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Identification and prioritization of factors affecting the adoption of electric vehicles using analytic network process

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ABSTRACT

BACKGROUND AND OBJECTIVES: Given the spread of environmental pollution, the development of strategies and changes in lifestyle to reduce urban environmental pollution is of great importance. One of the existing solutions is to develop and promote the use of electric vehicles. An electric vehicle is a car that uses a battery pack to store the electrical energy that powers the motor. EV batteries are charged by plugging the vehicle in to an electric power source. These days, electric vehicles are considered as one of the most modern innovations in the car business. However, the use of these vehicles has not been particularly widespread in third world countries, and this may be due to several reasons. Despite the high level of air pollution in Iran, People and the government still do not accept electric vehicles as an important way to reduce air pollution, and electric vehicles are rarely seen on the streets. The main factors that can affect the reception of electric vehicles by the Iranian people are economic, technical, access, laws, marketing, and personal.
METHODS: The factors extracted from literature and identified factors were prioritized using the analytic network process technique. After data gathering with help of questionnaire which its relaiablity and validity was confirmed through inconsistency index and content validity ratio consecutively, the data analysis was performed using SuperDecision software.
FINDINGS: The results showed that Economic with 23%, Technical with 17.8%, Accessibility with 16.4%, laws with 15.3%, marketing with 15.1% and personal with 12.2% had the most significant effect in acceptance of the Iranian people of electric vehicles.
CONCLUSION: The results showed that economic factors had the most significant effect in comparison with other criteria. depreciation time, producer company, fuel subsidy, availability of repair shop, car and importance to the environment were the most significant factor in each criteria.

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INTRODUCTION

In recent decades, environmental issues have been addressed in various ways. The environmental issues began in the 1960s and their main focus was on industrial pollution, due to the growth of industrial economies (Khalil and Inam, 2006). In the late 1970s, the link between trade development and the environment peaked, and environmentalists organized widespread opposition and rallies around the world to protest the state of the environment as trade grew. They believed that as a result of trade liberalization and increased exports, economic activity, including pollutant activity, will expand exponentially and resource and energy use will increase improperly (Khalil and Inam, 2006). Emission from motor vehicles are one of the most important sources of human exposure to air pollution (johansson *et al.*, 2017). The World Health Organization (WHO) estimates 2.4 million fatalities due to air pollution every year. Since the breathing of polluted air can have severe health effects such as asthma, increased cardiovascular risks, most countries have strengthened laws to control the air quality and mainly focus on emissions from automobiles. (Müller *et al.*, 2017). Developing Electric Vehicles (EVs) has a significant meaning in protecting the environment (Adnan *et al.*, 2017). Plug-in electric vehicles can potentially emit substantially lower CO2 emissions than internal combustion engine vehicles, and so have the potential to reduce transport emissions without curtailing personal car use (Graham-Rowe *et al.*, 2012). These days the use of EVs in the world is increasing. In 2012, approximately 110,000 batteies in the electric vehicles were used worldwide, and this number was mounted to nearly 3.3 million in 2019. (Huda *et al.*, 2019). Environmental and energy security issues have prompted governments to pursue a number of incentive policies to upgrade electric vehicles and benefit from policy dividends, beyond the global threshold of 1 million electric cars on the road in 2015, and went and closed at 1.26 million (Wang *et al.*, 2019). Electric vehicles (EV) are introduced as a medium-term technology suitable for reducing dependence on fossil fuels and eliminating or reducing GreenHouse Gases (GHGs) emissions associated with conventional vehicles (CVs). Despite the benefits of electric cars, several barriers need to be overcome before the widespread adoption of electric vehicles. (Egbue and Long 2012).

The environmental and economic impact of electric vehicles will depend on the users that can accept EVs of a given capability, and then in turn on how those EVs are actually used. *(Tamor et al.,* 2013). However, the low public acceptance of EVs hinders the promotion of EVs in Iran. To address this problem, this study examines the factors that can affect the acceptance of electric vehicles by the Iranian people. The result of this research can define the barriers of Iranian EVs acceptance and also categorize the most important factors of EVs acceptance. Also, by identifying barriers to EV acceptance, not only can barriers be overcome, but also the electric vehicle industry and electric vehicle acceptance can be improved.

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The transport sector plays an important role in air pollution and consequently climate change due to Greenhouse gas emissions in urban areas (Chapman, 2007) Thus replacing internal combustion vehicles with new energy vehicles such as electric vehicles (EVs) is a promising step in predicting urban sustainability. Technologies related to electric mobility have changed exponentially (Song and Aaldering, 2019) Therefore, the literature covering these changes has increased significantly furthermore EVs adoption by society plays important role in this situation and some factors affect this adoption. But what is the most important factors that affecting EVs adoption? China's electric vehicle market has expanded rapidly, making China the world's largest electric vehicle market. Therefore, research on China and how to expand the acceptance of electric vehicles in this country is so important (Du and Ouyang, 2017). Based on a research in China, Tu and Yang (2019) stated that when consumers believe that electric vehicles are more profitable on individual, environmental or at the national level, or that they find it easier and more convenient to use electric vehicles, they will show a more positive attitude towards buying electric vehicles. Consumers' access to buy electric cars and their accessories will have the greatest impact on their behavioral attitudes. However, the opinions of buyers' friends regarding the use of electric vehicles also significantly affect their behavioral intention to buy electric vehicles. Thus, individual and accessibility factors plays an important role in EVs adoption. Wang *et al.,* (2017) stated that government rules is one of the effective factors in EVs adoption and China by

Stimulating encouraging policies, promoted sales of EVs exceeded 500,000 in 2016. In a research in Toyota company about purchasing Toyota Pirus, Ozaki and Sevastyanova (2011) stated that the financial benefits related to transport policy are an important factor in consumer hybrid purchase motivations and therefore economic and marketing factors play an important role in accepting EVs. In another study Jensen *et al*., (2013) mentioned that one the important factors in EVs adoption is technical factors and stated that there are major changes in the preference for driving range, top speed, fuel cost, battery life and charging in city centres and train stations. In Table 1 some of the important previous studies about EVs acceptance and their result are mentioned. These studies are classified to 6 criterias that affecting EVs adoption in

Table 1: important previous studies about EVs acceptance

Result	Refrence
Mentioned driving a plug-in hybrid electric vehicle can save hundreds of dollars annually on gas and diesel costs and contribute to environmental sustainability	Khooban *et al.,* (2016)
Classified the effecting factors as environmental-related, cost-related, comfort-related, trust-related, and technology-related argumentations.	Ziefle *et al.,* (2014)
Indicated that the higher a consumer's perception of the price of electric vehicles and the long charging times are, the less a consumer's willingness to buy a new electric car is .	Junquera *et al.,* (2016)
Showed that frequent car use, climate awareness, fuel economy, range, reservation price are EVs use effective factors.	Bigerna and Micheli (2018)
Showed the effect of fuel type and operation method, availability of charging facilities, fuel cost and vehicle price on EVs choice	Choi *et al.,* (2018)
Stated EVs' effective factors can be classified as command and control, economic (direct investments in r&d or infrastructure, preferential pricing policies, subsidies for EV purchase or EV infrastructure construction and tax incentives for EVs), procurement, collaborative, communication, and diffusion	Leurent and Windisch (2011)
Showed that personal norms have a positive impact on the intention to adopt the EV, and such influence is moderated by external costs, including perceived price and perceived complexity. The former moderates it, while the latter has the effect of the nonlinear adjustment. Also, awareness of the consequences, the description of responsibility and perceived consumer effectiveness are positive predictors of personal norms	He and Zhan (2018)
Indicated that some prople are unfamiliar with the concept of net cost and the long-term benefit of EVs.	Gillingham *et al*., (2009); Allcott and Greenstone, (2012); Gillingham and Palmer, (2013)
Stated that some believe that car consumers prefer novel technology to traditional technology so they use EVs	Arning *et al*., (2013); Joffe, (2003)
Showed the geographical characteristics such as age, education, and gender are proved the affect EVs acceptance	Wilkowska and Ziefle, (2013); Carley *et al.,* (2013)
The effect of vehicle confidence or environmental attitudes on electric car purchases was proven	Graham-Rowe *et al.,* (2012), Daziano and Bolduc (2011) and Turcksin *et al*.,(2013)
In a research determined that middle-aged women are far more likely to use electric vehicles than men and young people. Also, being aware of the benefits and how to use this type of vehicle can affect their tendency to use this type of vehicle.	Kumar and Kumar (2020)
Showed the complexity/ease of, trialability. observability and social norm effect on EVs acceptance	Dütschke *et al.,* (2013)
Believed that when consumers believe that electric vehicles are more beneficial at the individual, environment or national level, or they believe that the usage of electric vehicles is simpler and more convenient, they will show a more positive attitude towards the purchase of EVs.	Tu and Yang (2019)

Continued Table 1: important previous studies about EVs acceptance

Found that ecological significance and individual preference affect EVs acceptance.	Adnan *et al.,* (2017)
Showd the effect of consumers'attitude, subjective norms, perceived behavioral control and personal moral norm on plugin hybrid electric vehicles adoption	Adnan *et al.,* (2018)
Showed the special skills needed for using the electric vehicle as novel technology are another factor that affects using EVs	Gaul and Ziefle, (2009); Melenhorst, *et al.,* (2006)
Stated social influence, perceived enjoyment, anxiety and facilitation condition affect EVs' intention to use.	Khazaei (2016)
Showed that the effect of perceived ease of use, perceived usefulness, perceived enjoyment, satisfaction, public attitude, perceived cost on EVs intention to use	Park *et al.,* (2018)
Indicated the effect of environmental concern, psychological benefit, infrastructure readiness, consumer knowledge, demographic on EVs intention to use	Sang and Bekhet (2015)
Stated that a major potential barrier to the widespread adoption of EVs is the uncertainty regarding EV battery technology and fuel source sustainability	Egbue and Long (2012)
Showed the limited charging time of EVs is another factor that affects people's negative attitudes toward Evs	Jensen *et al.;* (2013); Krupa *et al.,* (2014)
Believed that the technical performance of EVs is an effective factor in consumers' acceptance of EVs	Ozaki and Sevastyanova (2011)
Showed that another factor that can affect EVs acceptance is perceived usefulness	Wilkowska *et al.,* 2014; Beul-Leusmann, *et al.,* 2014). Ziefle *et al.,* (2014)
Concluded that cruise range, purchase price, road tolls exemption, purchase tax exemption, tax exemption, parking fee exemption, insurance fee exemption, public charging fee exemption, purchase restriction rescission, driving restriction rescission, and access to bus lanes affect electric vehicle acceptance.	Wang *et al.,* (2017)
Investigate the role of 7 different incentives including exemption from purchase tax, exemption from VAT, vehicle license fee reduction, exemption from road tolling, free parking, bus lane access and free ferry tickets on battery electric vehicles.	Bjerkan *et al.,* (2016)
Stated that a regulatory framework can affect EVs using.	Haddadian *et al.,* (2015)
Showed the government role in EVs purchasing	Lane and Potter (2007)
Showd the environmental protection awareness effect on EVs acceptance	Hidrue *et al.,* (2011); Tian (2012) and Plötz *et al.* (2014)
Studied the technical level, marketing, perceived risks, and environmental awareness are the most effective factors in public acceptance of EVs.	Wang *et al.,*(2019)
Stated that besides supportive national policies, skillful marketing is needed to get it accepted and diffused throughout society.	Gärling and Thøgersen (2001)
Stated that without the advantage of increased gasoline prices, the growth of the hybrid vehicles market is insignificant, and that the Internet has a significant influence on the word of mouth effect in the purchasing process.	Choi *et al.,*(2013)

the world (technological, economic, marketing, rules, individual, accessibility).

Despite the high level of air pollution in Iran, the popularity of electric vehicles as an important way to reduce air pollution is very low and electric vehicles are rarely seen on the streets. This paper is structured as follows. It opens with a general discussion of EVs and the factors which can affect their acceptance and then followed by the conceptual model, the methodology and the analysis of empirical findings. Finally, the paper outlines the conclusions. The current study has been carried out in Tehran in 2020.
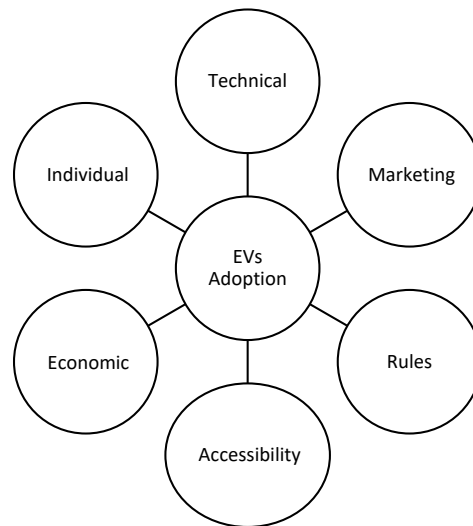
Fig. 1: Conceptual model

MATERIALS AND METHODS

Although many studies about the prioritization of factors affecting a particular issue and its evaluation have been applied in the AHP, studying the factors influencing the acceptance of electric vehicles needs to have a way beyond the hierarchical relations. The hierarchy network can show top-down linear connections and is weak in showing dependency or subordination and complex direct or indirect relationships. Since the use of AHP to prioritize the factors of electric vehicle selection is limited, we intend to use the ANP method in prioritizing the factors influencing the acceptance of electric vehicles, because it considers the factors and the relationship between them. The ANP method can identify intangible interdependencies and the relationship between factors, subfactors, and alternatives. It is possible that some elements of a cluster may affect one or all of the other cluster elements. The reasons for using the ANP method are as follows:

1- Prioritizing the factors affecting the acceptance of electric vehicles is a multi-criteria decision problem.
2- Dependence on network elements, in which each element affects another
3- It is difficult to achieve the relative importance of some criteria using the simple weighting method (Agarwal *et al.*, 2006)

The advantage of using the ANP in factor prioritization is to show the effect of factors on each other in which each factor can interact with other clusters (i.e., factors) and their sub-factors. In addition, sub-factors of each factor can influence other factors. The ANP method requires the use of a pairwise comparison matrix (Hosseini *et al.*, 2013). This complex and sensitive pairwise comparison is performed by a skilled team of experts. The opinion of some experts about the pairwise comparison is presented in this article and the mean of this collation is calculated according to their opinions. The ANP can be used to find the best strategy. AHP / ANP reduces a multidimensional problem to a one-dimensional problem (Saaty and Sodenkamp, 2008). Like AHP, in ANP the main logic is based on pairwise comparisons. However, this pairwise comparison matrix in ANP is more complex than that in the AHP. In ANP, to complete the super matrix, we need to consider the relationship between factors / sub-factors and the relationship between sub-factors in one cluster to sub-factors in another cluster. Then a pairwise comparison must be made between the network elements, which is different from the AHP network comparison (Hosseini *et al.*, 2013). To find the matrix priority and calculate the consistency ratio (CR), SuperDecision is used software. Based on the literature about the factors affecting EVs adoption, EVs adoption factors are classified as technical, marketing, rules, access, economic, individual factors. Fig. 1 shows the research model and Table 2 shows the criteria and sub-criteria with their codes.

Table 2: EVs adoption effective factors coding

Code	Criteria	Code	Sub-Criteria
C1	Technical	S1	Charging time
		S2	Parts availability
		S3	Vehicle appearance
		S4	Depreciation time
		S5	Technology development
		S6	Competitiveness
		S7	Production run
		S8	After-sales service
		S9	Accessory supply
		S10	Product variety
		S11	Safety assurance
C2	Marketing	S12	Advertising
		S13	Producer country reputation
		S14	Branding
C3	Rules	S15	Tax deficit
		S16	Purchase facility
		S17	Fuel subsidy
		S18	Import license
C4	Accessibility	S19	Information on how to use it
		S20	Access to fuel station
		S21	Ability to charge at home
		S22	Availability of repair shop
C5	Economic	S23	Car price
		S24	Fuel price
		S25	Repair cost
		S26	Accessory cost
		S27	Insurance cost
		S28	Amortization cost
C6	Individual	S29	Importance to the environment
		S30	Gender
		S31	Education
		S32	Age
		S33	Community acceptance

The statistical sample includes automotive industry experts with a minimum bachelor's degree, more than 5 years of work experience and organizational position of management and academic experts in industrial engineering with an associate degree. Based on the purposive sampling the total numbers of 40 experts were selected as sample. An analytic network process questionnaire was designed according to purposes, criteria, sub-criteria, and intervention effect of each criterion. The ANP is a broad form of AHP that considers the relationship of factors to each other, the effect of each element on other criteria, and independency between and within levels. The steps for using the ANP method are as follows (Yuksel and gdeviren, 2007; Lee, 2012):

Step 1: determining the importance value of factors, based on **6** elements (technical, marketing, rules, accessibility, economic, individual). This step is the common part between AHP and ANP for pairwise comparison and priority vectors.

Step 2: determining the magnitude of subfactors (e.g., Charging time, Parts availability, Vehicle appearance, and Depreciation time) should be done as the second stage. For comparing the elements in each cluster, scales in discrete interval {1-9} are chosen (Saaty and Sodenkamp, 2008). Scale 9 shows the extremely preference of an element in comparison with others and scale 1 shows the same preference of the elements, in which aij indicates the importance of the ith element with respect to the jthe element (Lee, 2012). After designing the questionnaire, it was completed by the selected population sample based on the numerical values in Table 3.

Step 3: Calculating the super matrix partitioned based on the cluster (factors) and Its elements are

Table 3: Numeral values for items comparison

Numeral value	Degree of importance in pairwise comparison
1	Same preference
2	Same to fairly preferred
3	Fairly preferred
4	Fairly to strongly preferred
5	Strongly preferred
6	Strongly preferred to very strong preferred
7	Very strong preferred
8	Very strong to extremely preferred
9	Extremely preferred

$$W = \begin{matrix} & & C_1 & C_k & C_n \\ & & e_{11}\,e_{12}\,\cdots\,e_{1m1} & \cdots & e_{k1}\,e_{k2}\,\cdots\,e_{k\,mk} & \cdots & e_{n1}\,e_{n2}\,\cdots\,e_{n\,nn} \end{matrix}$$

Fig. 2: super matrix partitioned based on the cluster (factors)

taken from a pairwise comparison.The super matrix which consists of N clusters is displayed as follows. where Ck is the kth cluster (k = 1, 2, . . . , n) and each cluster K consists of mK items showd by $ek1$, $ek2$,...,$ekmk$. Each column of Wij is the priority vector acquired from the identical pairwise comparison, indicating the preference of the elements in the ith cluster with respect to an element in the jth cluster (Lee, 2012).

Step 4. The calculation of the weight of the super matrix by multiplying this matrix by the priority of the factors should be done as the final step. Then, the limited super matrix is obtained by increasing a weighted super matrix to power. As a result, we have some fixed numbers to find an alternative as a solution.

Application of the ANP methodology in prioritization of EVs adoption factors

The general information about the characteristics of respondents, including their age, gender, work experience are shown in Table 4. the majority of respondents were male (34), between 40-50 years old (17), and have greater than 15 years of work experience (19).

Interdependency between EVs adoption factors is shown by analyzing the impact of each factor on the other factors based on literature review. Using the analysis of internal and external conditions of the organization, the dependency between EVs adoption factors which the questionnaire was designed based on them, are shown in Fig. 3. The reliability of the questionnaire was assessed using the inconsistency index and if this index is below 0.1, the questionnaire is reliable. The validity of the questionnaire was assessed using the CVR index and because this index is higher than 0.29 (the valid number in the sample population of 40 people), it can be said the questionnaire is valid. After designing the questionnaire, it was completed by the selected

Table 4: Sample demographic characteristics

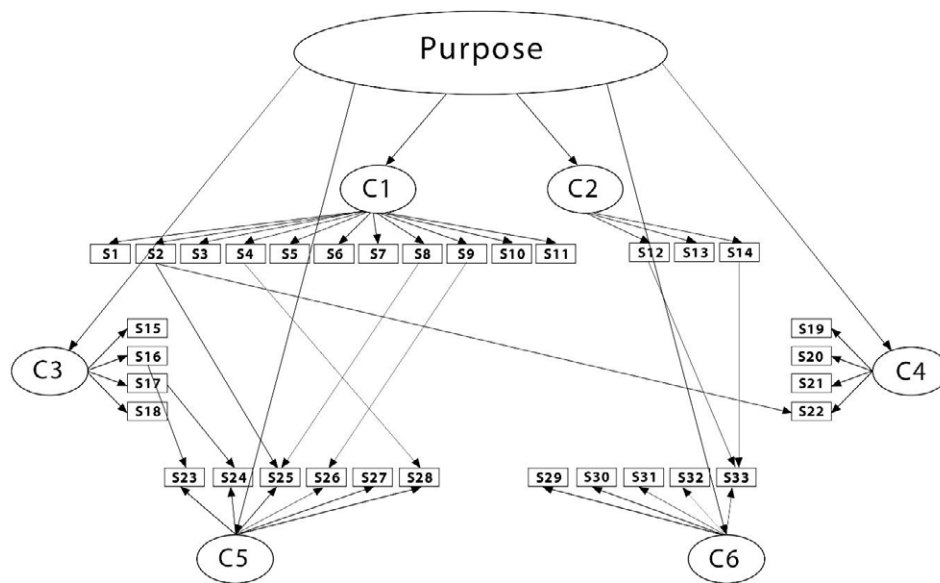| Demographic profile	Category	Frequency	Frequency Percent
Gender	Male	34	85%
	Female	6	15%
Age	<30	3	8%
	30-40	5	13%
	40-50	17	43%
	>50	15	38%
Experience	5-10	6	15%
	10--15	15	38%
	>15	19	48%

Fig. 3: The relationships between criteria and sub-criteria (ANP structure)

population sample based on the numerical values in Table 3. After data gathering, the data analysis was done using SuperDecision software. To implement the ANP analysis, the main criteria, the sub-criteria of each criterion, the sub-criteria that are intrinsically linked to each other, and the main criteria by controlling the effect of each criterion must be compared together. The result of each comparison and the weight of each criterion and sub-criteria are shown below. Results of calculation of compatibility of criteria and sub-criteria indicated that incompatibility was less than 0.1 in all cases, and thus the prioritization of pairwise comparison of matrices was acceptable, and consistency of responses was confirmed; hence, the assigned coefficients were reliable and paired comparisons could be obtained.

RESULTS AND DISSCUSION

Based on the results shown in Table 5, the economic factors are the most important criteria in comparison with the purpose

Based on the results shown in Table 6 the depreciation time is the most important technical factor which can affect EVs adoption.

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Table 5: Pairwise comparison matrix of main criteria in comparison with the purpose.

	C1	C2	C3	C4	C5	C6	Normalized	Idealized
C1	1.000	1.600	1.190	1.200	0.614	1.230	0.178	0.775
C2	0.625	1.000	1.450	0.610	0.671	1.530	0.151	0.658
C3	0.840	0.690	1.000	1.210	0.658	1.470	0.153	0.666
C4	0.833	1.640	0.826	1.000	0.658	1.360	0.164	0.714
C5	1.628	1.490	1.520	1.520	1.000	1.470	0.230	1.000
C6	0.813	0.654	0.680	0.735	0.680	1.000	0.122	0.531
Inconsistency				0.019				

Table 6: Pairwise comparison matrix of technical sub-criteria

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	Inconsistency
S1	1.000	0.725	0.787	0.840	0.794	1.620	0.847	0.820	0.870	0.926	1.786	
S2	1.380	1.000	0.694	0.855	0.847	1.230	0.847	0.794	0.752	0.709	0.877	
S3	1.270	1.440	1.000	0.840	1.610	0.775	0.621	0.752	1.695	0.613	1.176	
S4	1.190	1.170	1.190	1.000	0.685	0.637	0.752	0.877	0.79	0.794	0.813	
S5	1.260	1.180	0.621	1.460	1.000	0.877	0.763	0.752	0.952	0.901	0.877	
S6	0.617	0.813	1.290	1.570	1.140	1.000	0.877	0.79	0.794	0.741	0.752	0.021
S7	1.180	1.180	1.610	1.330	1.310	1.140	1.000	0.694	0.658	1.176	0.794	
S8	1.220	1.260	1.330	1.140	1.330	1.410	1.440	1.000	0.901	0.794	0.877	
S9	1.150	1.330	0.590	1.410	1.050	1.260	1.520	1.110	1.000	0.709	1.351	
S10	1.080	1.410	1.630	1.260	1.110	1.350	0.850	1.260	1.410	1.000	0.813	
S11	0.560	1.140	0.850	1.230	1.140	1.330	1.260	1.140	0.740	1.230	1.000	
Normalized	0.1	0.1	0.09	0.1	0.1	0.1	0.09	0.08	0.08	0.08	0.09	
Idealized	0.92	0.97	0.89	1	0.92	0.97	0.82	0.76	0.81	0.74	0.86	

Based on the results shown in Table 7 the producer company reputation is the most important marketing factor which can affect EVs adoption.

Based on the results shown in Table 8 the fuel subsidy is the most important rules factor which can affect EVs adoption.

Based on the results shown in Table 9 the availability of a repair shop is the most important

Table 7: Pairwise comparison matrix of marketing sub-criteria

	S12	S13	S14	Normalized	Idealized
S12	1.000	0.901	1.150	0.334	0.846
S13	1.110	1.000	1.540	0.394	1.000
S14	0.870	0.649	1.000	0.272	0.691
Inconsistency			0.004		

Table 8: Pairwise comparison matrix of rules sub-criteria

	S15	S16	S17	S18	Normalized	Idealized
S15	1.000	1.180	1.360	0.690	0.258	0.870
S16	0.847	1.000	0.552	1.160	0.209	0.703
S17	0.735	1.810	1.000	1.550	0.297	1.000
S18	1.450	0.862	0.645	1.000	0.237	0.798
Inconsistency			0.056			

Table 9: Pairwise comparison matrix of accessibility sub-criteria

	S19	S20	S21	S22	Normalized	Idealized
S19	1.000	1.270	1.350	1.180	0.292	0.927
S20	0.787	1.000	1.290	0.543	0.210	0.668
S21	0.741	0.775	1.000	0.571	0.184	0.585
S22	0.847	1.840	1.750	1.000	0.314	1.000
Inconsistency			0.014			

Table 10: Pairwise comparison matrix of economic sub-criteria

	S23	S24	S25	S26	S27	S28	Normalized	Idealized
S23	1.000	1.160	1.650	1.810	1.280	1.230	0.219	1.000
S24	0.862	1.000	0.826	1.280	1.360	1.350	0.178	0.810
S25	0.606	1.210	1.000	0.570	1.210	1.220	0.152	0.691
S26	0.552	0.781	1.754	1.000	1.590	1.580	0.185	0.843
S27	0.781	0.735	0.826	0.629	1.000	1.250	0.137	0.626
S28	0.813	0.741	0.820	0.633	0.800	1.000	0.129	0.588
Inconsistency				0.021				

accessibility factor which can affect EVs adoption.

Based on the results shown in Table 10 the car price is the most important economic factor which can affect EVs adoption.

Based on the results shown in Table 11 the importance of the environment is the most important individual factor which can affect EVs adoption. So it can be concluded that the contributed factors which

Table 11: Pairwise comparison matrix of individual sub-criteria

	S29	S30	S31	S32	S33	Normalized	Idealized
S29	1.000	1.410	1.360	1.220	1.290	0.246	1.000
S30	0.709	1.000	1.110	1.170	1.200	0.201	0.819
S31	0.735	0.901	1.000	1.190	0.685	0.176	0.717
S32	0.820	0.855	0.840	1.000	1.260	0.188	0.763
S33	0.775	0.833	1.460	0.794	1.000	0.189	0.768
Inconsistency				0.012			

affect EVs adoption in order of priority are:
1. Economic: 23.0%
2. Technical: 17.8%
3. Accessibility: 16.4%
4. Rules: 15.3%
5. Marketing: 15.1%
6. Individual: 12.2%

In this research the results of previous researches were collected together and were generally placed in 6 categories. For example, Bjerkan *et al.,* (2016), named purchase tax as one of these factors and in another study, Huang and Qian (2018), cited operational cost as an influential factor. The results in this research showed that economic factors had the most significant effect in comparison with other criteria. depreciation time, producer company, fuel subsidy, availability of repair shop, car and importance to the environment were the most significant factor in each criteria. According to Egbue and Long (2012), the major potential barrier to the widespread adoption of EVs is the uncertainty regarding EV battery technology and fuel source sustainability (technical and individual factors). Although based on this research, economic factors are the major barriers to acceptance of EVs for Iraninan people. Lane and Potter (2007), stated that government rules has the major effect on people's electric cars acceptance. It seems that government policies in EVs has also the major effect in Iran. Because government rules can effect on other factors, such as accessibility and economic and make a better circumstances for EVs acceptance. Arning *et al.,* (2013) in their studies on customer acceptance and behavior towards new products, and Joffe (2003) in examining the risks associated with new products, concluded that the general public is more interested in new and up-to-

date technologies than traditional products. In these studies, researchers showed the tendency of people to use electric cars and indicated people tendency in the direction of modern technologies; In the continuation of these researches, it is showed what factors determine the degree of this tendency and what is the role of each of these factors in this choice. In one of the researches in the field of electric vehicles, Tu and Yang (2019) had studied the benefits of using electric vehicles and has explored them in individual, environmental or national level. In general, the benefits of using electric vehicles in that research are examined and the benefits of using electric vehicles have been investigated in the study. These factors motivate people to buy electric cars. However, what factors and how much affect the purchase of these cars is something that was addressed in this study regarding Iran, so that by recognizing these factors and working on them, it can be provided the basis for more use of these cars for sustainable development.

CONCLUSION

The world is going through important issues such as energy shortages, air pollution, and Greenhouse Gases (GHGs) emissions. Electric vehicles, which use internal and electric combustion engines for propulsion purposes, appear to be a very promising prospect. Despite the importance of EVs in pollution reduction, in Iran, people are not interested in buying these types of vehicles. Therefore, in the current study the factors affecting the acceptance of electric vehicles by consumers of vehicles have been identified and priorized. To this end, factors influencing the acceptance of electric vehicles were identified by reviewing the literature. Then, the identified factors were prioritized using the ANP

technique. In general, six criteria and thirty-three sub-criteria were compared. those 6 criteria, based on priority in percentage, are: Economic (23.0%), Technical (17.8%), Accessibility (16.4%), Rules (15.3%), Marketing (15.1%), Individual (12.2%). According to the results, the policies implemented by the government in the acceptance of electric vehicles are in the fourth place influencing this issue. But the important point is that in Iran, government policies affect 5 other factors (especially economic factors) and it can be said that government policies play a key role in the adoption of electric vehicles. However, due to the fundamental role of domestic automakers in the country's economy, the government has not been able or unwilling to adjust policies for the use of electric vehicles in the Iranian economy (This also applies to the import of foreign cars into Iran). For example, because domestic automakers, auto parts makers, and auto-related industries have taken over a large chain of the country's economy, implementing any changes that hurt domestic automakers could provide an introduction to the emergence of other economic problems. Also because the government has not provided the necessary infrastructure in this area, carmakers do not have the necessary technology and knowledge, and therefore the cost is high and consequently car prices have risen, and because in Iran, the economy is the most important factor in acceptance of Electric cars, it is beyond the economic power of the people to buy such cars. Therefore, it seems that, at present, the best way to adjust the government's policies in the field of accepting electric vehicles is to strengthen domestic automakers in order to launch an electric vehicle production line to minimize any side effects of accepting electric vehicles and consequently reducing the use of traditional vehicles, or to neutralize each other at best. Also, the technology implemented by car manufacturers, in addition to maintaining the quality compared to traditional cars, must also have a reasonable price, so that people can buy these cars, or in other words, prefer to buy electric cars to traditional cars. This is also true in terms of accessibility, because the more appropriate the government's policies on access to electric vehicle services, the more motivated people would be. In addition, attracting foreign capital and the entry of the private sector into the industry can be one of the solutions to this problem, because with the launch of the domestic industry and the

beginning of competition between industries at the national level, not only production standards increase but also its impact on the country's economy will be considered.

AUTHOR CONTRIBUTIONS

Kh. Eshtiaghi performed the literature review, experimental design, analyzed and interpreted the data, prepared the manuscript text, and manuscript edition. M. Aliyanezhadi performed the literature review and manuscript preparation. A. Najafian performed the literature review and manuscript preparation.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy has been completely observed by the authors

ABBREVIATIONS

ANP	Analytic Network Process
CO2	Carbon dioxide
CVR	Content validity ratio
Evs	Electric vehicles
GHG	Greenhouse gas
VAT	Value-added tax

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