A Study to decipher the intension to switch to Electric Vehicles: An Application of push, pull and mooring model.

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Abstract

EVs have experienced a resurgence in the twenty-first century because of technological developments, a focus on renewable energy sources, and the potential to reduce the impact of transportation on climate change, air pollution, and other environmental challenges. In this study, we used the Push Pull Mooring method to examine users' intentions in India to switch from fuel-powered to new energy vehicles. After conducting a review of the literature to identify themes, we created a questionnaire that was distributed to 250 current car owners. Investigative factor analysis was carried out to analyse and explore the factors. Multiple regression was employed to identify the variables that were most indicative of adoption behaviour. The study's findings show how environmental factors influence consumer preferences for and acceptance of electric vehicles. Because only four variables were considered and the Punjab region of India was the study's location, the findings may alter when applied to other regions of India or when other variables are used.

Keywords: Push Pull and Mooring, Switching behaviour, Green Environment, Normative and Regulatory Environment, Self-Efficacy, EV Vehicles.

Introduction

Electric Vehicle Industry

Electric vehicles are defined as those that are powered by one or more electric motors (EV). A battery, a collector system, or electricity from extravehicular sources can all be used to power it independently (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator). When electricity was one of the favoured sources of motor vehicle power in the late 19th century, electric vehicles (EVs) first made their appearance, providing a degree of comfort and usability that gasoline automobiles of the day were unable to equal. Internal combustion engines reigned as the major form of propulsion for automobiles and trucks for over a century, while electric power remained common in other vehicle types, such trains, and smaller vehicles of all

kinds. The International Energy Agency asked countries to take more steps in 2021 to meet climate commitments, including imposing limits on big electric vehicles. For the most part, electric automobiles use lithium-ion batteries.

Electric Vehicle Industry – Global Perspective

In 2021, EVs used about 55 terawatt-hours of electricity, with two-wheelers in China accounting for 10% of that total. In 2021, the global share of electricity consumed by electric vehicles was only about 0.5 percent. In 2021, the global share of electricity consumed by electric vehicles was only about 0.5 percent. Globally, the usage of EVs prevented the emission of more than 40 million tonnes of carbon dioxide equivalent of GHC throughout the year 2021. In 2021, the number of electric vehicle (EV) sales doubled from the previous year to reach a new high of 6.6 million. Only 120 000 electric vehicles were sold globally in 2012. In 2021, the market share for electric vehicles was about 10% worldwide, up from just 2% in 2019. With 2 million electric vehicle sales in the first quarter of 2022, a 75% increase over the same time in 2021, the market for electric vehicles has continued to grow rapidly. By 2030, Europe may produce 31% of the world's batteries, according to Bloomberg NEF. In contrast, the continent's percentage of the world's battery output in 2021 was only 7%. For instance, Toyota said that it will release 30 new BEV models by 2040, while VW predicted that almost all its sales would come from zero-emission vehicles.

Electric Vehicle Industry – Indian Perspective

Although the Indian car sector is now rated fifth, experts predict that it would rise to third by 2030. India is the world's top manufacturer of tractors, buses, two-wheelers, and three-wheelers, and ranks second in the production of buses. The car sector currently contributes about 49% of India's manufactured GDP and the country's overall GDP. This means that the country's economy will suffer. Between 2023 and 2025, the nation's EV market is projected to generate sales of $2 billion and $7.09 billion, respectively. There were 13, 92,265 electric cars on Indian roads as of August 2022. (Data by Ministry of Road Transport and Highways, India). Between April 2000 and March 2022, the industry saw FDI equity inflows of $32.84 billion, or 6% of total FDI in equities during that time. India has already achieved one of the criteria for the EV market.

Literature Review

Through the integration of the push-pull mooring model and institutional theory, research by Asmi, Chu, Anwar (2020) investigates people's intents to move from driving motorised vehicles to driving electric vehicles.

The study by Bhattacharyya and Thakre (2020) realized that the automotive sector in India was undergoing a change from conventional vehicles to more environmentally friendly battery-operated electric vehicles (EVs).

Everyday life in Pakistan's urban areas is severely hampered by the severe smog pollution. Most of the smog pollution is caused by transportation, which is leading to several health issues. (Sofia Anwar et al 2022) used the PPM framework to study how pollution affected people's intentions to move from conventional to green vehicles.

This study by (Wang et al 2020) intends to investigate how person propensity to switch to green transportation is influenced by push, pull, and anchoring variables. Individuals are pushed away from private automobiles by push factors like perceived environmental risks and inconvenience, while they are pulled by factors like green transportation policies, campaigns, and systems.

(Agrawal et al 2022) aims to advance the push pull-mooring hypothesis by establishing the LASS (Luxury as a service) framework, which provides more evidence for why customers choose sustainable luxury or do not. They discovered that the push factors voluntary conscious lifestyle, social norms, pull factors mindful consumption, and mooring factors materialism, social status.

(Yoon and Lim 2021) wants to investigate the variables that affect customers' decision to transition from standard online banking services to internet-only banking services in Korea. To do this, a research model based on the migration theory known as the push-pull mooring model (PPM) was created.

(Lin et al 2021) tries to understand the aspects that influence consumers' behaviour when switching between multiple platforms to keep users and make businesses more competitive. To build a structural equation model of customer switching behaviour on online learning platforms.

(Handarkho and Harjoseputro 2019) address the primary factor influencing an individual's adoption of mobile payment (MP) in physical stores, the study aims to develop a theoretical model based on the Push-Pull Mooring framework, which includes direct, indirect, and moderating effects.

(Xin Lin et al 2021) presents a detailed empirical examination of major factors influencing the choice of distant education by medical students through the integrated multi-model framework.

By building an evaluation method, (Zixin Dou et al 2021) intends to analyse the growth pattern of the manufacturing sector in the Guangdong-Hong Kong-Macao Greater Bay Area (from 2008 to 2018). Green sustainability of manufacturing industry and Development level of manufacturing industry, Technology development level are the PPM factors taken.

(Kim and Heo in 2019) realized that the technology-push factors are the attributes of the electric car itself, the range with a full charge, the number of models that can be selected, and the price difference between the same-class internal combustion engine vehicles (ICEVs) and EVs.

(Sun et al 2020) Investigated factors affecting individual investors' switching intention from traditional financial market to crypto-currency financial market. By sampling factors of individual investors related with crypto currency, the study applies structural equation modelling method (SEM) to investigate their effects on switching intention by integrating PPM and Reinforcement Sensitivity theories (RST).

(Ghazali et al applies the "push-pull-mooring" model of migration to explain home purchase intention in a suburban township. Dissatisfaction and high housing costs in one's current neighbourhood, consumers perceived value of the suburban township were the PPM factors.

(Guo et al 2021) proposed that the PPM model can be used as a significant theoretical lens in this study to understand different factors affecting the brand switching behaviour of smartphone users across different categories, namely, push, pull, and mooring factors.

(Jung et al 2017) tested the applicability of the push-pull-mooring (PPM) migration theory to travellers' airline selection to clarify their switching behaviour.

Need of Study

Because of wealthy consumers, improved infrastructure, and pro-electric car government regulations, sales of electric vehicles have somewhat grown in developed countries. Even in the most advanced economies in the world, the market for electric cars is still quite tiny. In growing economies like India, the adoption of electric cars is a recent trend. According to the literature review, most of the studies in this field have been carried out in industrialised nations. The findings of research that reveal Indian customers' tastes and the utilities they demand from electric vehicles might be useful information for producers and policymakers of electric vehicles in India.

Objectives

- Exploring the role of push, pull, and mooring variables toward intention to switch to electric vehicle.
- Determining the factors most predictive of electric vehicle switching intention.

Methodology

Research Design

The research used a descriptive research design. More particularly, it assists in answering the what, when, where, and how questions pertaining to the research dilemma, instead of the why of the dilemma.

Questionnaire Design & Administration

To identify various themes influencing consumers' preference towards electric vehicles, a review of the literature was conducted. Identified themes were used to develop a questionnaire that was circulated amongst 250 existing car owners. The questionnaire helped achieve the Objectives of the research. The sample consisted of diverse demographics as listed below:

Table 1: Demographic profile of respondents

Gender	Male	139
	Female	61
Monthly Income	20000-40000	39
	41000-60000	43
	61000-80000	71
	81000 & above	47
Educational Qualification	Higher Secondary	20
	Bachelor's Degree	49
	Postgraduate	124
	Doctoral Degree	7
Occupation	Working	187
	Non-working	13

Source: Primary data

Sampling Technique

A judgemental sampling was used for selecting the respondents of the study where the respondents agreed to express their opinion towards Electric Cars. 217 questionnaires were collected back, of which 15 questionnaires were found to be incomplete and were not found suitable for the study. 2 questionnaires were found to be extremely skewed in their responses and hence were rejected. 200 questionnaires were found to qualify for the analysis after the data cleaning process.

Statistical Tools

To investigate and explore the factors influencing consumer perception and preferences towards electric vehicle (passenger electric cars) adoption, exploratory factor analysis was performed. To determine the factors most predictive of adoption behaviour, multiple regression was used.

Push Factors:

Environmental Concerns

Due to a large increase in customer demand for energy independence and environmental awareness, the sale of electric cars has increased significantly in the United States. Numerous customers have stated that they much prefer hybrid or electric vehicles to regular gasoline or diesel-powered cars. According to the report, shoppers who are environmentally conscious are driven to make these purchases. The results also demonstrated that in developed nations, the environmental benefits of electric vehicles are regarded more highly than their economic and social benefits. Consumers' pro-environmental self-identity was found to have a substantial effect on their opinion of and willingness to buy electric cars. It was also argued that the reduced environmental impact and friendliness of electric vehicles were a major draw for their widespread use.

Pull Factors:

Government Support & Infrastructure

The regulatory agencies need to build a conducive environment for any invention to spread. Consumers' interest in purchasing alternative fuel vehicles was found to be affected by government support (Tax incentives, Subsidies, etc.), according to the study. To expand the market for electric vehicles beyond its current niche, the government must take the initiative to mobilise a wide range of stakeholders, including academic institutions, renewable energy providers, financial institutions, electric vehicle manufacturers, power companies, policymakers, and consumers. Provision of grant of Rs 1.38 lakh for EVs was made under FAME (Faster Adoption and Manufacture of Hybrid and Electric Vehicles). It can be difficult to build an electrical grid in a country like India, where many areas still lack access to electricity and power outages are more commonplace even in major urban centres. For the most part, EV drivers may need to charge their vehicles at home rather than at oil and gas stations. Regular usage of EVs was found to be nearly impossible due to the lack of a charging station at either home or work, which can be a cause for concern in economies still working to establish a reliable electrical infrastructure.

Perception of Economic Benefit

It was determined that the purchase price of the automobile was the most crucial aspect. Potential car purchasers often want to maximize the added value they can get at a greater price. When the price of EVs was significantly greater than that of conventional vehicles, there was a strong indication of a disparity in preferences among the public. Some research has found that those with higher incomes are less affected by price changes than those with lower incomes, while other research has found no such effect to exist. Consumers paid a hefty premium when purchasing an EV (with batteries accounting for as much as 50% of the total price). But research shows that most people aren't willing to spend more for an electric vehicle. It was widely agreed that, especially in emerging nations, the industry or government should subsidise a sizable portion of the cost of batteries to encourage the widespread adoption of electric vehicles and make them price competitive. One-third of those polled in Austria believed that electric vehicle adoption could be accelerated only if EVs were priced similarly to conventional vehicles. The cost of a battery lease was found to affect consumer preference negatively.

Mooring Factors:

Perceived Control Behaviour

The degree to which a person's sense of outside behavioural control influences their intentions and subsequent behaviours varies greatly. Self-efficacy and controllability are two subgroups of perceived behavioural control. Self-efficacy is the belief in one's own capacity to complete a task. Depending on how conscious they are of their own resources, such as money, a person's sense of control over their fate might vary. Factors including the impression of greater costs and restricted availability hamper the penetration of organic foods. substantial corpus of research attributes purchasing organic food to a person's income.

Discussion on Results

Objective-I: Exploring the role of push, pull, and mooring variables toward intention to switch to electric vehicle.

The questionnaires were analysed for internal consistency using reliability statistics. To explore the factorial structure of consumer preference and acceptance of electric cars, with the specific sample, all items were subjected to an exploratory factor analysis with ProMax rotation and maximum likelihood extraction method which curtailed a large set of items into a small set of factors. KMO (Kaiser-Meyer-Olkin) value of 0.817 verified sample adequacy and that reducing several variables into fewer factors was appropriate. Further, Bartlett test of Sphericity was 0.000 which concluded that correlations in the data set were appropriate for EFA (Table 2).

Table 2: KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.817
Bartlett's Test of Sphericity	Approx. Chi-Square	4317.741
	Df	190
	Sig.	.000

Maximum likelihood factor analysis with a cut-off points of .40 and Kaiser's criteria of eigenvalues greater than 1 (Field, 2009; Steven, 1992) yielded a four-factor solution as the best fit for the data accounting for 75.275% variance (Table 3):

Compo nent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Tota l	% of Varianc e	Cumula tive %	Total	% of Varianc e	Cumula tive %	Total	% of Varianc e	Cum ulativ e %
1	7.18 0	35.899	35.899	7.180	35.899	35.899	4.026	20.132	20.13 2
2	3.69 9	18.496	54.395	3.699	18.496	54.395	3.818	19.089	39.22 1
3	2.56 5	12.824	67.219	2.565	12.824	67.219	3.617	18.085	57.30 6
4	1.61 1	8.056	75.275	1.611	8.056	75.275	3.594	17.969	75.27 5

Table 3: Total Variance Explained

Statements having high factor loadings on factor one corresponded to Environmental factors influencing consumer preference and acceptance of electric cars. Dangerous level of air pollution has made Indian drivers think about switching to an environment-friendly vehicle market. In addition, about 87 per cent of Indians would like to buy an electric car, if it helped reduce air pollution, according to a new survey. Statements having high factor loadings on factor two corresponded to Governmental aid and infrastructure-related factors. The government of India is also working towards inculcating a holistic electric vehicle ecosystem seeking cooperation from multiple stakeholders.

Table 4: Rotated Component Matrixª				
	Component			
	1	2	3	4
I will shift to electric cars because they can help solve the problem of pollution in India	.864			
I will shift to electric cars because it's a clean fuel	.860			
I believe the use of electric cars is a long-term step towards a sustainable future	.857			
I believe that the use of electric cars will help reduce the risk of respiratory diseases caused by harmful emissions by cars running on oil and gas	.855			
I believe electric cars will help reduce ozone layer depletion	.823			
I will shift to electric vehicles if the Government of India helps promote convenient purchase options (Easy loans, Lower interest rates etc.)		.857		
I will shift to electric cars if the Government of India will devise electric cars friendly policies		.852		
I will shift to electric cars if the Government of India will subsidize the usage of charging station		.844		
I will shift to electric cars if the Government of India ensures enough availability of service stations		.818		
I will shift to electric cars if the Government of India will work towards building infrastructure (roads, enough charging stations) facilitating the use of electric cars		.799		
I believe electric cars will help lower the cost of electricity			.826	
I will shift to electric cars if they are priced appropriately			.815	
I will shift to electric cars if the maintenance cost of such cars is low as compared to existing vehicles.			.789	
I will shift to electric cars if they provide relatively cheaper means of private transport			.769	
I will shift to electric cars if the sales tax on the initial purchase of electric vehicles can be waived off			.762	
I think I can make the decision to buy an electric car by myself				.857
I think I have enough knowledge to shift to electric cars				.852
I do not have any constrain on money and I can easily switch to electric cars				.845
I have all resources I need to shift to electric cars				.834
I do not depend upon anyone but myself to make critical decisions in my life				.813
Cronbach's alpha	.915	.906	.899	.933
Eigenvalues (percentage of variance)				75.275
KMO				0.817
Bartlett's test of Sphericity				
Approx. Chi Square				4317.741
Df				190
Significance				0.000
a. Rotation converged in 5 iterations.				

Determining the Factors Most Predictive of Electric Vehicle Switching Intension

The following multiple regression presumptions were tested on the data: On a continuous scale, the dependent variable (Intention to switch to electric automobiles) was measured. The dependent variable was predicted using four independent variables, all of which were measured on continuous scales. It was determined if observations were independent using Durbin-Watson statistics. Although the data had a test value of 1.821, which was within the allowed range of 1.5 to 2.5, autocorrelation was not present. When predictors in a model correlate with one another, this phenomenon is known as multicollinearity. Its presence may have a negative impact on regression outcomes. Generally, strong multicollinearity is present when a VIF is more than 10. With values in this instance around 1, the outcomes were deemed favourable to move forward with multiple regression. In the data, no notable outliers were discovered. The residuals, however, were not evenly distributed. Table 5 below discusses the complete results:

Table 5: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.759[a]	.576	.558	5.69097

Source: Primary Research

A value of 0.759 for R indicates a good level of prediction. This is an extent of the strength of the association. The value of R square (coefficient of determination) as .576 indicates independent variables (attitude, subjective norms, and perceived behavioural control) can explaining/predict 57.6% of the variance in the dependent variable. An adjusted R square value of .558 (almost the same as R Square) again signals the predictive power of independent variables.

Anova Table

The F-ratio in the ANOVA table inspects the overall regression model fit for the data. Table 6 shows that the predictor variables statistically significantly predict the dependent variable with $F (4, 95) = 32.39$, $p < .0005$, which means that the regression model is a good fit for the data. Std. The error of Estimate (SEE; the standard deviation of the residual SEE) is 5.69. This means on the average estimate of consumer perception and acceptance will get wrong by 5.69 which is negligible in the context of intention to switch to electric car.

Table 6: Anova Table

	Sum of Squares	df	Mean Square	F	Sig.
Regression	4196.4	4	1049.1	32.393	.000[a]
Residual	3076.7	95	32.8		
Total	7273.2	99			

Source: Primary Research

Coefficients

Regression coefficients represent the mean change in the response variable for one unit of change in the predictor variable while holding other predictors in the model constant. This statistical control that regression provides is important because it isolates the role of one variable from all the others in the model.

Table 7: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig	Lower Bound	Upper Bound
1	(Constant)	1.204	.323		-3.722	.000	-1.842	-.566
	Environmental concerns	.494	.044	.301	6.369	.000	.193	.367
	Government support and infrastructure	.336	.042	.368	7.966	.000	.253	.419
	Perception of Economic benefit	.280	.072	.331	6.859	.000	.352	.637
	Perceived behavioural control	.210	.051	.223	.4796	.000	.243	.541

Source: Primary Research

As clear from the multiple regression results, **electric car** switching behaviour = 1.204 + .494*Environmental concerns + .336*Government support and infrastructure + .280*Perception of economic benefits +.210* Perceived behavioural control. To find out the factors most predictive of electric car switching behaviour, a regression model was applied by taking "environmental concern (Push), Government support and infrastructure (Pull), Perception of economic benefits (Pull) and Perceived behavioural control" (Mooring) as independent variables & "electric car switching behaviour" as the dependent variable. The regression model produced: R Square= 0.576, F= 32.393, P< .000.

Conclusion & Implications

The automotive industry around the world is fascinated with electric cars. There is a lot happening in the Indian electric car market because the government of India is striving for full electrification as soon as 2030. Nearly 40% of Indian car owners would prefer a lower price for an electric vehicle. Thirty percent more are prepared to spend the same as they would for a regular vehicle. Fifteen percent of India's automobile owners are willing to pay more. In the present day, the price of an electric automobile is at least 25% higher than the price of a comparable car powered by gasoline or diesel. Since Indian consumers have demonstrated a pro-environmental attitude toward electric car adoption, it would be helpful for government agencies and automakers to develop joint marketing campaigns emphasising the environmentally friendly aspects of electric cars. This would help ease the electric car adoption process by raising awareness among the masses who are still undecided about the advantages of electric over traditional vehicles. It is important to plan for the government's role in reducing the cost of purchasing and recharging electric vehicles and for the automotive industry's role in educating customers about how the reduced maintenance needs of electric vehicles can help offset the initial purchase price.

Results from factor analysis were consistent with this view. The most trustworthy responses were found to have

high factor loadings on factor one of the studies, which represents environmental characteristics that affect consumers' preferences and acceptance of electric vehicles. Due to India's disturbingly high levels of air pollution, many drivers are considering buying environmentally friendly vehicles.

It was also observed that consumers' concern for the environment (the "Push factor") was one of the most telling factors in determining whether they would make the changeover from conventional to electric vehicles The fact that transitioning to an electric vehicle is so simple financially and that the government offers substantial rebates for doing so may explain why perceived behavioural control was the least predictive variable.

Limitations

The study was restricted to the Indian state of Punjab. So, it's probable that the study's findings don't apply to all of India. Future study will benefit from having people from other regions of India. In the investigation, just four variables all of which reflected either push, pull, or mooring were used. Future studies might consider more aspects, providing electric car makers with a fuller insight of what motivates consumers to switch. This study employed a cross-sectional research design. But, given the field's youth and how transparently it is developing, there might be multiple significant changes in how people accept electric vehicles.

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