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Research Article

Travelers' Adoption Behavior towards Electric Vehicles in Lahore, Pakistan: An Extension of Norm Activation Model (NAM) Theory

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This study aims to identify the travelers' adoption behavior towards electric vehicles (EVs) using the theoretical background of the Norm Activation Model (NAM) theory. A questionnaire was designed and conducted in Lahore, Pakistan. A total of 402 usable samples were obtained. The collected data were analyzed using factor analysis and Structural Equation Modeling methods. The factor analysis confirmed the hypothesis of the statements designed according to the NAM theory, that is, awareness of consequences (AC), ascription of responsibility (AR), and personal norm (PN). Other factor analyses resulted in the following reliable factors: social and economic values (SEV), personal preferences (PP), willingness to buy (Buy), and willingness to use (Use) of an EV. The results of SEM revealed that the AC, AR, and SEV are significant predictors of PN, whereas the PN and PP are also positive predictors of travelers' willingness to buy and use. The young travelers (≤30 years), motorcycle users, employees, and trip distance (>10 km) have significant and positive correlations with the PN. The car ownership status of travelers has a positive correlation with the ownership and usage of EVs. Suitable behavioral intervention techniques were derived to promote the ownership and usage of EVs in the context of developing regions.

1. Introduction

In recent decades, environmental pollution has been considered as one of the main causes of global warming, air pollution, and climate change. At the moment, the world is going through some of the most urgent issues such as energy scarcity, emissions of Greenhouse Gases (GHGs), and air pollution [1]. The transport sector is a major contributor of carbon dioxide (CO_2), which emits around 23% of its total emissions [2] and is among the main reasons behind global warming. In this pretext, electric vehicles (EVs) are one of the potential alternatives which can substantially reduce the amount of CO_2 emission, provided that the electricity is produced through renewable energy sources [3]. However, from the economic viewpoint, a major reason which impedes the adoption of electric vehicles as compared with conventional vehicles is their acquisition costs and limited range of driving due to insufficient battery technologies [4, 5]. The inclusion of electric vehicles and the reduction of emissions related to national vehicle fleets were studied by comparing different scenarios using traffic simulation in several countries [6, 7]. According to McKinsey's EV index, which assesses the readiness of nations for the adoption of EVs, Japan, the United States, France, Germany, and China are standing in descending order. The automotive industries are buckling up to lower the operation costs of EVs and reduction of CO_2 emissions [8].

Pakistan is facing some severe environmental challenges including air contamination, water pollution, and deteriorated quality of air due to smog in major cities, which are

largely due to unplanned growth and reliance on nonrenewable energy sources [9]. The growth in the industrial and transport sector has been on the rise in recent years because of the increased population. In road transportation, the share of EVs is relatively negligible as compared with conventional vehicles, which are the main causes of CO_2 emissions. It has been estimated that the amount of CO_2 will increase from 858 kg/year to 1650 kg/year by the end of 2030 [10, 11]. Moreover, transport sector is among the three largest sources of CO_2 emissions in Pakistan [11].

The local and central governments are under great stress to alleviate these environmental problems through policy interventions and mitigate the ecological damage on an urgent basis. In this context, the adoption and promotion of electric vehicles are promising efforts to substantially mitigate the emissions of CO_2 especially when electricity is produced through renewable energy sources [12]. In comparison with the conventional vehicles, EVs have many advantages in terms of social, economic, societal, and environmental aspects such as reduction of carbon emissions, improvement of energy security, and promotion of the usage of renewable and clean energy alternatives [13]. Many governments around the world are initiating different incentive programs for the uptake of electric vehicles. The US has implemented the federal tax credit of 7500 dollars, exemption from sales tax, and reduction in the license fee for the adoption of EVs. This initiative was meant to popularize the adoption of EVs and minimize the impacts of higher selling prices [14]. Similarly, the Japanese government has introduced a free charging policy to encourage the usage and adoption of EVs [15]. The Ministry of Science and Technology of Pakistan is keenly interested in the promotion of EVs to mitigate environmental pollution and energy problems in the country. The government of Pakistan is considering incentives and subsidies to encourage people to adopt EVs [12].

Governments around the globe are serious to address environmental concerns through sustainable transport policies including promoting the share of EVs in the market. The understanding of customers' behavior towards the purchase and usage of EVs will provide a clear insight into how these issues can be battled to save environmental degradation [16]. Several studies explored the areas of EV adoption and purchase intentions [4, 13, 17–24]. These studies reported that purchase price and travel ranges are the predictors of EV purchase. It is found that the spread of electric vehicles is closely linked to the spread of recharging areas, which allow a widespread diffusion of these transport systems [25]. In addition, the introduction of electric car-sharing in cities can be an ideal solution for people to test electric cars on the road and to highlight their convenience and advantages over vehicles with combustion engines. It is, therefore, an opportunity to educate people about electric mobility and to get them used to EVs before they buy them [26]. Electric car-sharing is also the most efficient solution for cities as it combines car-sharing with zero-emission technology, with positive effects on both traffic congestion, thanks to the reduction of cars on the road, and the environment, thanks to zero-emission traffic [27, 28]. The integration of demand response transport (DRT) with electric vehicles can provide significant environmental, economic, and social benefits; however, it presents challenging planning issues due to EV charging constraints [29–31].

Given the shortcomings in the literature, especially in a developing country like Pakistan, this study attempts to explore the travelers' EVs purchase and usage intentions through the application of the Norm Activation Model (NAM) theory. This may assist the researchers in identifying the driving factors for the adoption of EVs in developing countries with similar socioeconomic and infrastructural characteristics. Furthermore, it proposes a framework for the encouragement and adoption of green mobility implementation. A comprehensive questionnaire was designed in this study, which was conducted in Lahore city. The factors affecting the travelers' willingness to buy and use an EV were identified using factor analysis and Structural Equation Modeling techniques.

The rest of the paper is organized as follows: in Section 2, relevant literature studies are mentioned, and Section 3 describes the data collection and organization of the questionnaire survey. Section 4 discusses the research results and main findings of this research study. Finally, Section 5 summarizes the main findings and proposes some policy interventions for the promotion of EV adoption in Pakistan.

2. Literature Review

Mainly, researchers have adopted two streams of research to explore the customers' behavior for the adoption of EVs. The first stream includes the role of instrumental attributes of EVs which play a significant role in the adoption of EVs. For example, the purchase price, performance, driving range, and recharging time have a significant impact on the purchasing intentions of the customers [32]. In this strand of research, usually, three sets of factors are considered as predictors for the adoption of EVs: consumer characteristics, technological factors, and contextual factors [33]. Consumer characteristics include the roles of gender, age, income, education levels, and social status as predictors for the adoption of EVs [34, 35]. In the technological factors, battery performance, driving range, and charging time are considered as predictors for the adoption of EVs [36]. The contextual factors involve the use of different policy interventions, fuel prices, and the availability of infrastructure as a guiding tool for the prediction of customers' behaviors [37, 38]. In addition, travelers who drive more especially for longer distances are more likely to prefer EVs [39].

However, the second stream includes the pro-environmental and economic perspectives to determine the purchasing behavior of the customers. Some studies have reported that environmental concerns and environmental attributes have a significant impact on the purchasing and adoption behavior of EVs in the customers [40, 41]. Similarly, a study discussed many advantages and disadvantages of EVs and explored the environmental concerns as a measure for the purchase intentions of the customers [42]. They measure the environmental concern in the sense that

"owning an EV will indicate care for the environment." Reference [43] also focused on the intentions of buying EVs and measured the environmental risk of conventional gasoline vehicles as well. Junquera et al. considered the purchase price (economic perspective) and its range for the measurement of customers' intentions to buy EVs but ignored the environmental dimensions [44]. Researchers explored the differentiated approach in the purchasing of high and low EVs and explored the generic perspective about the environment; for example, "it is important to drive a car that harms the environment as little as possible" [45]. Hence, they did not explore the EV-specific environmental performance in their study and no comparison was made between price and range concerning the economic point of view. However, a study explored the environmental concern, which was defined as "the degree to which people are aware of problems regarding the environment and support the effort to solve them or indicate the willingness to contribute personally to the solution" [40]. Again, they followed the generic approach concerning the environmental dimension and did not investigate the economic standing and environmental performance of EVs on customers' purchasing intention. Due to the environmentally friendly nature of EVs, the adoption behavior of customers involves self-interest and altruism. In addition, Perceived Customer Effectiveness (PCE), which is an estimate of the contribution of a customer in solving the problem, also plays an important role in solving proenvironmental behaviors [19, 46]. The customers who believe that they can contribute their part to proenvironmental behavior would utilize their consciousness as a guiding tool for their behaviors. In addition, researchers also focused on optimizing the charging infrastructure to further reduce the emissions and subsequently fulfill the needs of the users [47, 48].

The NAM theory was developed by Schwartz to explain the prosocial and environmentally friendly behavior of the customers [49]. The NAM theory has been used by many researchers to explore the proenvironmental behavior of consumers in different dimensions such as reducing car use [50], recycling [51], and energy-saving behaviors [52]. The NAM contains three primary variables, namely, personal norms (PN), awareness of consequences (AC), and ascription of responsibility (AR). PN represents the moral obligation to perform or refrain from specific actions. It plays a vital role in the NAM and is used to predict altruist (prosocial) behavior. AC represents the awareness about the negative consequences of nonaltruistic behavior and AR represents the feelings of responsibility for the negative consequences arising as a result of nonaltruistic behavior.

Several researchers have used NAM theory and its extensions to model the proenvironmental behavior of travelers to adopt electric vehicles. Researchers employed an extended NAM model to explain the relationship between personal norms and the intentions to adopt electric vehicles [53]. They reported a significant influence of personal norms (PN) on the intentions to adopt EVs, which was moderated by external costs. In addition, AC, AR, and perceived consumer effectiveness were found to have a positive influence on PN. Other existing studies also show that PNs are positively related to prosocial behavior such as intentions to adopt alternative fuel vehicles [54–56]. However, it is believed that many times customers fail to act in a proenvironmental behavior because of the costs involved, that is, monetary costs and behavioral costs [57]. Though customers agree and approve the environmental benefit of EVs, still they are reluctant to act because of the incurred higher costs of purchasing (economic concerns), driving range, and availability of charging infrastructure [18]. A summary of relevant literature concerning the scope of this study is presented in Table 1.

As mentioned above, many of the previous research studies have explored and investigated different dimensions of EVs ranging from price range to economic and environmental concerns regarding the purchase intentions of customers. However, none of the previous studies explored the adoption behavior of customers regarding EVs in the contexts of prosocial and proenvironmental behaviors in Pakistan. In this research study, NAM theory is applied to study the altruistic behavior of customers for the adoption of EVs from prosocial and proenvironmental behaviors in Pakistan. Some of the external factors of socioeconomic characteristics of the customers are introduced in the model to study how they influence and affect the adoption of EVs. Overall, the contribution of this research study in the body of the existing literature is twofold. Firstly, it explores the determinants of purchase and usage intentions of EV customers using NAM theory in a developing country, that is, Pakistan. Secondly, the social, economic, and environmental concerns are added as moderators within the relationship of NAM theory factors and EVs purchase and usage intentions. This proposition might answer researchers who advocated that the incorporation of the knowledge (about the environment, social costs, and EVs) into holistic multivariate modeling can effectively help in predicting the intentions of customers about their purchase and usage intentions [19].

3. Research Methods

3.1. Characteristics of the Study Area. This research study was conducted in Lahore city, which is the second biggest city in Pakistan and the capital of the most populated province of the country. According to an estimation, the population of Lahore city is more than 11 million [70]. In recent years, the city has expanded exponentially because of the increased economic, educational, healthcare, and recreational opportunities in the city. This city is surrounded by the industrial sector, which is a main source of employment in the region, thus attracting many of the inhabitants to settle in the city for better living opportunities. This increased population has created an influx which accelerated the need for traveling in the city. However, the public transport system of the city is not adequate to meet this demand, which has led to a rapid increase in private car ownership in the recent years. This increased private vehicle ownership mostly consists of conventional vehicles with a negligible share of EVs in the city. The emissions from these conventional vehicles have greatly worsened the air quality and the city is facing severe smog issues in the winters and burning heat

Table 1: A summary of relevant literature.

Authors	Country	Summary of important results
Nordlund et al. [58]	Sweden	(i) Hybrid EV/plug-in hybrid EV/EV owners were significantly more receptive to change and less conservative and manifested more self-efficacy and problem awareness, as well as a higher moral obligation, compared to the owners of CVs and alternative fuel vehicles.
Asadi et al. [59]	Malaysia	(ii) Perceived value, attitude, the AR, AC, PN, subjective norm (SN), and perceived consumer effectiveness influenced the EVs purchase intentions.
Dong et al. [60]	China	(iii) EV customers are more apprehensive about cruising power and availability of charging stations. (iv) In addition, perceived behavioral control (PBC), PN, SN, and feelings and emotions influence the intentions of urban households to purchase EVs.
Westin et al. [61]	Sweden	(v) Education and age were found to have positive effects on EVs ownership. (vi) In addition, PN was found to be the most important factor affecting the ownership of EV.
Cui et al. [62]	China	(vii) The results found the environmental concern (EC) to be the most significant driver of the motivation to buy EVs.
Wahl et al. [63]	Germany	(viii) The respondents' anticipated effort, PN, expected performance, and facility conditions significantly affect EVs adoption intentions.
Bockarjovaand Steg, [43]	Netherlands	(ix) Customers were especially more likely to embrace EVs when perceived negative outcomes of CVs were more serious and when EVs were expected to reduce these consequences.
Ng et al. [64]	Hong Kong	(x) Perceived value, responsive efficacy, willingness to pay, and trust in EV had significant and positive effect on the intentions to purchase EVs.
Xu et al. [65]	China	(xi) EV driving experience directly as well as indirectly influences the intentions to adopt EVs.
Shalender and Sharma [66]	India	(xii) Attitude, SN, moral norm, PBC, and EC have a positive relation with the EVs adoption intentions.
Chu et al. [67]	Korea	(xiii) Patient people and people with higher car usage are more probable to be early adopters of EVs.
Higueras-Castillo et al. [68]	Spain	(xvi) Driving range, reliability, and incentives are the most reliable drivers of the intentions to purchase EVs.
Bobeth and Kastner [69]	Germany	(xv) Personal norm appeared to be an important predictor of EVs adoption intentions.

waves in the summer season each year, which is getting intense each passing year. As EVs are potential alternatives for reducing emissions of GHGs and CO_2, there is a great need to explore the purchase intentions of customers towards EVs in the city. This is one of the compelling reasons which motivated the objectives of this study and that is why this study is selected to extract some of the predictors of willingness to buy and willingness to use EVs in the city. It is high time to look for the potentials of EVs in Lahore city keeping in view the deteriorated environmental quality.

3.2. Questionnaire Design. A comprehensive questionnaire was designed to achieve the aforementioned objectives. The respondent's socioeconomic demographics (SEDs) were in the first part of the questionnaire. These SEDs included gender, age, marital status, income, profession, education, car ownership, and travel mode and trip frequency with the same mode, trip cost, and trip distance of the daily one-way trip. The second part of the questionnaire consisted of several statements that were designed based on the variables of the NAM theory and personal preferences and perceived social and economic values in traveling. The variables of AC, AR, and PN were measured using two statements each. The AC variable was measured seeking the travelers' awareness related to the deterioration of the urban environment due to excessive use of gasoline or diesel vehicles and waste of natural resources such as oil or gas. The AR variable measures the travelers' sense of responsibility regarding consumption of natural resources and environmental pollution due to the use of gasoline or diesel vehicles. The PN variable assesses the travelers' moral obligations for the betterment of the urban environment and society and to preserve natural resources. Some statements were constructed to know the travelers' perceived social and economic values in traveling and personal preferences. It was assumed that social and economic values and personal preferences in traveling may have a significant influence on people's PN, willingness to buy, and using an EV. Three statements were designed to get responses on travelers' willingness to use EVs. The willingness to use an EV was asked considering the scenario of preservation of natural resources, reduction of air pollution, and availability of cheap electricity. Four statements were designed for willingness to buy an EV. The presented scenarios for willingness to buy included cheaper than gasoline/diesel cars, maintenance and battery costs less than gasoline/diesel cars, proper information on mileage, and long life of batteries. All the statements of the second part were evaluated using a five-point Likert scale for level of agreement, that is, strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). This scale was chosen considering the reliability of the data and the easiness and understanding of the respondents in reporting the responses to each statement.

3.3. Surveying and Sampling Methods. This survey was conducted with the target population in Lahore city. The target respondents included the current car users and non-car-users who have the potential to own an electric vehicle in

the future. The users of various modes belonging to different economic groups were included in the target sample. A convenience-based random sampling strategy was adopted in this survey. The target respondents were selected randomly at each selected location in the study area. The selected locations included some commercial activity centers, government and private educational institutions, and official buildings, where it was easy to get the required respondents. The required sample size was decided considering the requirements of Structural Equation Modeling (SEM). A sample size of 200 is required to minimize the bias in the results [71, 72]. Suggestions also included a ratio of 10 observations or samples per indicator [73], and the sample size should be at least 10 times the number of free parameters in the model [74, 75]. In this study, a sample size of around 400 was decided based on the mentioned recommendations. This survey was conducted with the help of university students. The students were trained and instructed regarding the contents of the questionnaire and survey techniques. All efforts were exerted to ensure the reliability of the collected data for the extraction of exact responses. A total of 402 useable samples were collected within three weeks.

3.4. Data Modeling Specifications. The collected data were analyzed using factor analysis and SEM methods. The SEM is a multivariate statistical analysis tool used to construct the correlations between the explanatory and objective variables. Initially, factor analysis was performed to confirm the correlations of observed variables with their corresponding factors or latent variables according to the NAM theory. This factor analysis was conducted using Maximum Likelihood (ML) and Varimax rotation. Second-order factor analysis was conducted to identify the factors of travelers' willingness to buy and use EVs. Third-order factor analysis identified the factors concerning perceived social and economic values and personal preferences in traveling. The reliability of the factors and internal consistency among respondents in the evaluation were examined with the help of factors' Cronbach's alpha values. Cronbach's value of more than 0.7 shows an acceptable level of reliability and a value of above 0.5 shows a moderate level of reliability [76, 77]. The results of factor analyses were combined to develop a structural model. This structural model was developed using SPSS Amos software. This software takes a confirmatory approach to construct the measurement equations and structural equations. Again, the ML method was used to develop this comprehensive structural model. The measurement models determine the correlations between observed variables and latent variables (factors). Measurement models are combined to identify significant structural equations between latent variables. In this study, observed variables of travelers' personal and trip characteristics were identified and included in the model to assess their impact on PN and willingness to buy and use EV. These variables were coded on a binary scale, that is, 1 or 0. The reliability of the structural model was determined and checked by comparing the values of the ratio of chi-square to the degree of freedom (CMIN/DF), the goodness of fit index (GFI), adjusted goodness of fit index (AGFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). The recommended value of CMIN/DF is 2–5; GFI, AGFI, and CFI should be greater than 0.9; and RMSEA needs to be less than 0.08 [72, 78, 79].

3.5. Research Hypothesis. Figure 1 presents the framework of the research hypothesis of this study. It was hypothesized that people's awareness about the consequences and sense of responsibility for the negative outcomes of their travel behavior influences the development of personal norms. The AC and AR are correlated with each other. The PN has a direct influence on people's willingness to buy and use the electric vehicle and it may also play the role of a mediator to explain the influence of AC, AR, and other defined variables of social and economic values and personal preferences on willingness to buy and use the EVs. It was hypothesized that perceived social and economic values and traveler's personal preferences in traveling may also have significant direct effects on travelers' willingness to buy and use the EVs, and willingness to buy may directly influence the users' intentions to use the EV. This study also assumed that the personal and travel characteristics of travelers may have a significant direct correlation with the PN and indirect influence on willingness to buy and use the EVs through the PN as a mediator.

4. Data Analysis and Results

4.1. Descriptive Statistics of the Respondents. The descriptive statistics show that the share of male and single respondents is more in the sample (Table 2). The share of the female working population is quite less in Lahore, resulting in their low share in the model split of Lahore, which justifies the low share of female respondents in the sample. The share of young respondents is high as around 65% of them are below the age of 30 years. The young people also make a high proportion of the overall population of Lahore city, so it is believed that this age distribution of the sample is consistent with the population. Students have a major share in the sample followed by employees. Most of the respondents fall into the low-income category, which is due to the presence of students in a large proportion in the sample. Around 45.27% of the respondents own one or more than one car. The model split shows that motorcycle, private car, and public transport modes have shares of 28.61%, 33.83%, and 12.94%, respectively. More than 70% of the respondents have a trip frequency of 5-6 days a week or higher. The trip length distribution is also presented in Table 2.

4.2. Factor Analysis and Average Responses. A factor analysis was conducted on collected responses regarding PN, AC, and AR variables of the NAM theory. This factor analysis confirms the association of observed variables with their corresponding latent variables, that is, AC, AR, and PN, as shown in Table 3. Average responses of each indicator are also presented in Table 3. The estimated values of Cronbach's

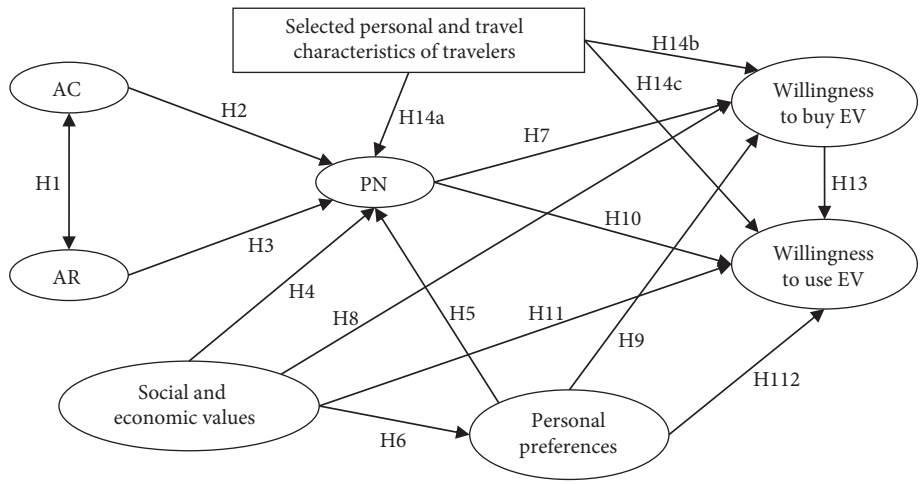

Figure 1: Framework of research hypothesis (AC: awareness of consequences, AR: ascription of responsibility, and PN: personal norm).

Table 2: Descriptive statistics of the respondents' SEDs.

Characteristics	Distribution (%)
Gender	Male (85.6), female (14.4)
Marital status	Single (66.9), married (33.1)
Age (years)	Below 20 (30.8), 21–30 (35.8), 31–40 (16.2), 41–50 (11.2), above 50 (6)
Education	High school or below (21.4), higher secondary/diploma (25.1), bachelor (38.3), master's or higher (15.2)
Profession	Students (38.3), employees (28.4), business (12.9), others (20.4)
Income	≤20,000 (43.8), 21,000–30,000 (10.2), 31,000–40,000 (8.2), 41,000–60,000 (11.7), 61,000–80,000 (8.2), >81,000 (17.9)
Car ownership	None (54.7), 1 (35.57), 2 (7.5), more than 2 (2.2)
Car driving license	Yes (37.3), no (62.7)
Usual travel mode	Walk/bicycle (9.9), private car (33.8), motorcycle (28.6), auto rickshaw/taxi (8.5), campus/office transport (6.2), public transport (12.9)
Trip frequency per week	Almost every day (57.9), 5-6 days (16.7), 3-4 days (15.2), 1-2 days (4.7), a few times a month (5.5)
Trip distance (km)	< 10 km (52.4), > 10 km (47.6)

Table 3: Rotated factor loadings of the NAM variables.

Observed variables	Mean	Factor		
		PN	AR	AC
I feel morally responsible for the betterment of the urban environment and society (PN-1)	4.025	0.793		
I feel a moral responsibility to preserve natural resources such as oil and gas (PN-2)	4.094	0.669		
I feel joint responsibility for the consumption of natural resources such as oil and gas (AR-1)	3.985		0.946	
I feel equal responsibility for the degradation of the environment due to an increase in traffic (AR-2)	4.014		0.495	
Excessive use of gasoline/diesel cars deteriorates (destroys) the urban quality of life and environment (AC-1)	3.992			0.875
Car usage causes a shortage of scarce (rare) natural resources, for example, oil and gas (AC-2)	4.025			0.494
Percentage of variance explained		21.678	20.561	17.512
Cronbach's alpha		0.737	0.715	0.673

alpha are more than 0.7 for PN and AR variables, whereas the value for the AC variable is near 0.7. The percentages of variance explained by PN, AR, and AC are 21.678, 20.561, and 17.512, respectively. These values show an acceptable level of reliability of these variables and internal consistency among respondents in the evaluation. The variable PN shows that the respondents placed high beliefs on their moral obligations for the betterment of the urban environment and society, as well as preservation of natural resources. The factor of AR depicts travelers' mutual sense of responsibility for the consumption of resources and degradation of the environment due to increased traffic demand. Also, the travelers have a good sense of awareness concerning negative outcomes of their behavior such as deterioration of urban quality of life and environment due to air pollution and reduction of natural resources due to use in transportation. It is believed that the travelers' sense of awareness and responsibility and moral obligations would

have a significant influence on their intentions to buy and use an EV.

Second-order factor analysis was conducted on respondents' responses concerning their willingness to use EV (Use) and willingness to buy EV (Buy). Cronbach's alpha values were estimated for both factors as presented in Table 4. The calculated alpha values are more than 0.7, which predicts an acceptable level of reliability of the factors and internal consistency among respondents in the evaluation of the observed variables. Most of the respondents are willing to use EVs for the preservation of natural resources, to reduce air pollution, and for the availability of cheap electricity. The results of the factor willingness to buy show that the targeted groups of travelers have high willingness to buy an EV provided that they have better awareness about the mileage of EVs, low initial and maintenance costs than oil/diesel cars, and batteries with long life. The results of factor analysis predicted positive attitudes, norms, and intentions of travelers towards the use and ownership. The percentages of variance explained by both factors are 24.977 and 22.810, respectively.

A third-order factor analysis was conducted on perceived social, economic, and personal aspects of traveling. This exploratory factor analysis resulted in two factors, that is, personal preferences (PP) and social and economic values (SEV). The estimated Cronbach's alpha values are more than 0.5, which shows a moderate level of reliability of the extracted factors. The PP factor depicts travelers' priorities in vehicle ownership and use of electric vehicles within a city as it is easy to charge the vehicle. The first observed variable in the PP factor has more influence in explaining the factor as it has high factor loading. In the SEV factor, the observed variable of "I prefer to drive a fuel-economical vehicle" has more impact on the SEV factor as it has a very high factor loading. It also shows that there are travelers who feel socially responsible to save the environment. The percentages of variance explained by PP and SEV are 21.282 and 21.082, respectively, as described in Table 5.

4.3. Structural Equation Modeling (SEM). A structural model was developed using the results of factor analysis. This model tested the stated hypothesis of Figure 1. Observed variables of travelers' socioeconomic demographics (SED) variables were defined as binary variables and tested for possible significant structural relationships with variables of PN, willingness to buy, and willingness to use EV. Various variables were defined and tested but here only significant variables are presented and discussed. These variables included profession (1 if travelers are employees and 0 otherwise), age (1 if age is less or equal to 30 years and 0 otherwise), travel mode (1 if the mode is a motorcycle and 0 otherwise), car ownership (1 if owning one or more cars and 0 otherwise), income (1 if income is between 21,000 and 60,000 and 0 otherwise), and trip distance (1 if the distance is more than 10 km and 0 otherwise).

The results of measurement and structural equations are presented in Figure 2. The rectangles and ellipses or circles in Figure 3 define the observed variables and latent variables, respectively. This structural model shows that all the measurement equations are positive and significant at a 1% or 5% level of significance. The AC and AR latent variables have a positive and significant association which depicts that the respondents who have awareness about negative outcomes also possess a sense of responsibility for the outcomes of their behavior. The structural coefficients of AC and AR with PN are positive and significant at a specific significance level. The significance and prediction power of these relationships are consistent with previous studies explaining sustainable travel behavior [51, 54, 56, 80]. These significant equations show that the travelers who have a sense of awareness and responsibility about negative outcomes of their behavior also felt a moral obligation to preserve the natural resources and for the betterment of the urban environment and society. The SEV variable has a positive and significant structural coefficient with the PN which predicts that the travelers who put high beliefs on social and economic values in traveling felt morally obliged to protect the environment and society and to preserve the natural resources. The young travelers (≤30 years), civil and private employees, trip distance (>10 km), and motorcycle users have positive structural relationships with the PN, whereas travelers with an income level of 21,000–60,000 PKR have a negative coefficient with the PN. Other researchers have also shown the significance of age, income, and profession in EV adoption behavior [34, 35]. These results show that the employees, young travelers, motorcycle users, and travelers with a trip distance of more than 10 km have high moral obligations, whereas the travelers who fall in mentioned income range have low moral obligations. The AC, AR, and SEV along with age, income, travel mode, profession, and trip distance variable explain almost 48% of the variance in the PN. The SEV and PP variables are positively related to each and significant at a 10% level of significance. It is shown that the travelers' perceived economic and social value influences their priorities in traveling and vice versa.

The structural equations of PN and PP with the willingness to buy and use an EV are significant and positive, which depicts that the development of prosocial norms among travelers and individual's priorities in traveling significantly influence the potential of EV ownership and usage. These results are in agreement with a significant role of problem awareness and personal norms in travelers' willingness to adopt sustainable transport policies [51, 56, 81]. The respondents who are employees and own a car also developed positive correlations with the willingness to buy an EV, and the variable of car ownership is also significant with willingness to use an EV. It means present car owners, and civil and private employees have a high propensity to own an EV in the future. The PN, PP, employees, and car ownership variables explain almost 67% of the variance in willingness to buy. Similarly, the variables of PN, PP, and car ownership collectively explain almost 32% of the variance in willingness to use. The PN variable also explains the role of the mediator to explain the indirect influence of AC, AR, and SEV on travelers' willingness to buy and use an EV. The PP variable is also a mediator between SEV and willingness to buy and use. The values of

Table 4: Rotated factor loadings of willingness to buy and use EV.

Observed variables	Mean	Factors	
		Willingness to use EV (Use)	Willingness to buy EV (Buy)
I am willing to use an electric vehicle for the preservation of natural resources (Use-1)	3.880	0.868	
I am willing to use an electric vehicle to reduce air pollution in the city (Use-2)	3.972	0.758	
I am willing to use an electric vehicle considering the availability of cheap electricity (Use-3)	4.037	0.534	
I would buy an electric vehicle if I have more information about the mileage with one-time charging (Buy-1)	4.082		0.776
I would buy an electric vehicle if the initial purchase cost is less than petrol or diesel vehicles (Buy-2)	4.164		0.588
I would like to buy an electric vehicle if the maintenance and battery costs are less than petrol or diesel cars (Buy-3)	4.206		0.542
I would like to buy an electric vehicle if the charging batteries have a long life (Buy-4)	4.278		0.437
Percentage of variance explained		24.977	22.810
Cronbach's alpha		0.786	0.702

Table 5: Rotated factor loadings of extracted factors.

Observed variables	Mean	Factor	
		Personal preferences (PP)	Social and economic values (SEV)
I like to have a car with a small engine capacity (e.g., below 1000 liters = 1.0 liters) (PP-1)	3.120	0.780	
Having an electric vehicle is a status symbol for me (PP-2)	3.381	0.445	
I would prefer to use an electric vehicle only within a city as it is easy to get charge of it (PP-3)	3.955	0.371	
I prefer to drive a fuel-economical vehicle (SEV-1)	4.281		0.939
I consider it as my social responsibility to save the environment (SEV-2)	4.527		0.383
Percentage of variance explained		21.282	21.082
Cronbach's alpha		0.515	0.508

the goodness of fit parameters fall within the recommended limits or near to the limits; for example, CMIN/DF lies in the range of 2–5, GFI and AGFI are more than 0.8, and RMSEA is less than 0.08. These values show that this structural model has an acceptable level of reliability in explaining the travelers' potential to own and use an EV under the framework of NAM theory. Table 6 shows the significance of the defined hypothesis. The significant hypotheses are mentioned as supported and insignificant hypotheses are stated as not supported. The hypotheses between PP and PN, between SEV and willingness to buy, and between SEV and willingness to use were not supported by the collected data. Only significant hypotheses of defined variables SEDs with PN, willingness to buy, and willingness to use are presented.

5. Discussion and Policy Implications

With the rapid increase in the population and inadequate public transport systems, Pakistan is becoming more dependent on conventional (gasoline) vehicles which jeopardize environmental sustainability, especially in urban areas. During the last few years, smog has severely hit the major cities in the winter, which is compelling the governments to close educational institutes and summer leads to severe heat waves which are causing many deaths each season [10]. Therefore, it is a national priority to improve the transport sectors which include the diversification of fuel towards sustainable and renewable energy resources. For road transportation, EVs are one of the very efficient energy alternatives to conventional vehicles. The respondents of this study manifested a positive attitude towards the adoption of EVs owing to their prosocial and proenvironmental behavior; a conceptual framework of derived EV behavioral intervention techniques is shown in Figure 3. This framework shows that the travelers' sense of awareness and responsibility about the negative outcomes of their behavior is essential to develop prosocial personal norms among them. It implicates that better awareness of travelers about environmental problems caused by conventional vehicles emissions and preservation of natural resources can play a predictive role in improving moral obligations for the betterment of the urban environment and society. The sense of social and economic values in traveling also has significant correlation with the travelers' moral obligations to protect the environment and save natural resources. The presence of these social norms and values and sense of responsibility among travelers can be handy in the promotion of environmentally friendly vehicles such as EVs. For this purpose,

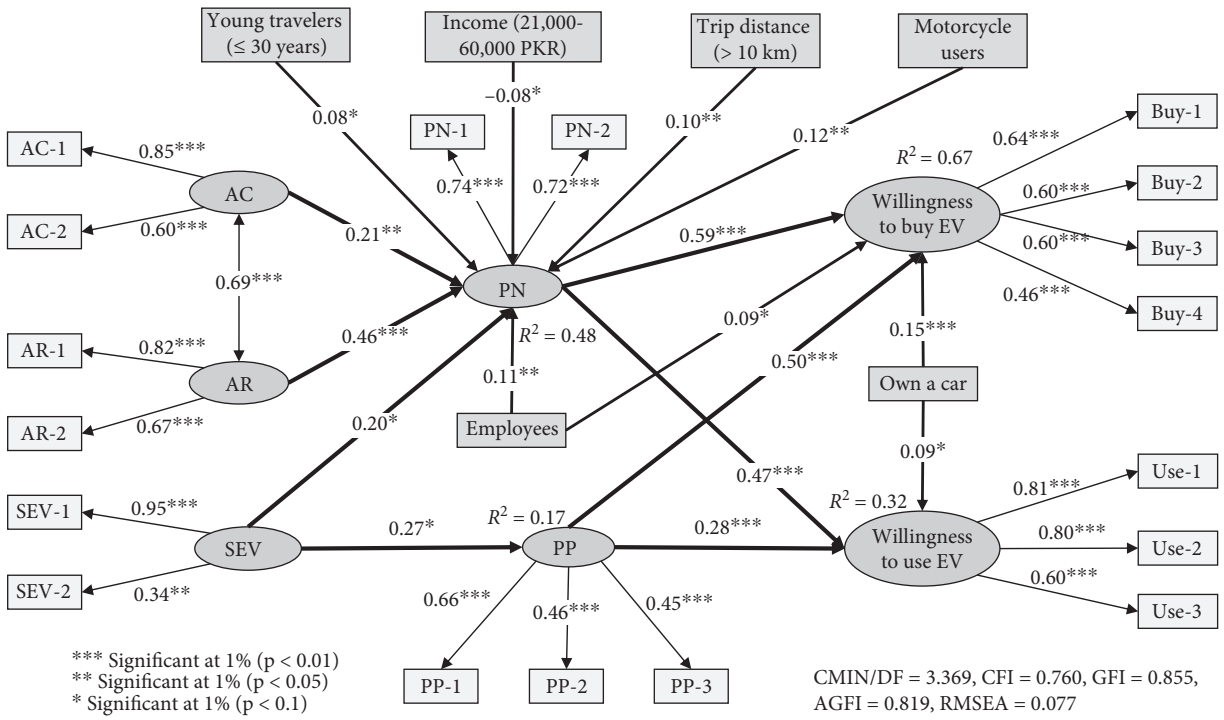

Figure 2: Structural model of travelers' willingness to buy and use an electric vehicle (AC: awareness of consequences, AR: ascription of responsibility, PN: personal norm, SEV: social and economic value, PP: personal preferences, CMIN/DF: chi-square/degree of freedom, CFI: comparative fit index, GFI: goodness of fit index, AGFI: adjusted goodness of fit index, and RMSEA: root mean square error of approximation).

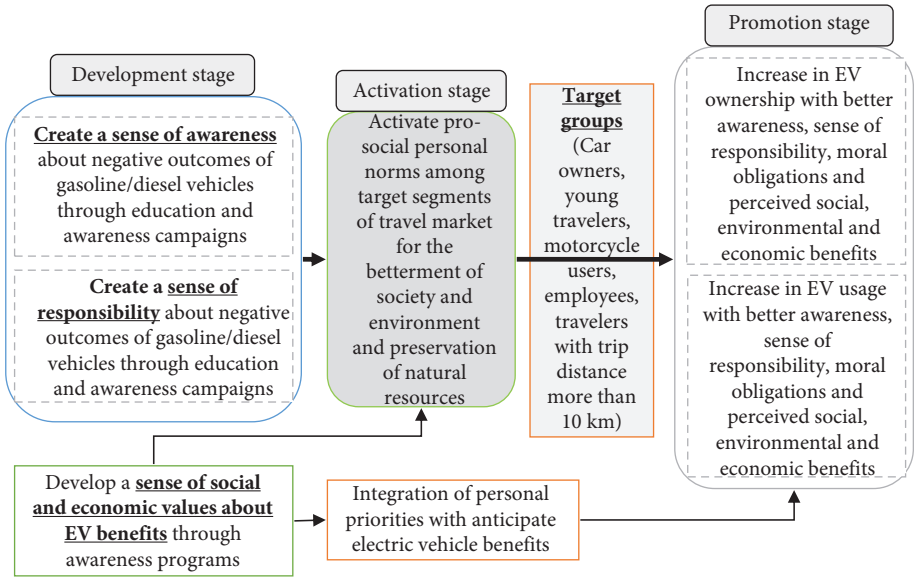

Figure 3: A conceptual framework of behavioral interventions to promote the EVs.

it is required to initiate appropriate awareness and education programs to highlight the benefits of EVs and disadvantages of gasoline/diesel vehicles among travelers. There is also a need to activate the sense of responsibility among travelers through education, seminars, and awareness as it will help to save the environment and natural resources and to enhance the purchase behavior of customers [82]. Once the travelers have better awareness about the economic and social benefits of EV, they would prefer to shift to sustainable vehicle technologies to protect the urban environment and society from severe air pollution resulting from the transportation sector. This favorable attitude of an individual towards environmental issues is more likely to be a compelling reason to purchase EV. The activation of person norms and integration of personal priorities with EV benefits would help in promoting EV ownership and usage for the target

Table 6: Results of hypothesis significance.

Hypothesis	Hypothesis description			Decision
H1	AC ↔ AR			Supported
H2	AC ⟶ PN			Supported
H3	AR ⟶ PN			Supported
H4	SEV ⟶ PN			Supported
H5	PP ⟶ PN			Not supported
H6	SEV ⟶ PP			Supported
H7	PN ⟶ willingness to buy EV			Supported
H8	SEV ⟶ willingness to buy EV			Not supported
H9	PP ⟶ willingness to buy EV			Supported
H10	PN ⟶ willingness to use EV			Supported
H11	SEV ⟶ willingness to use EV			Not supported
H12	PP ⟶ willingness to use EV			Supported
H13	Willingness to buy ⟶ EV willingness to use EV			Not supported
H14a	Motorcycle users, young travelers, employees, trip distance >10 km, middle income	⟶	PN	Supported (only significant equations are reported)
H14b	Own a car, employees	⟶	Willingness to buy EV	Supported (only significant equations are reported)
H14c	Own a car	⟶	Willingness to use EV	Supported (only significant equations are reported)

groups of the travel market as shown in Figure 3. The identified target groups of the travel market would possess the required potential to purchase and use an EV considering associated prosocial, environmental, and economic benefits [34]. The selection of appropriate target groups is very important for crafting energy and transport policies and for the inclusion of EV policies as a success. The main target groups can be present car owners and motorcycle users, civil and private employees, and young travelers who have the potential to own a car in the future. Also, there is a need to provide required economic and infrastructure incentives on EVs ownership and usage. These incentives include subsidies, cheap electricity, low registration taxes, tradable permit schemes, and the availability of charging stations [83, 84]. Therefore, it is required to develop a system to provide necessary information about spatial coverage of charging stations as it will help to attract potential buyers and users of EVs [12]. Awareness of travelers about available economic, social, and accessibility incentives is an important policy to enhance the adoption behavior of the masses. For this purpose, awareness campaigns through electronic, print, and social media can be initiated to create awareness about the benefits of EVs. The sense of awareness and responsibility and activation of moral obligations would help in promoting EV ownership and usage. In this regard, the government and other social organizations should join forces and work in close collaboration to create awareness and improve the understanding of the potential customers about how conventional vehicles are the main contributing factor towards deteriorated air quality in the main cities. The change in the adoption behavior of travelers will help in alleviating the environmental problems in Lahore city and other developing regions. It is believed that there would be an increase in the purchasing and adoption behavior of EVs if these policy measures are implemented with utmost effort. The government should encourage private auto market to launch EVs in the country by providing special subsidies and reducing taxes. The government's financial incentive programs for the auto industry and its users would help in developing green transport infrastructure in the country. The private companies should initiate the installation of charging stations along major highways and at other key points to facilitate the potential users of EVs. It is required to deploy special marketing strategies to educate the travelers regarding availability of cheap EV and associated benefits and facilities such as location of charging stations. A proper contribution from the private sector is important in promoting the use of EVs in developing countries. However, proper financial and administrative support from the government is also vital in this regard. Electric mobility can be integrated with ridesharing and DRT to reduce the environmental impacts of transportation infrastructure. Special economic incentives to the riders of EVs in combination with car-sharing and DRT can help to shape the cities' transport sustainably.

6. Conclusion

This study identified behavioral interventions for the promotion of EVs using the results of a questionnaire survey. The framework of the NAM theory was extended including personal and travel characteristics, as well as perceived economic and social values and personal priorities in traveling. The factor analysis confirmed the correlations of questionnaire statements with AC, AR, and PN according to the NAM theory. The other extracted factors also have an acceptable level of reliability in explaining the EV adoption behavior. The AC, AR, and SEV factors are significant and positive predictors of the PN. The PN and PP factors are strong predictors of travelers' willingness to buy and use an EV. The young travelers, motorcycle users, employees, and trip distance

are positively related to their moral obligations, whereas the income group (21,000–60,000 PKR) has a negative correlation with the PN. The PN variable also plays a role of a mediator to explain the influences of AC, AR, and SEV variables on willingness to buy and use EVs. The travelers' willingness to buy and willingness to use EVs are positively influenced by their present car ownership status.

The findings implicate that the development of a sense of awareness and responsibility about the negative outcome of their behavior would help in activating the prosocial norms among travelers for the betterment of the urban environment and society and preservation of natural resources. Similarly, travelers' awareness regarding economic, social, and environmental benefits associated with the use of EVs would help to develop positive personal norms among travelers. The current car owners, young travelers, current motorcycle users, and employees can be target groups of the travel market for this promotion. The availability of charging stations, cheap electricity, and economic incentives from the government in terms of tax relaxation and subsidies would be handy pull measures to alter the adoption behavior. On a broader scale, this study aims to contribute to the efforts of the government in maintaining a more sustainable transport infrastructure in Lahore city, where energy and transport policies are needed to be urgently integrated and special efforts are required to understand the motivations of the customers to understand their purchasing behaviors towards EVs.

The sample of this study mainly comprised young people and students, which may cause bias in the extracted findings and policy implications. Future studies should focus on large samples consisting of adequate representation of different groups of the travel market. Also, the policies derived from stated preferences studies may be biased as the actual intentions of the travelers may differ once the relevant policy is implemented. Therefore, further studies are required after the implementation of the EV policy to examine the actual preferences of travelers. Those studies should also evaluate the influence of charging stations accessibility, electricity price, and spatial coverage of charging stations, as well as mileage with one-time charge of electric batteries on traveler's willingness to use the EVs. Despite limitations, the findings of this study would provide useful insight into significant behavioral interventions to promote the EVs and reduce the environmental issues.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Disclosure

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Conflicts of Interest

The authors declare no conflicts of interest.

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