

“SPECULATING ADOPTION INTENTION TOWARDS ELECTRIC MOBILITY IN BANGALORE USING EXTENDED THEORY OF PLANNED BEHAVIOR”

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Abstract:

Automobile industry is into transmogrification as pollution is an immediate global concern today. “The Air Visual 2020” World air quality report by IQ Air figured out that 15 of the world’s 20 worst polluted cities are sited in India. Hotan, located in China is the worst affected city on planet earth. Most polluted Indian cities include Ghaziabad, Bulandshah, Bsrakh, Bhiwadi, Noida, greater, Noida, Kanpur, Lucknow, Delhi, Faridabad, Meerut, Jind, Hisar, Agra, Muzaffarnagar. Extended theory of planned behavior is used to predict and analyze the adoption intention towards electric vehicles of 222 respondents from Bangalore. Among all the factors considered in the research signifies that attitude towards electric vehicle, Perceived Behavior Control and Environmental concern and has significant influence on actual intention to adopt electric vehicles.

Keywords: EV- Electric vehicles, PHEV- Plug-in hybrid electric vehicles, FAME, ETPB- Extended Theory of planned behavior, Sustainability

Introduction:

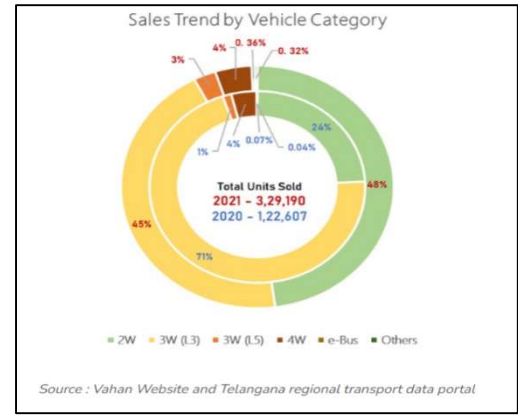
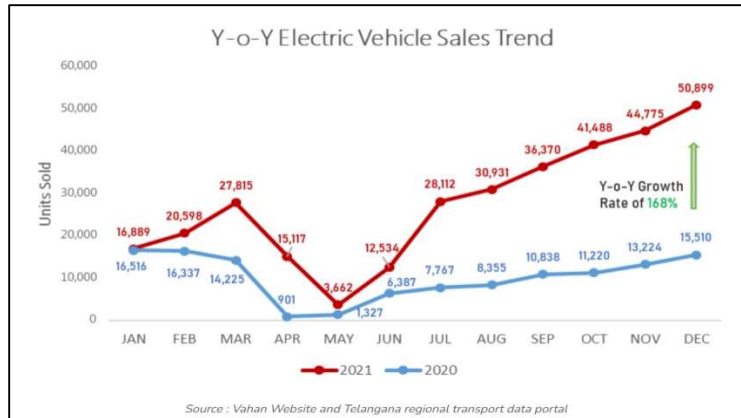
Contextualizing the global IQ Air report. Major sources of air pollution encompass Vehicle exhaust and Transportation, Biomass burning, electricity generation, Construction, Industry, Waste burning, and episodic agricultural burning (Niall McCarthy Mar 16, 2021). According to the neoteric data from the Global Carbon Project, the top five countries that produced the most CO₂ are China, the U.S., India, Russia, and Japan. India is the third largest emitter of carbon dioxide with 2.65 billion metric tons of CO₂ in 2018. (ANDRIY BLOKHIN January 31, 2022) According to a new study surveyed by international council on clean transportation, Milken Institute School of Public Health from George Washington University, and the University of Colorado Boulder, 66% of air pollution related deaths in India was due to diesel vehicles. (Barkha Mathur (March 5, 2019). To promote the infrastructure and use of Electric vehicles in India, Central

and state Government has undertaken noteworthy initiatives and launched schemes like Alternate Fuel for Surface Transportation Program, National Electric Mobility Mission Plan 2020 (NEMMP), FAME-I Faster Adoption and Manufacturing of Electric Vehicles Scheme, FAME-II Scheme for facilitating and expediting the process of electrification of vehicles (Nikhil Puthran May 11, 2021)

The Indian Electric vehicle market is valued at 5 billion USD and is expected to outstretch 47 billion USD by 2026 with Speculated CAGR of 44% (2021 -2026). There is an optimistic growth in Electric two-wheeler vehicles in India.2019 was a landmark year with highest number of registered electric vehicle annual sales reaching a milestone of 1,60,000 Units. The EV sales dropped by 26% across pan India in 2020. (JMK Research & Analytics January 7, 2021). To boost the sales and usage of Electric vehicles in India, Union government has introduced policies and scheme like FAME-1, FAME-2, Scrapage policy and PLI schemes. Users of Electric vehicles have been provided with concessions including financial subsidy on purchase, Reduced GST, Road tax exemption, Low interest rate loans and registration charges. Make in India's initiatives towards E-mobility have prompted many EV Manufacturers to Invest in Indian Market to start their operations. 38 Original equipment manufacturers have registered 114 new models with the department of Heavy industry with 69,500 sales in India (Neeraj Kumar Singal June 6 2021) California records significant usage of Electric vehicles with 42% of EV share nationwide followed by Florida and Texas as of December 30, 2020 (Experian Information Solutions June 14, 2021)

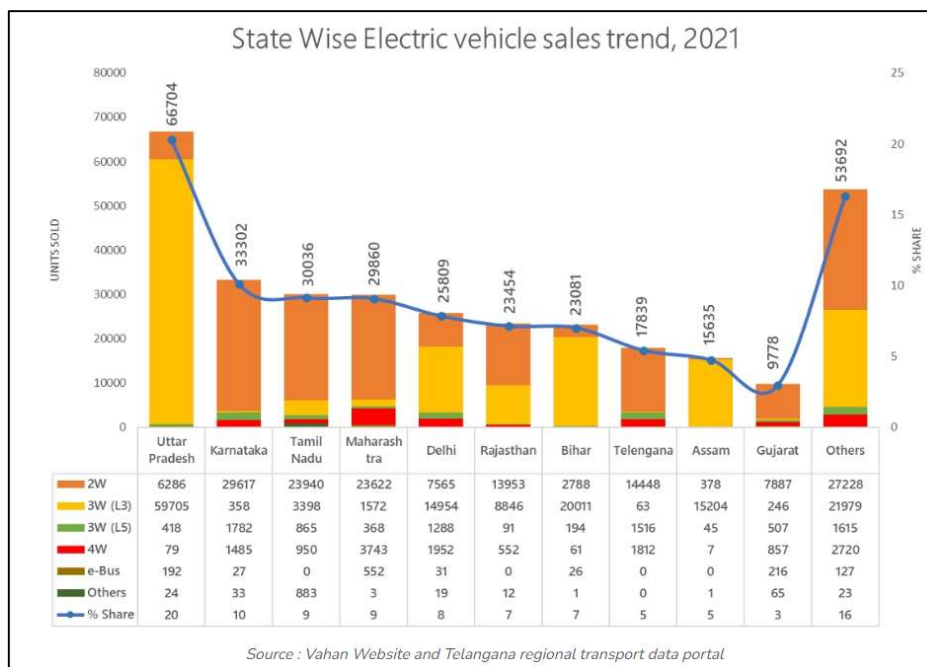
Uttar Pradesh records highest sales of Electric vehicles and contributed towards 20% of total Electric vehicles sales in FY21 with volumes of 66,704 Units followed by Karnataka, Tamil Nadu (Nandini Sen Gupta, Apr 15, 2021) These three states see highest EV sales in India. Indian Electric vehicle market is currently in its infancy and expected to exponentially grow at a CAGR of 90% by 2030 to reach \$150 billion according to RBSA Advisors. EV sales have penetrated and accounts to 1.3% of total vehicle sales in India in 20-21(Bismah Malik Dec 01, 2021)

India ranks low in sustainability performance index 2022 while Denmark is on the top tier when it comes to promotion of sustainability with significant commitments towards the globe (LYLA BAVADAM June5,2022)



Source : Vahan Website and Telangana regional transport data portal

3,29,190 units of electric vehicles were sold In India, with 168% increased growth over previous year's sales accounting to 1,22,607 Units. Two wheelers' sales constitute the highest sales with 48% followed by low speed L3 category three wheelers with 45% sales, electric L5 accounts to 3% and Electric 4Ws with 4% sales for 2021



Spike in fuel prices, favorable government incentives, policies, reduced GST, availability of Electric vehicles at the nearest place, Batteries, Spare parts, accelerated improvement in Infrastructure in metropolitan cities has hastened the millennials adoption of electric vehicles (EV reporter Jan 11, 2022)

Review of literature:

Early adopters' perception and evaluation is an important determinant towards EV adoption intension for large group of customers (Kumar shalender et.al 2020).

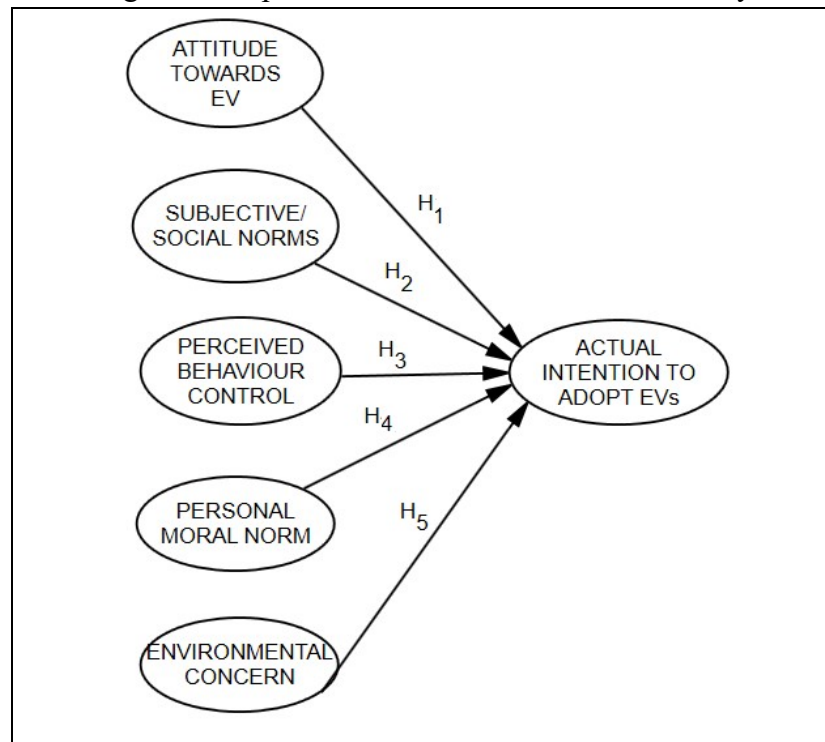
Consumer attitude, subjective norm along with perceived behavioral control and personal norm has notable affect towards adoption intention of EV- A study considering China (Wang, et.al.2016). Environmental awareness is significantly escalating along with attitudinal shift and social norms towards sustainability (Ramayah et.al 2012). Study on switching to a HEV/PHEV/EV through norm activation theory of altruism, value belief norm, and theory of environmentalism on three groups i.e alternative fuel vehicle owners, fossil fuel owners and hybrid/plugin/electric vehicle owner found that HEV/PHEV/EV owners differed notably from CV and AFV owners had acceptance towards change, less conservative, expressed a higher level of problem awareness, self-efficacy, and a vigorous personal norm towards EV adoption intension (Nordlund, et.al 2016). Major indicators towards EV Adoption included recharging infrastructure, technology, resale value, environmental performance along with travel behaviour and social demographic characteristics (Tiwari et.al 2020). High acquisition cost, short driving distance range, are substantial factors which impede the diffusion of EV towards go green and sustainability. Environmental performance being major predictor of attitude (Gegirmenci et.al 2017). Public policy support, charging technologies, psychological preferences towards switching intentions were vital considerations towards market penetration of EV's (Bhattacharya et. al 2020).The study aimed to examine factors that may influence EV adoption. Past research focused on technical factors, financial incentives, infrastructure and ECs. The model proposed in the study had Perceived Economic Benefit, Environmental concern, social influence, and self-image as independent variables. The attitude was the mediation variable to test Behavioral intention. The study found that the Perceived economic benefit is not related to the Behavioral Intention to adopt EVs. Instead, it has a strong positive effect on Attitude. (Khurana, A., Kumar 2020). Total cost of ownership, Lower fuel costs, minimal component parts, public charging facilities during idling hours, battery technology, Pre booking of charging outlets will be key factors for growth of electric vehicles in India. (Kumar, A., Choudhary 2018). Considering development, historic government policies implementation, Indian people buying concerns, response to new technologies and economics, the growth of IC engine technology will remain in demand with automatic transmission vehicle demand will rise in future. Hybrid fuel technology growth will be limited due to cost. Conversion of the conventional vehicle into the plug-in hybrid electric vehicle by retrofitting may have a tremendous market in India. EV and PHEV will have promising future in India; however, its current growth will be limited and the limit is decided by policies and awareness creation. A way towards sustainable transportation will go in slow space for some more time due to lack of EPT manufacturer, clear policy and its implementation. (Gujarathi, P. K., Shah, 2018). The statistics show that despite having a positive attitude towards the growth of the EV market, people are reluctant to switch to EVs because of the various barriers associated with them. The battery cost and purchase cost are the top concerns and are ranked 1st and 2nd by the respondents. there are customers with a "wait-and-watch" attitude, waiting until the purchase cost for EVs comes at par with the cost for a CFFVs and switching to EVs would be affordable. The public charging infrastructure is ranked 3rd in the social factors. (Digalwar, A. K., & Rastogi 2022).

Research Methodology

The research survey questionnaire for the present research was designed based on literature reviews. In the present study, a total of 25 Likert based questions were designed asking the respondents to rank their importance of agreement on a scale of 1 to 5 with '1 Strongly Disagree' and '5 as Strongly Agree'. As far as data collection is concerned, a total of 222 respondents were interviewed through a structured online questionnaire from randomly selected respondents from Bengaluru city.

Theoretical Framework:

Fig 1: Conceptual framework of the research Study



H₁: Attitude has significant influence on Actual Intention to adopt EVs.

H₂: Subjective/Social Norms has significant influence on Actual Intention to adopt EVs.

H₃: Perceived Behavioral control has significant influence on Actual Intention to adopt EVs.

H₄: Personal Moral Norm has significant influence on Actual Intention to adopt EVs.

H₅: Environmental Concern has significant influence on Actual Intention to adopt EVs.

Table 1: Descriptive Statistics

Variable	Category	F	%		
Gender	Male	129	58.1		
	Female	93	41.9		
Age	16 -24	185	83.3		
	25 - 40	29	13.1		
	41 -56	6	2.7		
	57 -75	2	0.9		
Education	Secondary	4	1.8		
	Undergraduate	151	68.0		
	Post Graduate	61	27.5		
	Doctorate	6	2.7		
Occupation	Student	158	71.2		
	Self employed	15	6.8		
	Salaried	45	20.3		
	Retired	1	0.5		
	Unemployed	3	1.4		
Income level	Depend income	13	5.9		
	Less than 15K	157	70.7		
	15 K - 30 K	13	5.9		
	30K- 45K	24	10.8		
	45K-60K	9	4.1		
	60K and above	6	2.7		
Mode of transport	MO – Most Often	O – Often	S – Sometimes	R – Rarely;	N – Never
Railways	3.6	5.0	15.8	37.4	38.3
Metro	3.2	5.4	25.7	31.5	34.2
Bus	12.6	13.5	20.7	25.2	27.9
Car	27.0	28.8	23.9	10.8	9.5
Railways	3.6	5.0	15.8	37.4	38.3
Auto	12.2	21.6	25.7	27.5	13.1
2-wheeler	48.6	18.9	9.9	10.4	12.2
Bicycle	1.8	9.9	18.9	27.0	42.3
Walk	29.3	17.1	27.0	16.7	9.9

Analysis and Results

Table 2 presented the relevant items, their standardized loading (correlation coefficients), and the composite reliability and Cronbach Alpha results through *Confirmatory Factor Analysis* (CFA) technique that was adopted to validate the measurement model consisting of *six* dimensions as shown in Figure 1. The standardized loading of items under each dimension is given in Table 1.

Table 2: Reliability and Loadings of Constructs influencing Actual intention to adopt EVs

Dimension	Item/Indicators	Loading	CR	CA	AVE
<i>Attitude towards EV</i>	I have positive attitude towards Using an EV (ATT_EV_1)	0.872	0.824	0.876	0.701
	I consider adoption of EV Beneficial (ATT_EV_2)	0.862			
	I like the idea of using EV (ATT_EV_3)	0.909			
<i>Subjective/ Social Norm</i>	EV have a positive image in society (SUB_NORM_1)	0.602	0.759	0.802	0.447
	Most people who are important to me think I should adopt an electric vehicle while adopting a vehicle in near future (SUB_NORM_2)	0.769			
	I would value the opinions of People who want me to prefer EV while adopting a vehicle in near future (SUB_NORM_3)	0.832			
	I would intend to buy an EV if my friends /peers have already used it and given Positive WOM (SUB_NORM_4)	0.720			
	An electric vehicle would reflect my personality (SUB_NORM_5)	0.519			
<i>Percieved Behavioural control</i>	I feel Driving an EV is easy (PER_BEH_1)	0.583	0.777	0.805	0.371
	Aware of EV's, their features, brands, price & benefits (PER_BEH_2)	0.580			
	Price is important to me when I decide to adopt EV (PER_BEH_3)	0.535			
	Availability of proper infrastructure and charging stations is important to me if I decide to adopt EV (PER_BEH_4)	0.621			
	The maintenance and repair costs of EV is important to me If I decide to adopt EV (PER_BEH_5)	0.590			
	I have the accessibility to buy EV when needed (PER_BEH_6)	0.752			

	I have the knowledge, resources and ability to use EV (PER_BEH_7)	0.743			
<i>Personal Moral norm</i>	It is important to drive a car, environmentally friendly (PER_MOR_1)	0.849	0.857	0.889	0.667
	I care about Energy conservation while making any decisions to adopt an EV vehicle in future (PER_MOR_2)	0.894			
	I am a green consume who is aware of my obligation towards the environment and sustainability (PER_MOR_3)	0.838			
	I believe it is my moral responsibility to reduce environmental pollution and greenhouse gas emissions (PER_MOR_4)	0.829			
<i>Environmental concern</i>	I am aware of Environmental problems and issues caused due to Vehicle emissions (ENV_CRN_1)	0.773	0.803	0.846	0.579
	I think environmental issues are becoming more serious in recent years (ENV_CRN_2)	0.860			
	I think we should live in harmony with the environment for achieving sustainable development (ENV_CRN_3)	0.853			
	I am happy for the initiatives taken by the government to promote Evs for achieving sustainable development goals (ENV_CRN_4)	0.708			
<i>Intention to adopt an EV</i>	I intend to adopt EV in near future (INT_ADPT_1)	0.870	0.622	0.767	0.622
	I am willing to adopt EV when adopting near future (INT_ADPT_2)	0.879			

Note: CR - Composite Reliability, CA - Cronbach Alpha, AVE – Average Variance Explained

Table 3: Discriminant Validity of the Measurement Model:

	ATT_EV	SUB_NORM	PER_BEH	PER_MOR	ENV_CRN	INT_ADPT
ATT_EV	0.837*					
SUB_NORM	0.571	0.669*				
PER_BEH	0.601	0.578	0.609*			
PER_MOR	0.559	0.617	0.552	0.817*		
ENV_CRN	0.499	0.479	0.566	0.681	0.761*	
INT_ADPT	0.671	0.650	0.516	0.757	0.642	0.789*

* Square Root of AVE values shown in Table 2

First, the Cronbach’s alpha reliability coefficient was calculated in order to assess the psychometric properties of the questionnaire. Cronbach’s alpha value ranges from 0 to 1, with value closer to 1 indicating greater stability and consistency, however for basic research the cut-off value is 0.60 (Nunnally, 1978) [Kalthom Abdullah & Others, 2012]. The results of Cronbach’s alpha is depicted in Table 2 indicating an acceptable consistency and stability of the instrument. Secondly, with respect to composite reliability it is observed from Table-1, it is observed that majority of the items demonstrated a loading greater than 0.50 clearly validating the convergence. Also, the cronbach alp

ha values of each dimension are above 0.60, more than the accepted value. Similarly Discriminate Validity result is depicted in Table 3 establish the discriminant validity among the latent variables in that they do not statistically overlap each other [since the inter-item correlation values are less than the square root of AVE value] and are free from the problem of multicollinearity.

Fig 2: SEM result of factors influencing Actual intention to adopt EVs

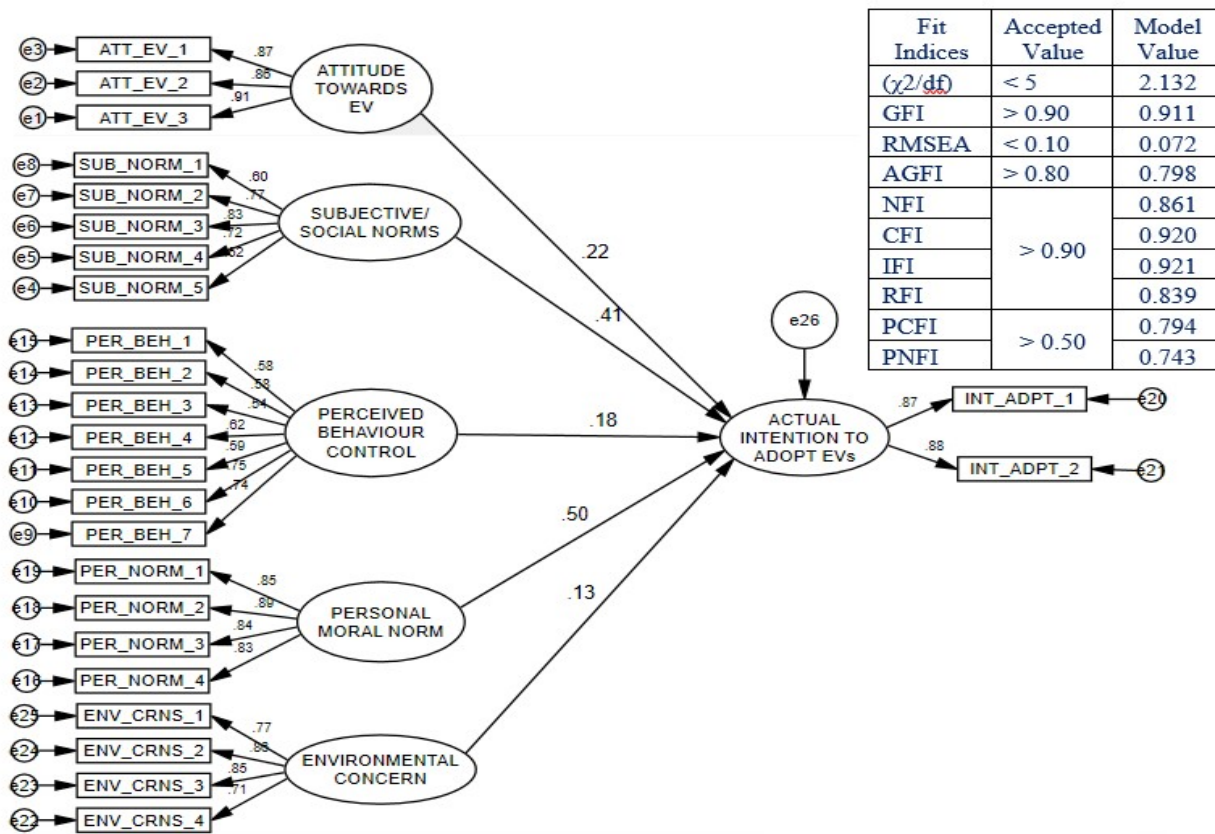


Table 4: Standardized Regression weights for dimensions influencing Actual Intention to adopt EVs

			Standard Estimate	S.E.	C.R.	P
<i>Actual Intention to adopt</i>	<---	<i>Attitude Towards EV</i>	0.223	0.049	3.740	0.000*

			Standard Estimate	S.E.	C.R.	P
<i>Actual Intention to adopt</i>	<--	<i>Subjective Norms</i>	0.408	0.090	5.139	0.000*
<i>Actual Intention to adopt</i>	<--	<i>Perceived Behaviour Control</i>	0.176	0.056	2.805	0.005*
<i>Actual Intention to adopt</i>	<--	<i>Personal Moral Norm</i>	0.501	0.060	7.613	0.000*
<i>Actual Intention to adopt</i>	<--	<i>Environmental Concern</i>	0.130	0.061	2.146	0.032*

* Significant at 5% level.

The regression result is provided in Table 4. It is observed that *Attitude towards EV* has a significant ($\beta = 0.223$; CR = 3.740, $p < 0.05$) influence on *Actual Intention to adopt EVs*, thus, H_1 could be completely accepted. The interpretation is that, for one unit increase in the rating scale of agreement on *Attitude Towards EV* construct, one could expect about 0.223 times (about 22 % increase in *Actual Intention to adopt EVs* dimension given other factors remain fixed or same. In other words, for every new 10 respondents rating as agree or strongly agree for *Attitude Towards EV* dimension, one would expect about **two** respondents ($\beta = 0.223$) likely to give a rating of agree or strongly agree on *Actual Intention to adopt EVs*. Though statistically significant, it is obvious that having a favorable attitude toward electric vehicles does not guarantee that a large number of individuals will adopt them overwhelmingly in future. A similar situation is observed with respect to *Perceived Behavior Control* and *Environmental Concern* influencing the *actual intention to adopt EVs*. As a result of the regression analysis, only two people are predicted to have a strong propensity on real intention of adopting EVs for every ten new persons who have perceived behavior control and are concerned about the environment.

Conclusion:

Nonetheless, the Personal Moral Norm and Subjective/social Norms appear to have a substantially bigger impact on the intention to use EVs, with roughly **four to five persons out of ten** expected to adopt EVs if they are concerned about personal moral and social norms. Among all the factors considered in the research signifies that attitude towards electric vehicle, Perceived Behavior Control and Environmental concern and has significant influence on actual intention to adopt electric vehicles.

References:

1. Niall McCarthy (Mar 16, 2021) The Most Polluted Cities on Earth, <https://www.statista.com/chart/17239/average-level-of-particulate-matter-pollution/>
2. ANDRIY BLOKHIN (January 31, 2022) The 5 Countries That Produce the Most Carbon Dioxide (CO₂) <https://www.investopedia.com/articles/investing/092915/5-countries-produce-most-carbon-dioxide-co2.asp>

3. Barkha Mathur (March 5, 2019) Diesel Vehicles Are Responsible For 66 Per Cent Of Air Pollution-Related Deaths In India, Says A New Study <https://swachhindia.ndtv.com/india-air-pollution-related-deaths-due-to-diesel-vehicles-says-a-new-study-31853/>
4. Nikhil Puthran (May 11, 2021) Policy roadmap for electric vehicles in India <https://www.carwale.com/news/policy-roadmap-for-electric-vehicles-in-india/>
5. JMK Research & Analytics (January 7, 2021) Registered EV sales in India in 2020 dropped by 26% on yoy basis <https://jmkresearch.com/registered-ev-sales-in-india-in-2020-dropped-by-26-on-yoy-basis/#/>
6. Neeraj Kumar Singal (June 6 2021) Electric Vehicle Policy Framework in India <https://medium.com/batterybits/electric-vehicle-policy-framework-in-india-6bdc3ed64ed7>
7. Experian Information Solutions (June 14, 2021) Electric vehicle registration by state <https://afdc.energy.gov/data/10962>
8. Nandini Sen Gupta, (Apr 15, 2021) These three states see highest EV sales in India <https://timesofindia.indiatimes.com/auto/news/these-three-states-see-highest-ev-sales-in-india/articleshow/82068471.cms>
9. Bismah Malik (Dec 01, 2021) India's EV market to grow by 90% to touch \$150 billion by 2030: Report <https://www.businesstoday.in/latest/story/indias-ev-market-to-grow-by-90-to-touch-150-billion-by-2030-report-314116-2021-12-01>
10. LYLA BAVADAM (June5,2022) India ranks at the bottom in a list of 180 countries in the 2022 Environmental Performance Index. <https://frontline.thehindu.com/dispatches/india-ranks-at-the-bottom-in-a-list-180-countries-in-the-2022-environmental-performance-index/article65497256.ece>
11. EV reporter (Jan 11, 2022) Electric vehicles sales trend for 2021 <https://evreporter.com/ev-sales-trend-in-india-in-2021/>
12. Yadav, R., & Pathak, G. S. (2016). Young consumers' intention towards buying green products in a developing nation: Extending the theory of planned behavior. *Journal of Cleaner Production*, 135, 732-739.
13. Wang, S., Fan, J., Zhao, D., Yang, S., & Fu, Y. (2016). Predicting consumers' intention to adopt hybrid electric vehicles: using an extended version of the theory of planned behavior model. *Transportation*, 43(1), 123-143.
14. Ramayah, T., Lee, J. W. C., & Lim, S. (2012). Sustaining the environment through recycling: An empirical study. *Journal of environmental management*, 102, 141-147.
15. Nordlund, A., Jansson, J., & Westin, K. (2016). New transportation technology: norm activation processes and the intention to switch to an electric/hybrid vehicle. *Transportation Research Procedia*, 14, 2527-2536.
16. Tiwari, V., Aditjandra, P., & Dissanayake, D. (2020). Public Attitudes towards Electric Vehicle adoption using Structural Equation Modelling. *Transportation Research Procedia*, 48, 1615-1634.

17. Degirmenci, K., & Breitner, M. H. (2017). Consumer purchase intentions for electric vehicles: Is green more important than price and range?. *Transportation Research Part D: Transport and Environment*, 51, 250-260.
 18. Bhattacharyya, S. S., & Thakre, S. (2020). Exploring the factors influencing electric vehicle adoption: an empirical investigation in the emerging economy context of India. *foresight*.
 19. Khurana, A., Kumar, V. R., & Sidhpuria, M. (2020). A study on the adoption of electric vehicles in India: the mediating role of attitude. *Vision*, 24(1), 23-34.
 20. Kumar, A., Choudhary, S. K., & Chethan, K. N. (2018). Commercial viability of electric vehicles in India. *International Journal of Mechanical Engineering and Technology*, 9(6), 730-745.
 21. Gujarathi, P. K., Shah, V. A., & Lokhande, M. M. (2018). Electric vehicles in India: Market analysis with consumer perspective, policies and issues. *Journal of Green Engineering*, 8(1), 17-36.
- Digalwar, A. K., & Rastogi, A. (2022). Assessments of social factors responsible for adoption of electric vehicles in India: a case study. *International Journal of Energy Sector Manageme*