on a vacation to daily activities, which meant paying more for life basics, this period provided researchers a setting to investigate how customers react to fluctuations in fuel prices. Unfortunately, some households were even obliged to cut their other expenses to balance their budget, but many found ways to have smaller gas pump receipts. This study examined how people responded and the approaches to soothe the burden of elevated prices. The results show that increasing gasoline prices cause particular changes in individuals' driving habits and directly affect sustainable transportation methods. Literature review and survey data of 550 people reveal that people take various precautions and adaptation strategies with increased gasoline prices. The novelty of the present paper is that it studies the phenomenon in a real-time setting. The results are discussed in light of the policy recommendations and practical implications of higher fuel prices for the potential for changes in people's travel behavior and transformation to a cleaner way of transportation.

To illustrate, decreasing VMT, switching to public transportation, applying driving techniques that will provide less fuel consumption, and turning to an intention to turn to more efficient cars or when thinking of the acquisition of an upcoming automobile considering the cost of fuel as an important factor and opting for an alternative fuel vehicle, shopping near homes are among the changes seen frequently. Taken together, these diverse strategies provide individuals with a comprehensive toolkit for effectively reducing fuel expenditure and fostering more efficient use of fuel, and the potential to significantly reduce carbon dioxide emissions, therefore, inclination towards embracing eco-friendly and energy-efficient transportation.

A significant portion - more than half of the participants- in the car owner sample stated that they tended to reduce their car use in response to alleviated fuel prices. Thus, those insensitive to changes in present-day price levels considered in this study reported an increased tendency to drop driving if the fuel prices continued climbing. Moreover, it is observed that people opted for public transportation or alternative

transportation methods to make up for less individual driving. Decreased preference for private riding potentially provides better air quality, less congestion and noise levels, and, most importantly, decreases CO2 emissions, mitigating climate change. It can be concluded that fuel cost is a way to influence travel behavior and transportation sustainability. In order to reduce individual driving, governments can introduce or increase fuel taxes. Higher fuel costs will encourage people to consider alternative modes of transportation, such as walking, cycling, or using public transit, which are more sustainable options. Although this modal shift has pro-environmental effects, it might pressure the existing infrastructure. Therefore, broader implications, such as the need for adequate infrastructure and addressing individual preferences and accessibility, should be considered. To accommodate more passengers, it might be necessary to invest in improving and expanding existing public transportation infrastructure and enhancing the frequency and coverage of routes to provide more reliable and efficient services for everyone. Also, although mass transportation is relatively less harmful to the environment than driving a car alone, the different modes of public transportation should be electrified. Thus, the electricity infrastructure should be resourced from renewable energy resources. Stakeholders from different disciplines, such as urban planners and academic researchers, should cooperate to ensure the transportation network is connected and the methods are integrated. In addition, walking appeared as the most preferred alternative to substituting individual driving. Walking is a sustainable mode of transportation that promotes physical activity, reduces pollution, and enhances community connectivity. Street pedestrianization is often considered a strategy to facilitate walking and encourage its adoption. Street pedestrianization involves transforming certain areas in urban settings into pedestrian-only zones. This research has confirmed that fuel pricing can be a powerful tool for modifying transport behavior and achieving climate targets.

Turning to and intention to turn to more efficient cars are among the changes seen frequently in response to alleviated fuel prices. Many respondents reported either buying additional (more efficient/alternative fuel cars) or replacing their cars with more efficient as well as EVs, hybrid cars and PHEVs. Moreover, almost half of the respondents mentioned willingness to buy alternative fuel vehicles. This tendency should be carefully evaluated. When thinking of the acquisition of an upcoming automobile, considering the cost of fuel as an important factor and opting for an

alternative fuel vehicle, especially EVs, have the potential to significantly reduce fuel usage and carbon dioxide emissions and mitigate climate change. Therefore this research has confirmed that fuel pricing can be a powerful tool for modifying transport behavior and achieving climate targets. However, despite rising fuel prices and climate concerns, EV adoption is not as large-scale as expected, as barriers to going electric still exist. When the participants were asked about factors that hinder buying an alternative fuel vehicle, the top 3 reasons appeared: (1) high initial costs, (2) lack of infrastructure, and (3) concerns regarding the battery. Although fuel-efficient cars promise long-term cost savings, some models have higher upfront price tags than conventional vehicles. Affordability is the top consideration for some individuals. Therefore, governments should offer financial incentives and subsidies for adopting alternative fuel vehicles. Moreover, transitioning to more fuel-efficient cars requires a supportive infrastructure, such as electric vehicle AC/DC charging stations. In order to overcome these drawbacks, governments and the private sector need to invest in the necessary infrastructure to encourage the adoption of these vehicles and ensure their practicality for consumers. Another important thing is removing people's concerns as it is a big obstacle to cleaner transportation. Unknown is a worry. The public and private sectors should unite to enlighten and break the ice between the end user and EVs. To sum up, addressing the barriers can assist the way for a widespread transition to more fuel-efficient cars, ultimately driving toward cleaner transportation and a greener future.

Notwithstanding the fact that the study has its strengths, several limitations should be acknowledged. For instance, longitudinal data would be useful to observe long-term effects; how people's driving habits and adaptation strategies change over time as they get used to high fuel prices. Moreover, while confirming some of the a priori assumptions, the evidence is based on observational data. Other factors or variables could also affect the decision of households and individuals decisions to make a change. In order to strengthen the confirmation of the hypotheses and to evaluate the statistical significance of the observed data, appropriate statistical analysis could be applied while also keeping an eye on confronting variables. Factors such as demographic characteristics could be considered for a better understanding of the complex relationship between fuel prices and driving behavior. Also, as mentioned, confounding factors or other variables such as the availability of alternative

transportation options or the participant's attitudes and motivations towards sustainability could play a role in changing or ability to change transport behavior. In short, identified deficiencies such as the lack of longitudinal data, quest of causal relationship and putting confounding factors into account appears as important gaps to fill for further research. Addressing these weaknesses will provide a more solid platform to understand the short and long term effects of the rising gasoline and diesel prices on driving habits and adaptation strategies. Besides, applying related statistical analysis and covering demographics will strengthen the confirmation of the hypothesis and the statistical significance of the observed data. These recommendations serve as a basis for further research to comprehend the subject matter better.

While previous literature and research focused on understanding household behaviors (for example, during the 1973-1975 period) to gain insights into future fuel crises happenings, today's research on the current energy crisis aims to provide ideas and solutions to be used in the shift away from fossil fuels. By examining historical studies conducted during previous fuel crises, researchers gained valuable knowledge about household behaviors and their response to fuel price fluctuations. However the focus of this research is the exploration of diverse motivations and perspectives to guide efforts in transitioning to sustainable transportation alternatives. As a result, it has been proven that increasing gasoline prices significantly affects individuals and increases the orientation towards sustainable transportation systems. This study reveals that gasoline prices can be used as a catalyst to promote a cleaner and more environmentally friendly transportation system.

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APPENDICES

Appendix A

The Survey

Energy Crisis, Rising Fuel Prices and Changing Transportation Behaviors

Dear Participant,

This questionnaire was designed to collect information about changing transportation preferences due to increasing fuel prices. For this purpose, you are asked to answer a series of questions. Please fill all questions with realistic answers. It is important for the study to mark the option that relates to you.

This study is purely for scientific purposes and the recorded data will only be used within the scope of scientific study. Participation in the survey is completely voluntary. Individuals aged 18 and over are expected to participate in the survey. No personal information such as name, e-mail, etc. will be requested from the participants, and the information obtained as a result of the survey will never be shared with a third party. All studies on the survey will be carried out anonymously within the scope of KVKK. Your participation in the survey will make a great contribution to this scientific study.

If you need more information about the research, please contact the following email address:

Thank you for your valuable participation.

Click "Next" to get started.

Gender*

Mark only one oval.

- Female
- Male
- Other

Age

Mark only one oval.

- 18-27
- 28-41
- 42-57
- 58-70
- 70+

Education status

Mark only one oval.

- Primary school
- Middle school
- High school
- Associate Degree (Vocational School)
- Undergraduate
- Undergraduate
- Master's
- PhD

Your Employment Status

Mark only one oval.

- Working in the office / at work
- Working from home
- Works hybrid (half office half home)
- Does not work
- Student
- Retired

Monthly Household Income *

Mark only one oval.

- 0-10.000 TL

- 10.001-20.000 TL
- 20.001-30.000 TL
- 30.001-40.000 TL
- 40.001 TL and above

Where You Live *

Mark only one oval.

- Urban
- Rural

Number of Persons Living in the Household *

- 1
- 2
- 3-4
- >4

If more than 1 person lives in the household;

Age Ranges of Households * (You can select more than one option.)

- <18
- 18-65
- 65+

Car Ownership

Number of Cars Owned by Household *

- 0
- 1
- 2 or more

If you do not have a car;

Do you use public transportation? *

- Yes
- No

If you do not have a car and use public transportation;

Which public transportation do you use? (you can select more than one option.)

- Bus
- Minibus
- Metro
- Izban
- Ferry
- Tram

If you do not have a car;

What other transportation methods do you use? * (You can tick more than one option.)

- Walking
- Bicycle
- Scooter
- Carpooling
- Motorcycle
- Taxi
- Service bus (work, school, airport, shopping center etc.)
- Other

Continue: If you own a car

What type is your car? *
(You can tick more than one option.)

- Traditional Gasoline Car
- Traditional Diesel Car
- Traditional LPG Car

- Electric Car
- Hybrid Car
- Plug-in Hybrid Car

How much is your monthly fuel consumption? * (Only type numbers, eg 5000)

Do you find fuel prices high? *

- Yes
- No

Has the increase in fuel prices affected your driving habits? *

- Decreased
- Not affected
- Increased

If not affected:

How much of a price increase from current levels is likely to have an impact on your driving habits?

	Very Unlikely	Unlikely	Neutral	Likely	Very Likely
0-25%					
26-50%					
51-75%					
76-100%					
>100%					

If decreased:

Do you use public transportation as an alternative?

- Yes
- No

If you use public transportation;

Which public transportation do you use? (you can select more than one option.)

- Bus
- Minibus
- Metro
- Izban
- Ferry
- Tram

Continue: if decreased;

What other transportation methods do you use? * (You can tick more than one option.)

- Walking
- Bicycle
- Scooter
- Carpooling
- Motorcycle
- Taxi
- Service bus (work, school, airport, shopping center etc.)
- Other

Have you taken any of the following cost saving and/or energy efficiency measures regarding fuel purchase? (You can tick more than one option.)

- Driving at a constant speed, avoiding high speeds
- Checking the tire pressures
- Keeping up with the maintenance time
- Reducing the use of air conditioning
- Avoiding unnecessary burdens

- Going to different gas stations to find the best price
- Filling the tank often, but buying sparingly (assuming prices fluctuate)
- other:

Have you taken any of the following cost saving and/or energy efficiency measures regarding your vehicle? (You can tick more than one option.)

- Replacing your current car with a more efficient one
- Replacing your current car with an electric, hybrid or plug-in hybrid car
- Buying a more efficient car in addition to the one you have
- Buying an electric, hybrid or plug-in hybrid car in addition to what is owned
- Buying a motorcycle
- Selling the existing car and not buying a new one
- Postponing the purchase of an additional car
- other:

Have you taken any of the following cost saving and/or energy efficiency measures regarding distance? (You can tick more than one option.)

- Moving residence
- Switching to remote work
- Leaving the job
- Shopping near home
- Combine shopping and other outings
- Canceling long-distance vacations
- Make shorter distance vacations
- Route creation using navigation to minimize unnecessary turns and optimize the route
- other:

In the future;

Do you consider buying an Electric, Hybrid or Plug-in Hybrid car? *

- I consider buying an Electric car
- I consider buying a Hybrid car
- I consider buying a Plug-in Hybrid car

- No, I don’t consider buying
- I am indecisive

If you consider buying an Electric, Hybrid or Plug-in Hybrid car;

What are the factors that encourage you to switch to an Electric, Hybrid or Plug-in hybrid vehicle? (You can tick more than one option.)

- Lower fuel / energy costs
- Low maintenance cost
- Being able to charge at home without going to a station
- Reducing air pollution and greenhouse gas emissions
- Being latest technology
- Performance (driving)
- To be noiseless
- Brand
- Design
- Status
- other:

What are the possible brands of Electric, Hybrid and Plug-in Hybrid* vehicles that you are considering purchasing in the near future? (You can tick more than one option.)

- TOGG
- Renault
- BMW
- Mercedes
- Volvo
- MG
- Citroen
- Mini
- Jaguar
- Porsche
- Tesla
- Toyota

- Jeep
- Honda
- Lexus
- Ford
- Subaru
- DS
- Range Rover
- Kia
- Hyundai
- Suzuki
- Other:

If you are not considering or indecisive;

What are the factors holding you back from moving to an Electric, Hybrid or Plug-in hybrid vehicle? (you can tick more than one option)

- Purchase cost
- Lack of information
- Lack of charging infrastructure
- Lack of trust in environmental benefit
- Immature technology
- Range
- Battery concerns
- Fewness of model options
- Availability
- other:

End.

Appendix B

SAYI : B.30.2.İEÜ.0.05.05-**020**-*250* 05.01.2023

KONU : Etik Kurul Kararı hk.

Sayın Prof. Dr. Mehmet Efe Biresselioğlu ve Selin Baysal,

"Enerji Krizi, Artan Akaryakıt Fiyatları ve Değişen Ulaşım Davranışları" başlıklı projenizin etik uygunluğu konusundaki başvurunuz sonuçlanmıştır.

Etik Kurulumuz 05.01.2023 tarihinde sizin başvurunuzun da içinde bulunduğu bir gündemle toplanmış ve Etik Kurul üyeleri projeleri incelemiştir.

Sonuçta 05.01.2023 tarihinde **"Enerji Krizi, Artan Akaryakıt Fiyatları ve Değişen Ulaşım Davranışları"** konulu projenizin etik açıdan uygun olduğuna oy birliğiyle karar verilmiştir.

Gereği için bilgilerinize sunarım.

Saygılarımla,

Prof. Dr. Murat Bengisu

Etik Kurul Başkanı