User's perceptions of electric, hybrid, and fuel-powered vehicles in Iraq and Jordan

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ABSTRACT

The shift towards the use of electric vehicles or hybrids has become one of the methods used to reduce the sources of pollution in many countries around the world. This study aims to understand drivers' perceptions and concerns with regard to electric, hybrid, and fuel-powered vehicles in Iraq and Jordan. An online survey was conducted through emails, social media, and connections to Iraq and Jordan. The study included 1352 participants, 662 (49%) from Iraq and 690 (51%) from Jordan. The chi-square homogeneity test was used to analyze the data. The majority of participants from Iraq reported that they do not have electric or hybrid vehicles because of the lack of charging stations. Participants from Jordan reported that they do not have electric or hybrid vehicles because they feel that electric or hybrid vehicles are unreliable. An additional logistic regression analysis was carried out to determine significant predictors that influence the person's choice of having friendly environmental fuel sources (electric or hybrid). Significant variables were found, such as country of region (Jordan and Iraq), gender, age group, car ownership, vehicle emissions, and climate change-related issues. The study identified regional, cost, performance, reliability, and environmental issues that affect people's perceptions and concerns about diversifying fuel sources used for vehicles. Raising public awareness of the benefits and actively changing society's perception, in the long run, requires an initiative that can be sustained constantly in society.

1. Introduction

In recent years, traffic volumes have increased in most countries in the world. This was accompanied by an increase in transportation emissions, affecting the environment and sustainability. Failure to address the sources of vehicle emissions will accelerate climate change and cause poor health conditions for transportation users and residents in areas with high pollution levels. Emissions cause severe respiratory problems for humans, weakening the body's immune system, reducing oxygen release to body tissues, mortality risks from cancer, congenital defects of newborns, and other health issues (Manisalidis et al., 2020). Besides, it has become a recognized necessity to ensure sustainable solutions for cities, especially in transportation and energy, at reasonable prices, safe, comprehensive, and integrated with infrastructures in the form of customer-focused services.

According to the most recent data, Iraq's transportation-related carbon dioxide pollution increased from 10% in 1970 to 30% in 2013 (Hashim et al., 2016). In Jordan, there was an increase of 30% in carbon dioxide emissions from the fuel burned for transportation (Jordanian Ministry of Energy and Mineral Resources, 2017). In 2003, Iraq stopped the financial support of fuel prices to become similar to the prices of fuel in most countries after the prices were subsidized and very low (James, 2007). However, the indications for the use of fossil fuel vehicles in Iraq are still overwhelming. The increase in traffic volumes has been accompanied by a clear decline in the infrastructure of the road system and its lack of development or expansion. As for Jordan, the government has established a goal to reduce greenhouse gas emissions by up to 41% by 2030 (Khouri, 2013). However, indicators show a continuation trend in the intensity of emissions, with an estimated annual increase of 2% in Gross Domestic Product (GDP) by 2030 (Ministry of Environment, 2017).

This study examines the environmental problems resulting from transportation in Iraq and Jordan. It also aims to address the perceptions of society and the role of the Iraqi and Jordanian governments in ways to

mitigate or reduce the damage of transportation emissions. The present survey explains Iraqi and Jordanian society's perceptions of transportation emissions, impacts, and mitigation mechanisms. The questionnaire was formulated to include different social categories from Iraqi and Jordanian societies with respect to ages, levels of education, incomes, and gender diversity. The survey was conducted using the Internet and through various social media platforms. This study is expected to show significant differences in participants' perceptions compared to other countries, such as the European or American communities. The completion of this study may compensate for some lack of information on Arab societies or the Middle East in transportation aspects and its impact on the environment.

2. Background

The world has suffered from air pollution problems because of its effects on the environment, humans, animals, and plants (Slovic et al., 2016). Many countries have sought to reduce pollutants by identifying their sources and finding alternatives that may reduce or limit the impact of sources of pollution (Riffat et al., 2016). Efforts to reduce pollution problems and damage vary depending on countries' financial, technological, and legislative capacities, ensuring that the necessary standards are met (Castaldi et al., 2015). The culture of people and their awareness of the problems of air pollution and their damage to the health and sustainability of society play a major role in reducing the spread of emissions (Jin, 2017). Nitrogen oxides (NO2) and particulates (PM2.5 and PM10) are the most characteristic features of ambient air pollution and have long-term effects on health (WHO, 2003). Transportation seems to be one of the main sources of the spread of these gases and particulate matter by burning fossil fuels in different vehicle engines (Chaichan et al., 2018).

The shift towards the use of electric vehicles or hybrids has become one of the methods used to reduce the sources of pollution in many countries of the world (World Economic Forum, 2018). Many governments are making efforts to promote electric or hybrid cars to improve air quality and reduce dependence on oil, which causes greenhouse gas emissions. Therefore, sales of electric vehicles have been increasing steadily, with the cumulative number of electric vehicles on the global market reaching 1 million in 2015 and 2 million in 2017 (Jin, 2017). With the increasing encouragement of citizens and municipalities to buy clean cars (DiChristopher, 2021), the number of electric vehicles is expected to increase to about 125 million by 2030.

In Iraq, despite rising fuel prices, demand for gasoline and diesel as primary fuels for vehicles is increasing as more vehicles are registered. The increase in fossil fuel consumption is causing financial pressure on both individuals and governments, as well as environmental and health damage (Khan and Kar, 2002). This requires understanding people's perceptions and concerns about diversifying modes of transportation, as well as diversifying fuel sources used for vehicles. The study also seeks to promote public awareness of the concept of sustainable and environmentally friendly transportation and to present the activities of the Iraqi government to encourage sales of electric and hybrid vehicles.

2.1. Vehicle technology

Vehicle manufacturers have made an accelerated paradigm shift in recent years towards the manufacture of fuel-efficient cars, hybrid cars, and finally to electric cars (Song and Potoglou, 2020). This development may be known as "energy electronics technologies," which aim at the optimal and efficient use of energy. The following narration shows the main general classifications of vehicles used on the road today according to their engines, with the possibility of special classifications within these general classifications. The first class of vehicles, the most common ones, is those with internal combustion engines (ICE). The second class of vehicles is the Hybrid Electric Vehicle (HEV), which includes an internal combustion engine (ICE) with an electric powertrain that uses

electricity only as a power source. The presence of the electric powertrain aims to achieve better fuel economy and performance. According to the International Energy Agency (IEA), Iraq's car fleet had less than 0.01% hybrid and electric vehicles in 2020. In a report published in Jordan times in 2020, hybrid vehicles represented around 1% of the total vehicles registered in Jordan. Fig. 1 shows a schematic illustration of the general classifications that have been mentioned, as well as parts of the special classifications.

The special classifications often include hybrid vehicles and electric vehicles, depending on the power transmission mechanism and source. Fully electric cars, known as "Battery Electric Vehicle (BEV)," do not include any internal combustion engine, which is the most significant difference from other vehicles. The other type of hybrid vehicle includes two separate engines: an internal combustion engine and an electric motor, known as a plug-in hybrid electric vehicle (PHEV).

3. Case study

This study was conducted in the State of Iraq and the Kingdom of Jordan, two neighboring countries in the western part of Asia, as shown in Fig. 2. Iraq has a diverse terrain of mountains, valleys, plains, and deserts. The total area of Iraq is about 437,072 square kilometers, with a population of about 39.34 million people, classified as males and females by 50.6% and 49.37%, respectively (Library Congress, 2006).

After 2003, Iraq witnessed dramatic changes in all directions, following the political turbulence in the country. Transportation has been the hardest hit due to lack of potential and the exploitation of most annual financial budgets on security aspects. Therefore, the field of transportation and all its components have been affected by the discontinuation of many strategic road projects and associated infrastructure, as well as most of the internal roads' projects of the cities. The chances of keeping pace with environmental developments have been greatly weakened, by the inability to pay attention to them, because of the complex security aspects of Iraq. The great weakness in the construction of new roads and infrastructure projects, in addition to the proliferation of security checkpoints, has greatly increased the problems of daily traffic jams. Stoppages for vehicles continue in protracted lines for very long periods, increasing vehicle emissions significantly and daily. The period for 2003, and several years thereafter, followed the entry of old and worn-out vehicles that did not have strict environmental specifications because of the country's preoccupation with maintaining security. Iraq has also imported huge quantities of vehicles, which do not meet the high standards of emissions treatment. In public transportation, whether owned by the government or the private sector, no transportation projects have been implemented for which electricity is the source of its operation.

The great role played by the Iraqi government in mitigating some of the problems of air pollution caused by transportation has been to reduce large quantities of old cars that were harmful to the environment (Iraqi Ministry of Environment et al., 2013). So, the Iraqi government has banned citizens from buying any new cars until an old car is canceled so that it can obtain a new vehicle plate number. Large quantities of old vehicles have disappeared, which has greatly contributed to the partial improvement of air quality.

As for Jordan, which is shown in Fig. 2 also, it is one of the countries with the least abundance of oil resources among the countries of the Arab region in the Arabian Peninsula, with a total area of 89,342 km^2. Jordan relies a lot on its economy to impose taxes on fuel and purchase vehicles and various goods. Jordan also depends economically on various fields such as agriculture, tourism, transportation, education, and health services. The population in 2020 had 10.8 million inhabitants, classified as males and females by 52.95% and 47.05%, respectively. The growth rate is 2.4%, and the population in urban areas is 70–80%, as most of the population is concentrated in urban areas, especially in the capital, Amman.

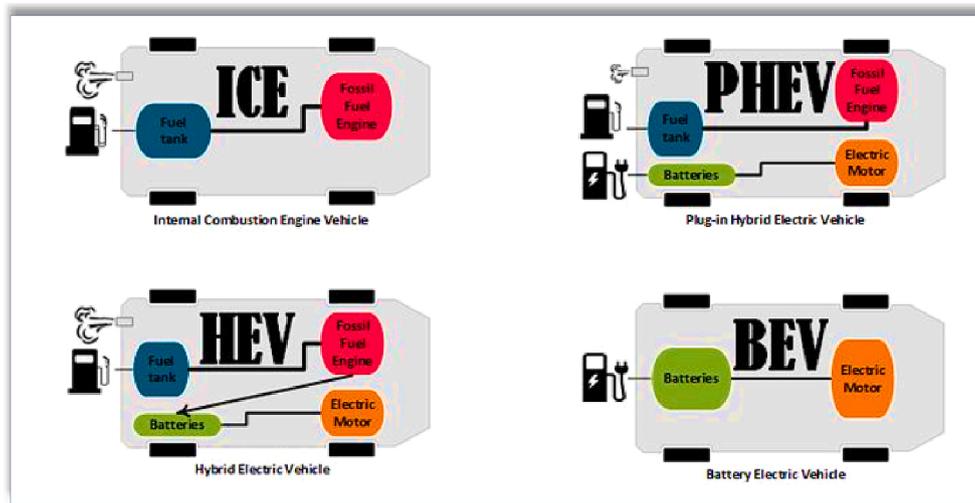In recent years, successive Jordanian governments have initiated

Fig. 1. Classification of vehicles by engine type.

Fig. 2. Field of study in Iraq and Jordan.

many measures that facilitate the spread of electric vehicles and hybrid cars to reduce dependence on fossil fuels and preserve the environment. The most important of those contributions was the reduction in taxes imposed on the import of electric and hybrid cars, although they lost the high tax revenues imposed on gasoline. Besides that, despite the remarkable increase in the number of electric and hybrid vehicles, Jordan still lacks infrastructure such as electric vehicle charging stations.

4. Methodology

4.1. Questionnaire design

The questionnaire was developed using existing research from other countries, such as China, United States, Malaysia, Indonesia, Saudi Arabia and Jordan (Chu et al., 2019; Sebaihi et al., 2019; Eneizan, 2019; Alhomaidat and Eljufout, 2021; Rahahleh et al., 2020; Alotaibi et al., 2022) while also taking into account Iraq and Jordan's unique peculiarities. We started by deciding which questions from the literature review should be included in the questionnaire. Questions that may impact the environment in Iraq and Jordan as a result of transportation. Previous studies have primarily been employed in other countries;

however, this study aims to focus on Iraq and Jordan.

The questions are divided into two categories. Part one examines the demographic features of the respondents, such as gender, age, educational level, and family status, as well as monthly income, career, family size, and whether or not they own a car. Part two focuses on factors that may impact the environment due to transportation, as shown in Table 1.

The study included a set of questions (19questions), starting with an introduction explaining the purpose of the research and asking the participants to choose between agreeing to participate or not. The questionnaire also included a set of guidelines and clarifications regarding the objectives of the study and the expected time to answer the questions. The study used the questionnaire via the Internet through a social media package to disseminate the survey to various groups of people. The reason for this is that more than 75 % and 88.8 % of people in Iraq and Jordan, respectively, have access to the Internet, making the sample more representative and random (ICT Facts and Opportunities in Jordan, 2011; Digital in Iraq, 2021). In addition, the survey was conducted online to facilitate and accelerate data collection and analysis. One of the most recent and distinguished programs was the use of the QuestionPro program to publish the questionnaire. The program includes a wide range of tools that give the researcher the freedom and ability to prepare the questionnaire to achieve the objectives of the study. It also provides monitoring of the responses and any obstacles that may appear in participants' answers, with the possibility of modification of questions during the period of distribution of the questionnaire. The questionnaire was published by email, Facebook, WhatsApp, and Viber. In addition, the survey program provides access to the results in the questionnaire simultaneously and across the Excel file with a set of charts.

Moreover, the detailed methodology of this research is summarized in Fig. 3, starting with determining the study objectives, reviewing previous surveys, developing and designing the survey, pre-testing on small groups, modifying and refining the final version of the survey, and administrating the questionnaire. Using statistical software STATA, descriptive statistics, chi-squared test, and logistic regression were analyzed. Finally, analyze the two countries' results (similarities/differences) and write the final report.

4.2. Description of the data

4.2.1. Statistical analysis

The nonparametric Pearson chi-square test (X^2) of homogeneity was conducted to test whether the percent distribution among Iraqi and Jordanians, respectively, differs with regard to car type, fuel preference, mode of transportation, and electric/hybrid car ownership. (X^2) is suitable for determining whether two grouping criteria are independent of each other in contingency tables (Washington et al., 2010). In addition, it allows the use of each cell in the contingency table with its matching cross-classification of attributes. The chi-square test (X^2) equation for the two-way contingency table is shown in Eq. (1). Whereas the null hypothesis is that the two study groups are statistically independent, the alternative hypothesis is that the two study groups are not statistically independent (Pandis, 2016).

$$X^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{\left(O_{ij} - E_{ij}\right)^2}{E_{ij}} \tag{1}$$

where the observed and expected frequencies are (O_{ij}) and (E_{ij}), respectively, and the degrees of freedom is $df = (r-1)(c-1)$. Where (i, j) denotes the expected count, the number of rows and columns represented by (R, C), respectively.

In order to provide information about the strength of all chi-squares significant associations, Cramer's V test was used and computed using the following Eq. (2). The strength of the association is provided through ranges from 0 to1.

Table 1
The questionnaire setting.

Questions	Answers
what fuel/charge do you use to fill your car	1-Gasoline, 2-Diesel, 3-Gas, 4-Electricity, 5-Hybrid car (gasoline and electricity)
If the cost and specifications of the car you want to buy are available, which car type will you choose	1-Gasoline, 2-Diesel, 3-Gas, 4-Electricity, 5-Hybrid car (gasoline and electricity)
Are most of your days traveling in the city, on the highway or mixed	1-City, 2-Highway, 3- Mixed
What is the transportation mode you prefer	1-My vehicle, 2-Taxi, 3-Public/Privet Bus 4-Train, 5-Other
Have you heard about Electric/Hybrid vehicles?	1-Yes, 2-No, 3- I do not Know
Would you be interested in owning/converting your vehicle into an Electric/Hybrid vehicle?	1-Yes, 2-No, 3- I am not sure
What is the reason for not having an electric/hybrid car?	1-Very expensive, 2-Maintenance (cost), 3-Performance issues, 4-Lack of charging station, 5-unreliable car, 6-all of them.
If you plan to buy electric/hybrid cars, how would you expect the price of hybrid cars compared to other cars?	1-More expensive than other fossil fuels cars, 2-slightly more expensive than other fossil fuels cars, 3-same price as other fossil fuels cars, 4-slightly cheaper than other fossil fuels cars, much cheaper than other fossil fuels cars, 5-I do not know.
If you plan to buy electric/hybrid cars, Are there any constraints?	1-Very expensive, 2-the specification of the car does not fulfill my need, 3-I need more information before buying the car, 4-constraints about charging issues.
Do you think vehicle emissions contribute to smog, the greenhouse effect, climate change, and affect the ozone layer?	1-Yes, 2-No,3-I do not Know
If your answer to the previous question was yes, what do you think is the solution to this problem?	1-Restrict the number of cars drive daily, 2-Fix cars emissions directly, 3-Replace fossil fuels with environmentally friendly vehicles (e.g., electric, or hybrid cars), 4-Encourage the use of active transport (walking or cycling) 5- provide the necessary infrastructure, 6-Tree planting to reduce carbon oxides, 7-use public transportation
Do you think vehicle emissions contribute to negative environmental impacts?	1-Yes, 2-No,3-I do not Know
Do you think that cars emissions affect people's health who have asthma?	1-Yes, 2-No,3-I do not Know

(*continued on next page*)

Table 1 (*continued*)

Questions	Answers
If your answer to the previous question was yes, what do you think is the solution to this problem?	1-Treat cars emissions directly, 2-Use masks, 3-Treat gases by controlling emissions by using techniques that control gases inside homes
Do you think that the Iraqi/ Jordan government contributes to reducing or mitigating the problems of transport emissions?	1-Yes, 2-No,3-I do not Know

$$v = \sqrt{\frac{\frac{X^2}{n}}{\min(k-1, r-1)}} \qquad (2)$$

A logistic regression model was also used to identify significant factors that influence people's decisions on what car type to choose based on fuel preference, mode of transportation, and electric/ hybrid car ownership student's/worker preference in the future in Iraq and Jordan. The choice of friendly environmental fuel (electric, hybrid, and others), as opposed to other fuel types (gas, diesel, and others), was the response of interest. Explanatory variables comprise several transportations, environmental, and socioeconomic factors that were collected from the online questionnaire. Tables 2 and 3 describe these factors. When the response variables are dichotomous, binary logistic regression is the best approach to utilize (Washington et al., 2010; Davis and Offord, 1997).

Given a set of explanatory or predictor variables, the logistic regression evaluated a person's chance to choose one of the friendly environmental fuels such as driving electric and hybrid vehicles over other types of fuel for transportation, such as gas, diesel, and others.

The following Equation depicts the mathematical formulation of logistic regression:

$$\ln\left(\frac{p}{1-p}\right) = \sum_{i=0}^{n} B_i x_i$$

Where p is the probability of a person driving electric and hybrid vehicles and x_i is the explanatory variable of interest with its corresponding coefficient β_i.

4.2.2. Data description

As stated earlier in the research methodology, an online questionnaire was distributed to over two thousand people through emails, social media, and connections to Iraq and Jordan. The survey was distributed randomly, with no preference for gender, level of education, or career. Over two thousand participants viewed the survey in both countries, and results were obtained from 1352 participants in total, with 662 (49%) from Iraq and 690 (51%) from Jordan. Furthermore, the study methodology offered ample insight into the specifics of the questionnaire, which aims to provide a clear understanding of the perception of car type, fuel preference, and electric/hybrid car ownership in Iraq and Jordan.

The male participation rate was 942 (70%), and the female participation rate was 410 (30%) for both genders. This age group had the
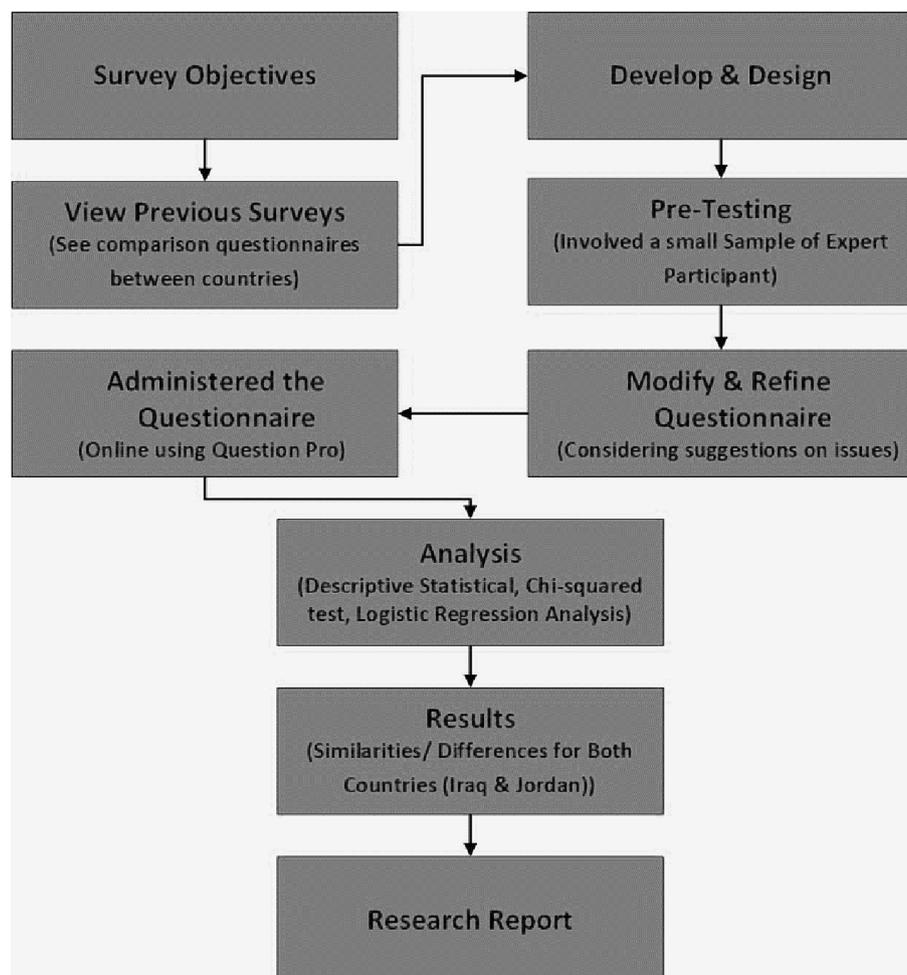

Fig. 3. Flow chart of the study methodology.

Table 2
Demographics of the participants.

Attribute	Gender	Observed	Frequency (%)
Gender	Male	942	70%
	Female	410	30%
Age	17–24	150	12%
	25–54	1080	80%
	>55	102	8%
Education Level	Middle school	62	5%
	High school	82	6%
	Community college	124	9%
	Undergraduate	660	49%
	Postgraduate	414	31%
Family Monthly Income	0–500 USD	354	26.18%
	501–1000 USD	478	35.36%
	1001–1500 USD	326	24.11%
	1501–2000 USD	100	7.40%
	2000 USD and more	84	6.21%
Country	Iraq	662	49%
	Jordan	690	51%

highest number of participants, with 80 percent of the participants being between the ages of 25 and 54. The participants' educational levels ranged from undergraduate to postgraduate, with 49 percent having a bachelor's degree and 31 percent having a master's degree. Participants were fairly spread across three income levels: 0–500 USD, 501–1,000 USD, and 1,001–1,500 USD per month.

5. Results and discussion

The chi-square homogeneity test was used to determine whether the observed Iraqi and Jordanian distributions by car type, fuel preference, mode of transportation, and electric/hybrid car ownership differed statistically. The findings are summarized in Table 3. In terms of fuel preference, there was a statistically significant difference in distribution between Iraq and Jordan (p = 0.000, Cramer's V = 0.197). The percentage of Iraqis who preferred using unfriendly environmental fuel sources for their vehicles (gas and diesel) was 57%. This percentage was lower among Jordanians who reported preferring to use unfriendly environmental fuel sources for their vehicles (40%). Regarding friendly environmental fuel sources for their vehicles (hybrid and electric) preferences, 41% of Iraqis reported, which was lower than Jordan's (60%). With regard to the current fuel type, the distribution among Jordan and Iraq showed a statistically significant difference (p = 0.00, Cramer's V = 0.217). The percentage of Iraqis who used gas fuel was 97%. This percentage was lower among Jordanians, who reported 78%. With regards to hybrid and electric fuel types, only 1% of Iraqi reported using them, which was lower than that of Jordan (15%).

The percent distribution of Iraq and Jordan for the mode of transportation was also examined. The distribution of Iraq showed a statistical difference compared with Jordan's distribution (p = 0.001, Cramer's V = 0.174). In general, the percentage of Iraqi people who were using their cars for their daily commute was 77%, but the percentage of Jordanians who reported using their mode of transportation was 83%. 13% of Iraqis reported using taxis or rideshare for their daily commute, which was higher than Jordan's by 8% as shown in Fig. 4.

Iraqi people's responses also showed a statistical difference compared with Jordanian people's responses when asked whether they have ever heard of hybrid vehicles (p = 0.000, Cramer's V = 0.205). For Iraq, the percentage (78%) said they had heard of hybrid vehicles, whereas 92% of Jordanian people reported when asked the same question. On the other hand, the percent distribution of Iraq and Jordan

Table 3
Association of the hybrid electric preference and transportation factors by country.

Category/statistical tests	Attributes	Iraq	Jordan
Fuel preference	Gas	55%	33%
Pearson chi2 (8) = 45.3261	Diesel	2%	7%
pr = 0.000			
Cramer's V = 0.1968	Electric	17%	19%
	Hybrid	24%	41%
	Other	2%	0%
Current fuel type	Gas	97%	78%
Pearson chi2 (8) = 41.9746	Diesel	2%	7%
pr = 0.000			
Cramer's V = 0.2174	Electric	0%	1%
	Other	1%	0%
	Hybrid	1%	14%
Mode of Transportation	My own car	77%	83%
Pearson chi2 (4) = 17.8143	public trans	8%	8%
pr = 0.001			
Cramer's V = 0.1739	Taxi	10%	2%
	rideshare	3%	6%
	other	2%	1%
Have you ever heard of a Hybrid car?	Yes	78%	92%
Pearson chi2 (2) = 24.6789	No	15%	6%
pr = 0.000			
Cramer's V = 0.2047	I am not sure	7%	2%
Reason for not having electric/hybrid car	Expensive	14%	11%
Pearson chi2 (6) = 29.8455	Maintenance (cost)	9%	20%
pr = 0.000			
Cramer's V = 0.1891	performance	13%	4%
	lack of charging station	22%	7%
	unreliable car	19%	47%
	All of them	23%	12%
The solution of car emission	fixing the car emission	50%	36%
Pearson chi2 (6) = 13.6077	wearing masks	0%	3%
pr = 0.003			
Cramer's V = 0.1713	control car emission for houses and building	10%	8%
	all the previous mentioned	39%	53%
Does the government attempt to control transportation emission?	Yes	4%	15%
Pearson chi2 (2) = 26.9715	No	86%	66%
pr = 0.000			
Cramer's V = 0.2398	I do not know	10%	19%

that have never heard of hybrid vehicles was (15%) and (6%). Participants were asked to identify the reason for not having electric/hybrid cars. The distribution across different reasons showed statistical differences across the two countries (p = 0.000, Cramér's V = 0.1891). In Iraq, lack of charging stations (22%) and unreliable cars (19%) were the dominant factors, while in Jordan, unreliable cars (47%) and maintenance (20%) were the main factors. Therefore, Iraqis were more sensitive to the lack of charging stations to have electric/hybrid cars, but for Jordanians, the decision was mainly influenced by unreliable cars. This finding has been reported to be prevalent in some European countries (Tiwari et al., 2020). A question about the solution to car emissions was also investigated. The distribution across the two countries showed statistical differences as indicated by Person chi-square and Cramér's V tests in Table 3 countries (p = 0.003, Cramér's V = 0.1713). Fixing the car emission from the car itself was the main factor that was pointed out to impede car emissions by 50% and 36% in Iraq and Jordan, respectively. This finding has been supported by previous work (Pielecha et al., 2020).
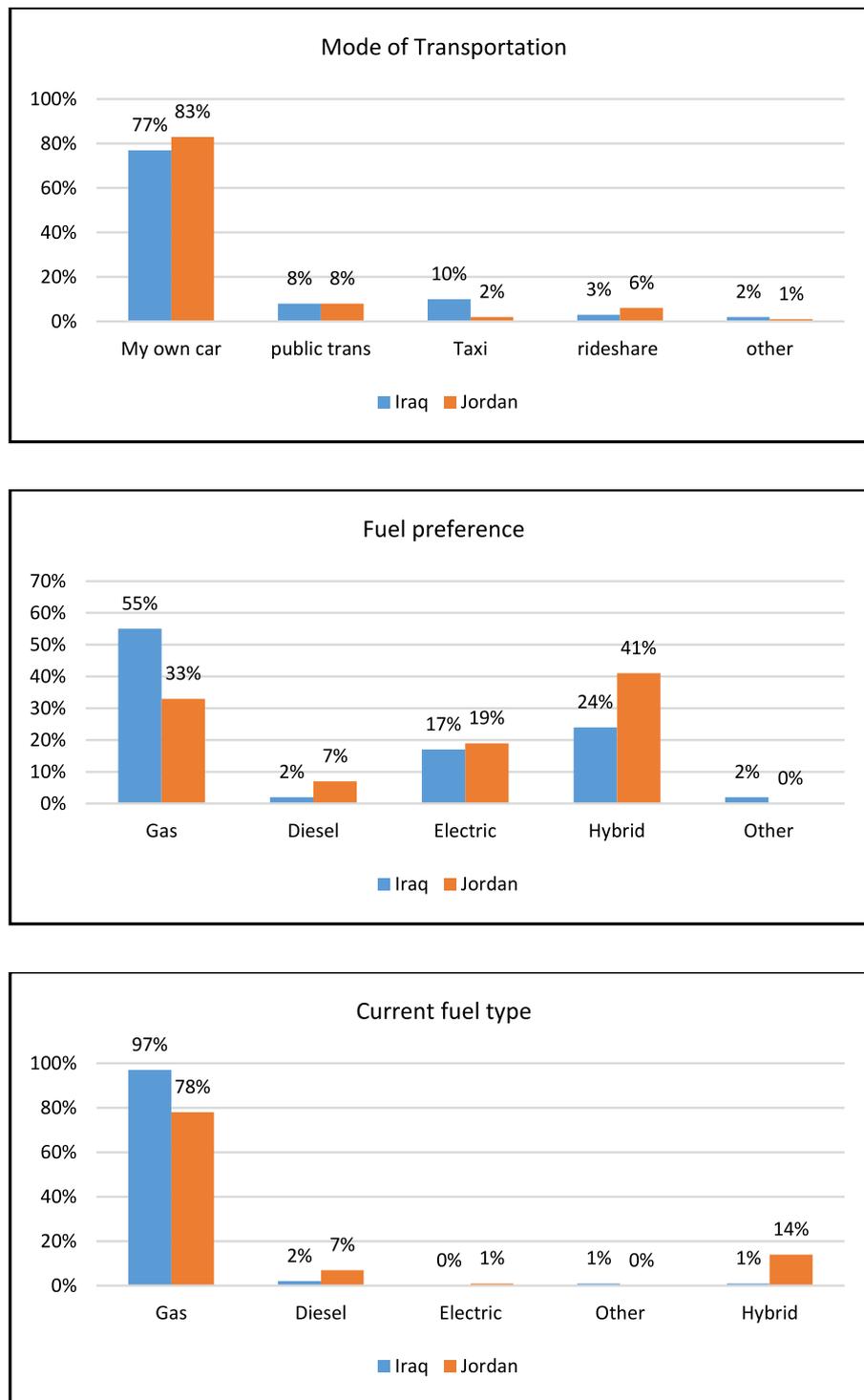
Fig. 4. Association of transportation mode, fuel preference, and current fuel type by each country.

Furthermore, Iraqi and Jordanian officials believe that car emissions for houses and buildings should be reduced by 10% and 8%, respectively. The percent distribution of Iraqi and Jordanian government attempts to control transportation emissions was also examined. The distribution of Iraq showed a statistical difference compared with Jordan's distribution (p = 0.000, Cramer's V = 0.239). In general, the percentage of Iraqi people who said no was 86%, but the percentage among Jordanians was 66%. For Iraq, a percentage (4%) said they think the government attempts to control transportation emissions, whereas 15% of Jordanian people reported when asked the same question.

A logistic regression model was used to further understand the main factors of a participant's type of fuel preference choice. The study looked into two types of fuel: friendly environmental fuel, such as driving electric and hybrid vehicles, and other types of fuel for transportation, such as gas, diesel, and others. A response variable was established using a dummy variable, with 1 representing gas, diesel, and other fuel types and 0 representing electric and hybrid vehicles.

As shown in Table 4, significant variables at a 95 % confidence level (p < 0.05) were used in the final model. Country, gender, age group, car ownership, fixing car emissions, and fixing negative environmental

Table 4
Modal choice logistic regression results.

Variable	cof.	Odd Ratio	Std. Err.	z	p > z
Country (Reference: Iraq)					
Jordan	0.449801	1.568	0.284	2.24	0.030
Gender (Reference: Female)					
Male	0.447247	1.564	0.302	2.07	0.038
Age group (Reference: Age 17–24)					
Age group (25–54)	−0.57448	0.563	0.178	−1.81	0.070
Car ownership	−0.56037	0.571	0.154	−2.08	0.038
Car emissions	0.605954	1.833	0.537	2.07	0.039
Negative Environmental Impacts	0.680568	1.975	0.455	2.96	0.003
Constant	−0.37542	0.687	0.265	−0.97	0.330

log-likelihood ratio test: LR Chi2 (6) = 26.71 > Prob 0.002 Pseudo R2 = 0.0409

impacts were significant predictor variables in predicting model choice. Being Jordanian and being concerned about car emissions and negative environmental impacts were all factors that increased the likelihood of owning a friendly environment fuel electric or hybrid car. On the other hand, factors such as the middle age group and car ownership have all been proven to significantly hinder the development of friendly environmental fuel electric or hybrid vehicles.

The model tested the high cost of owning an electric or hybrid car, high maintenance costs, performance issues, a lack of charging stations, car unreliability issues, and the solution for car emissions and climate change-related negative environmental impacts. For all the reasons to not have/have electric/hybrid cars that were investigated in this study, only solution car emissions and climate change-related issues significantly contributed to the person's choice of friendly environmental fuel (electric, hybrid) ($p < 0.05$). Therefore, raising public awareness of the benefits such as reducing car emissions by choosing a friendly environmental fuel (electric, hybrid) will be more likely to be the most dominant fuel use.

6. Conclusion

In the Arab world, many factors can influence a person's choice of friendly environmental car fuel (electric, hybrid) as opposed to other types of car fuel (gas, diesel, and others), such as country. This study investigated people's perceptions and concerns about diversifying modes of transportation, as well as diversifying fuel sources used for vehicles in two Arab countries, Iraq and Jordan. The questions were structured to obtain different factors that influence the person's choice of friendly environmental fuel sources used for vehicles, such as gender, age, education level, family monthly income, the reason for not having an electric/hybrid vehicle, country, and car emission-related issues.

The nationality gap in friendly environmental fuel sources used for vehicles was observed for people in both countries. Jordanian people preferred using hybrids and electric cars to Iraqis. Despite reporting that their family's monthly income is higher than Jordanians, Iraqi people preferred to use gas-fueled cars to go to school or the workplace. Raising public awareness of the benefits and actively changing the perception of society and Iraqis, in the long run, requires an initiative that can be sustained constantly in society. One of the activities may be to raise awareness of the relevant benefits of electric car studies and workshops at the university, highlighting the environmental benefits of sustainable energy. Education can target Iraqis whose perceptions prevent them from participating in environmentally friendly automobile fuel sources. Furthermore, many media outlets can be used to convey educational

campaigns and programs to the general public, which can aid in raising awareness and actively changing society's attitude toward electric or hybrid vehicles in the long run.

CRediT authorship contribution statement

Fadi Alhomaidat: Conceptualization, Methodology, Software, Writing – original draft. **Raed Abdullah Hasan:** Conceptualization, Methodology, Writing – review & editing. **Tamer Eljufout:** Writing – review & editing. **Abbas Hadi Abbas:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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