Neutrosophic Systems with Applications, Vol. 6, 2023
https://doi.org/10.61356/j.nswa.2023.26

An Electric Vehicle Analysis Model for Sustainable Environment in Devoicing Nationals

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Abstract: The usage of fossil fuels is regarded as the generation of energy alternative towards electric vehicles (EVs) in third-world nations for a cleaner transportation sector. The rapid development of EVs is the most effective solution, even if the short-term ecological benefits for third-world nations cannot cover the short-term expenses. Since ecological issues have opened the door for certain developing nations to catch up to the worldwide competition, it is important to weigh other options to bring EVs to the marketplace. Hence, the study proposes a model of neutrosophic set combined with entropy to deal with uncertain cases. The proposed model uses the single-valued neutrosophic to compute the weights of criteria and rank alternatives. A case study with three options, eight criteria, and ten alternatives are proposed to examine the EVs implementation decision-making procedure. The results show that the performance criterion as the best criteria in EVs. Consumers place a high value on the speed, maneuverability, and interior comfort of EVs.

Keywords: Electric vehicles; Sustainability; Entropy; MCDM; Neutrosophic set.

1. Introduction

Electric vehicles' positive effects impact on environment. Many electric vehicle models are recommended for widespread use. The market for electric vehicles is growing and diversifying to meet consumer demand. The rising tide of patents indicates that EVs will dominate the market in the near future. However, policymakers should be concerned about the increasing demand for power that would result from the widespread adoption of EVs. Unfortunately, the upfront costs of EV use might outweigh the immediate advantages in certain situations [1, 2].

The development of EVs technologies vary from one nation to the others depending on various factors, e.g., macroeconomic circumstances and worldwide standing of national industry, that can lead to the failure of the effort to reform the current system. The demands of the stakeholders and the state of the micro and macro economy should inform technical strategy. There may be a roadblock in the social adoption of the latest innovations even if financial and technical circumstances are favorable. However, policy combinations at both the macro and micro levels alleviate some of the issues and ready the current system for the transition [3, 4].

For EVs development, policymakers should encourage even radical shifts in popular culture and consumer habits. Traditions should be considered throughout the planning stages of company-wide and system-level modifications. The literature provides enough evidence of the challenges policymakers face when attempting to deploy EVs, both in terms of the financial sector at large and the spread of new technologies. The proposed study aims to provide light on the decision-making process and draw policy implications for the introduction of EVs in countries where green energy generation is also a priority [5, 6].

For deploying and analyzing EVs strategic choice a variety of scenarios are explored that mimic real-world settings and expose the bottlenecks of the transition difficulties. The study particularly concerned about the impact of EVs on the framework of the power market and the pace of transformation in the use of fossil fuels [7, 8]. The high cost of infrastructure improvements is a major financial barrier in the transportation and energy industries. The financial backing of the stakeholders is necessary, since the effects of change on the automobile sector are more visible. Though costly, incorporating EV technology has far-reaching effects on the financial system.

Regarding the power of the market, the process of change has the greatest immediate impact on consumer appetite for hydrogen and power as the need for fossil fuels for cars declines. Electric vehicles have the potential to lessen transportation's reliance on fossil fuels. If energy generation does not rely on fossil fuels, it is more probable that the installation of EVs will accomplish effective environmental measures in a shorter amount of time. The future of wealthy nations with their investments in green power resources have grown overall [9], [10].

However, the majority of the developing world's power still comes from fossil fuels. For instance, the new EV innovations may provide a chance for developing nations to catch up to the global rivalry in the automobile sector, since hydrogen consumption is predicted to treble by 2040. The question is not whether to deploy EVs, but rather how to execute them for maximum efficiency. Hence, it is crucial to provide decision-makers in developing countries with an awareness of alternative ways to use EVs. Frameworks for decision-making with a fuzzy basis have been effectively applied to many issues [11, 12].

The Reset of the paper is structured as follows: Section 2 shows the use of battery electric vehicles for sake of clean transportation. Section 3 proposed a neutrosophic entropy model that will be used to rank EVs alternatives with respect to certain criteria. Section 4 illustrates a result of numerical case study with optimal ranking of alternatives to aid decision makers. Section 5 concludes the summary and the future work of the current study.

2. Battery Electric Vehicles

Recently, the replacement of combustion cars with cleaner technology is being driven in part by increasing prevalence of ecological legislation, sustainability practices, health concerns, and ecological awareness. Unfortunately, most automobiles today still rely on fossil fuels, that produce harmful emissions. According to Kumar and Alok, greenhouse gas (GHG) emissions such as CO, CH4, N2O, and CO2 from the transportation sector are the primary cause of smog and loss of ozone causes in global warming. Therefore, people have started swapping out their combustion automobiles with cleaner ones that run on renewable energy [13, 14].

Non-renewable-based technology, like combustion-powered automobiles, poses a greater risk of causing warming and climate change. Sustainable development offers hope for future generations in terms of social, ecological, and financial advancement. Environmental preservation and financial and social stability are twin pillars of sustainable development. Environmental sustainability, sustainable transportation offers several potential benefits for the environment, society, and economy. Many wealthy nations have switched to EVs in an effort to combat environmental pollution and promote sustainable development. Hence, electric vehicles have been seen as a practical means of contributing to safer, less polluting petrol emissions [15, 16].

The broad adoption of EVs plays a crucial role in addressing the automobile industry's ecological and financial challenges. However, several studies pointed out that the environmental benefits of clean cars and the EU's zero-emission aim on transport are only possible if power is generated from green sources such solar and wind [17, 18].

EVs are a viable option for traditional vehicles because of improvements that have reduced their limitations, such as high price, limited battery range, and slow peak speed. Battery electric vehicles (BEVs), hybrid electric vehicles (HEVs), and plug-in HEVs are the three kinds of EVs on the market. Zero-emission cars, referred to as BEVs, are powered only by electricity from a generator and onboard batteries. Cleaner transportation is provided by BEVs since they don't use fossil fuels. Furthermore, BEVs may be seen as a critical component in the shift to a civilization powered by renewable energy. Environmental worry and expectation that BEVs would mitigate environmental dangers are both positively correlated with BEV adoption, as shown by Chen et al. As a result, increasing the availability of BEVs is probably the best bet for sustainable transportation networks [19, 20].

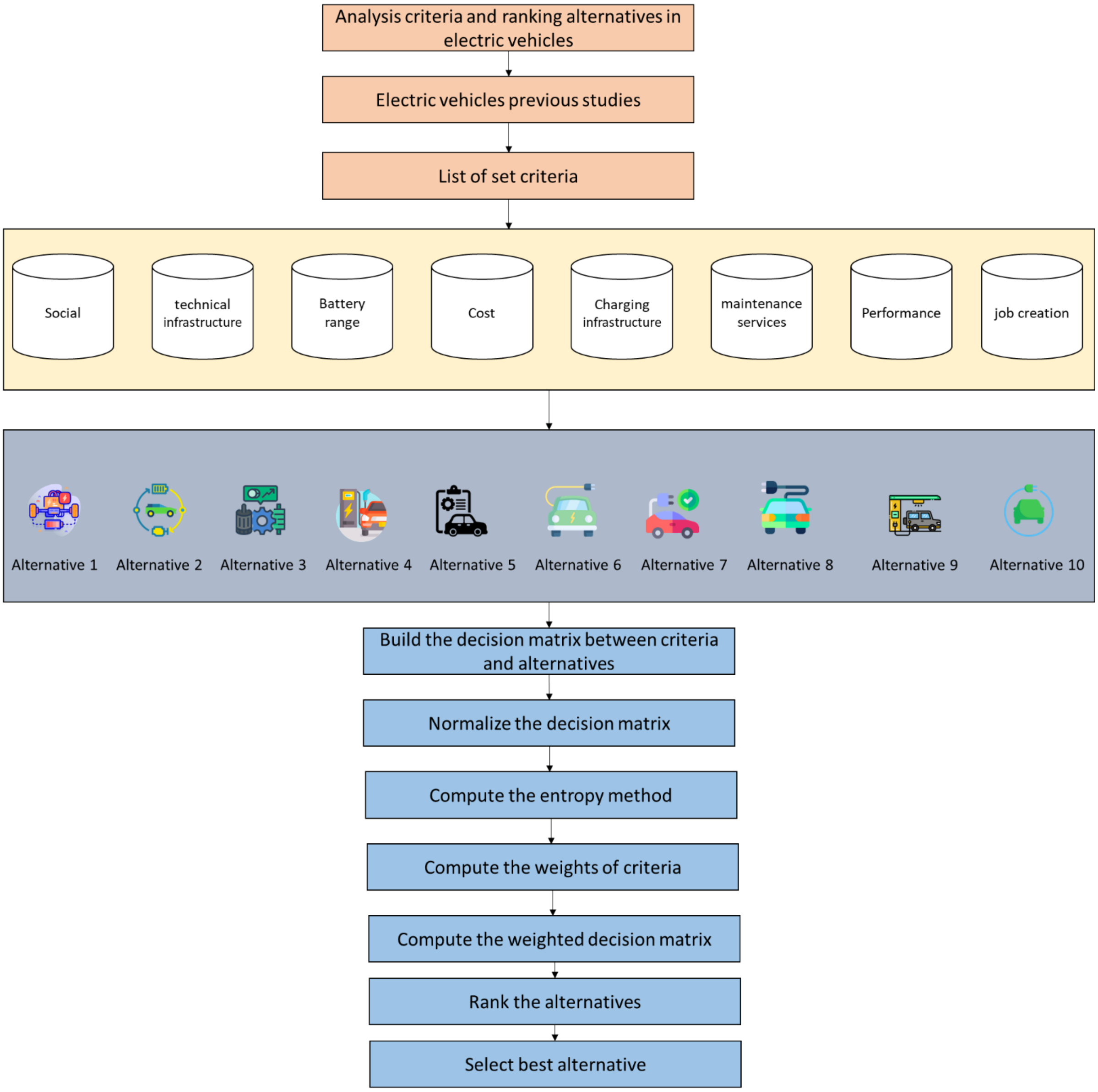

Figure 1. The model of electric vehicles analysis.

3. Neutrosophic Entropy model

The proposed model ranks various alternatives of EVs with respect to certain criteria. The study combined neutrosophic theory with entropy to efficiently handle uncertain cases.

The proposed model highlighted the steps of the single-valued neutrosophic set with the entropy method to compute the weights of criteria and rank the alternatives. The study used the single-valued neutrosophic set [21, 22]. Zadeh's fuzzy set theory has great potential for improving surface modification methods in a wide range of reinforcement settings. Since its inception, however, fuzzy sets have undergone a process of rehabilitation that has resulted in a wide variety of new forms, such as intuitionistic "fuzzy sets," single-valued "neutrosophic" sets, interval-valued "fuzzy sets," and so on [23]–[26]. Figure 1 shows the framework of this study. The steps of the proposed model are mentioned as follows:

Step1: Build the decision matrix between criteria and alternatives.

Step 2: Normalize the decision matrix.

$$E_{ij} = \frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}} \quad (1)$$

Where $i = 1,2, \ldots m; j = 1,2,3, \ldots . n$

Step 3: Compute the entropy method.

$$n_j = -\frac{\sum_{i=1}^{m} E_{ij} \ln(E_{ij})}{\ln(m)} \quad (2)$$

Step 4: Compute the weights of criteria.

$$w_j = \frac{1-n_j}{\sum_{i=1}^{n} (1-n\_j)} \quad (3)$$

Step 5: Compute the weighted decision matrix.

Step 6: Multiply the weights of criteria by the decision matrix.

Step 7: Rank the alternatives by the highest value of each row.

4. Results of Electric Vehicles

This section introduces the results of the analysis criteria and ranking the alternatives of the proposed neutrosophic entropy model. EVs are gaining popularity as a viable replacement for conventional petrol and diesel cars. The advantages of driving an electric car are 1) cleaner air and less greenhouse gas emissions are the result of electric vehicles' lack of exhaust emissions, 2)electric cars have lower operating expenses than conventional vehicles since they are more fuel-efficient and need fewer repairs, 3)electric vehicles improve national energy security by decreasing reliance on foreign oil, and 4) electric vehicles (EVs) improve the driving experience in a number of ways compared to conventional automobiles.

The proposed method illustrated eight criteria and ten alternatives. The criteria of electric cars are:

How far an electric car can drive on a single charge is mostly determined by its battery, making range an essential requirement. The broad adoption of EVs depends on the accessibility of charging infrastructure. Electric cars are costlier than conventional automobiles, hence their price is a major factor for purchasers. Consumers place a high value on the acceleration, handling, and interior comfort of electric vehicles. Social, technical infrastructure, job creation, and maintenance services. The decision-makers evaluate the criteria and alternatives to build the decision matrix. Then normalize the decision matrix by using Eq. (1) as shown in Table 1. Then compute the value of entropy by using Eq. (2) as shown in Table 2. Then compute the weights of the criteria as shown in Figure 2. Then rank the alternatives by multiplying the weights of criteria by the decision matrix then compute sum of each row as shown in Figure 3. The results show that the performance criteria as the best criteria in EVs. Consumers place a high value on the speed, maneuverability, and interior comfort of EVs, and EVA10 is the best alternative.

Table 1. Normalization input between criteria and alternatives.

	EVC_1	EVC_2	EVC_3	EVC_4	EVC_5	EVC_6	EVC_7	EVC_8
EVA_1	0.048001	0.069544	0.159571	0.088515	0.064011	0.091837	0.067858	0.035945
EVA_2	0.11992	0.069544	0.084966	0.061409	0.211863	0.091837	0.06846	0.113063
EVA_3	0.075052	0.048247	0.084966	0.1789	0.187658	0.188153	0.204033	0.202355
EVA_4	0.048001	0.069544	0.058947	0.093552	0.066508	0.099303	0.073329	0.077985
EVA_5	0.075052	0.054655	0.129407	0.093552	0.096425	0.064709	0.105697	0.077695
EVA_6	0.1139	0.161327	0.084966	0.064527	0.064283	0.097063	0.150669	0.035832
EVA_7	0.079323	0.181493	0.054342	0.063567	0.091233	0.091588	0.105697	0.164957
EVA_8	0.048001	0.069544	0.059154	0.061409	0.063294	0.091837	0.111713	0.078217
EVA_9	0.196884	0.107237	0.084966	0.088515	0.063294	0.091837	0.044685	0.106975
EVA_{10}	0.195867	0.168865	0.198715	0.206055	0.091431	0.091837	0.067858	0.106975

Table 2. Values of entropy in the entropy method

	EVC_1	EVC_2	EVC_3	EVC_4	EVC_5	EVC_6	EVC_7	EVC_8
EVA_1	-0.0633	-0.08051	-0.12719	-0.0932	-0.07641	-0.09523	-0.07929	-0.05192
EVA_2	-0.11046	-0.08051	-0.09098	-0.07441	-0.14278	-0.09523	-0.07973	-0.10703
EVA_3	-0.08441	-0.06352	-0.09098	-0.13371	-0.13636	-0.1365	-0.14084	-0.14041
EVA_4	-0.0633	-0.08051	-0.07248	-0.09626	-0.07829	-0.0996	-0.08321	-0.08641
EVA_5	-0.08441	-0.06899	-0.11492	-0.09626	-0.09795	-0.07694	-0.10315	-0.08621
EVA_6	-0.10746	-0.12782	-0.09098	-0.0768	-0.07662	-0.09832	-0.12385	-0.0518
EVA_7	-0.0873	-0.13451	-0.06873	-0.07608	-0.09487	-0.09508	-0.10315	-0.1291
EVA_8	-0.0633	-0.08051	-0.07264	-0.07441	-0.07587	-0.09523	-0.10634	-0.08656
EVA_9	-0.13896	-0.10398	-0.09098	-0.0932	-0.07587	-0.09523	-0.06032	-0.10384
EVA_{10}	-0.13868	-0.13044	-0.13945	-0.14136	-0.09499	-0.09523	-0.07929	-0.10384

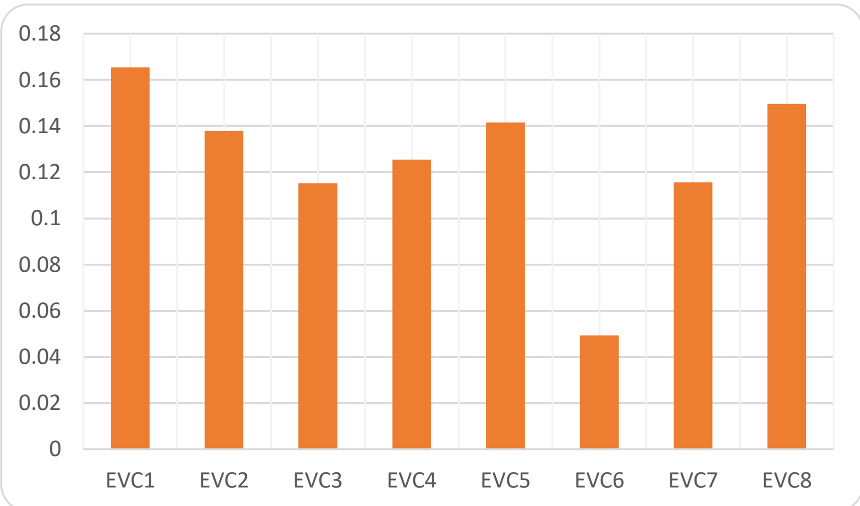

Figure 2. The weights of criteria by the entropy method.

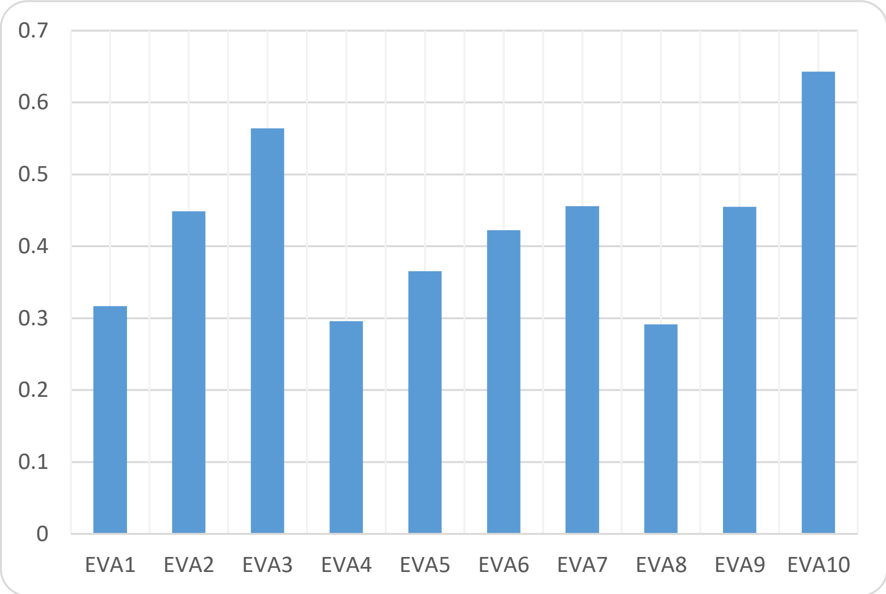

Figure 3. The score value of alternatives.

5. Conclusion

Despite the fact that electric cars have the potential to greatly decrease GHG emissions and enhance air quality, there are still obstacles that must be overcome before their widespread adoption can be achieved. Electric vehicle adoption may be influenced by charging infrastructure, advancements in battery technology, government regulations and incentives. This study analysis criterion and rank the alternatives in EVs. In this research, we investigate the factors that go into deciding whether or not to introduce EVs into a developing nation where fossil fuels are the primary source of energy. Three options are evaluated in a hypothetical situation that is used to examine the decision-making process. Since the immediate environmental costs may outweigh the long-term advantages of EVs, solutions should center on when to introduce them. While the model predicts an increase in the usage of fossil fuels in the short term, it also predicts that the new system will be put into effect more quickly. This research examines the findings and discusses their potential policy consequences. Since the expected long-term benefits are so high, the temporary setbacks are manageable. There is already a lot of work involved in getting things set up, and you'll need to devote a certain amount of resources (both time and money) to the process. Investment in renewable energy generation is important; but, this should not delay the immediate introduction of EVs. This study used the neutrosophic entropy model to compute the weights of criteria then rank the alternatives. The proposed model aid decision makers to achieve suitable alternatives according to certain criteria. A numerical case study illustrated to show the applicability and efficiency for the proposed model.

Data availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data but are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that there is no conflict of interest in the research.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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Received: Nov 07, 2022. Accepted: Jun 06, 2023