Modeling Purchase Intentions towards Electric 2-wheeler Vehicles by customers of Delhi/NCR

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Abstract:
Purpose - The rise of greenhouse gases, global temperature, air pollution and the various incentives by the central government i.e FAME I, FAME II, state governments helping in shifting gear for the greener mode of transport i.e "Electric Vehicles". The automobiles sales in India are largely contributed by the sales of 2-wheeler i.e., approx. 80%. On the other hand, the Government has set a target of 30% Electric Vehicle on road by 2030. So, in order to bring EV into market it is mandatory that the ICE 2 wheelers to be replaced by high-speed Electric 2-Wheeler in cities first specifically so that required level of thrust could be reached.
Design/Methodology - In this research we uses Stimulus – Organism – Response (SOR) Framework to model the purchase intentions of customers of Delhi/NCR towards Electric Two Wheeler. A structured questionnaire was prepared containing questions on the variables Perceived Economic Benefit, Environmental Cognition, Ease of Use, Government Subsidy, Subjective Norms as Stimuli Factors, Attitude measuring Purchase intention of the customers with moderating variable as User Safety. Responses from 450 residents of Delhi/NCR customers were analyzed using Confirmatory Factor Analysis (CFA).
Findings - The result of the survey confirms strongest relationship between Perceived Economic Benefit and Attitude, while the least significant relationship was among Environmental Cognition and Attitude.
Practical Implications – The results can guide the development of targeted marketing strategies, policy interventions, and consumer awareness campaigns to foster a greater uptake of 2-Wheeler EVs and contribute to the reduction of greenhouse gas emissions and air pollution in the area.
Originality/value - The findings of the study will empower the EV manufacturers to design the vehicle keeping the most significant variable in mind and that further increases the penetration rate of the Ecofriendly vehicles.

Keywords - Purchase Intentions, 2-Wheeler Electric Vehicles, Confirmatory Factor Analysis, SOR.

I. INTRODUCTION

In recent years, there has been a notable surge in the demand for electric cars (EVs), but their market share remains rather modest when compared to the overall volume of new vehicles sold worldwide. Electric vehicles (EVs) are now in the early stages of transforming the landscape of road transport in India. In the year 2020, the worldwide sales of electric vehicles reached a total of 10 million units, accounting for a mere 1% of the total sales volume. In 2020, electric two-wheelers (E2W) emerged as the dominant category within the electric vehicle (EV) market, boasting a staggering 25 million units. This significant market share may be mostly attributed to the surge in demand witnessed throughout several Asian nations. Asia is widely recognised as the largest market for electric two-wheelers, mostly owing to the presence of rapidly rising economies like as India, China, and Japan. The Indian automotive market is primarily characterised by the prevalence of two-wheeled vehicles, with over 80% of total automobile sales in India being attributed to this category. The Indian government has set a target indicating that by the year 2030, approximately 30% of the total automobiles sold within the country will be electric, with the aim of mitigating air pollution. According to the Society for Industrial and Applied Mathematics (SIAM), a total of 1,51,19,387 motorcycles and scooters were sold in India during the fiscal year 2020–2021. Among these 1,43,837 units were specifically electric two-wheelers. In the year 2021, the sales volume of electric two-wheelers accounted for a proportion of less than 1% of the whole market. Despite the implementation of several government initiatives, the adoption rate of electric two-wheelers (E2W) remains very low in India. The adoption rate of electric two-wheelers in India has experienced a decline mostly attributed to factors such as elevated initial expenses, concerns regarding limited driving range, insufficient availability of charging infrastructure, and the costs associated with battery replacement.

India's rapid economic growth and industrial development have come at a significant environmental cost, positioning the nation as the third-highest emitter of carbon dioxide globally, following only China and the United States (IEA, 2019). The urgent need to address this environmental challenge has prompted a growing interest in adopting sustainable alternatives, such as electric vehicles (EVs). Considering that the transportation sector is projected to account for half of the total greenhouse gas emissions by 2030 (IEA, 2018), the importance of transitioning towards cleaner mobility options cannot be overstated. India's ranking as the third-largest global emitter, with the auto sector contributing a substantial 87% of total emissions, accentuates the urgency of embracing EVs as a viable solution to combat air pollution and reduce carbon emissions (PIB, 2019).
The escalating need of personal ownership in the country has emerged as a significant opportunity with a staggering increase of registered 2 wheelers at a rate of more than 12% with the base sales of 12.86 Crore (Statista, 2022). Particularly about Delhi, the influx of lakhs of vehicles from neighbouring states daily, has compounded the problem, leading to a surge in air pollution in the

form of particulate matter (PM2.5 and PM1.0) and harmful gases. As a consequence, Delhi's Air Quality Index (AQI) remains perilously above safe levels for several months each year, resulting in severe implications for public health. India has witnessed the highest number of pollution-related mortalities worldwide, with approximately 6,00,000 premature deaths annually attributed to poor air quality (Lelieveld, 2015); (Bisht, 2016); (WHO, 2016).

Delhi and the National Capital Region (NCR) have borne the brunt of this environmental crisis, with the average life expectancy in the region declining by 6.4 years due to exposure to PM2.5 (Singh, 2021). Such dire circumstances underscore the urgent need to address the adverse impacts of escalating passenger vehicle usage on both the environment and public health. Moreover, the mounting dependency on crude oil for fuelling these vehicles poses economic challenges, given India's heavy reliance on fossil fuel imports. This dependency leaves the nation vulnerable to fluctuations in crude oil prices, creating economic instability (Madras I.I.T., 2019).

EVs have been recognized by researchers for their potential to offer multiple advantages, including substantial improvements in air quality through zero greenhouse gas emissions, enhanced energy efficiency, lower operational costs, and the ability to recharge using renewable energy sources (Haddadian, 2015) (O'Neill, 2018). Despite these benefits, the widespread acceptance of EVs in India faces various barriers, such as higher energy storage costs, limited charging infrastructure, and longer charging times (Nair, 2017); (She, 2017); (Haddadian, 2015).

The automotive industry in India serves as a critical driver of economic growth and employment, providing jobs for approximately 35 million people (SIAM, 2020). Consequently, any significant disruption caused by the transition from conventional internal combustion engine (ICE) vehicles to EVs could potentially impact the overall performance of the sector, leading to potential job losses. It is, therefore, essential to devise a balanced mix of policy initiatives that facilitate a seamless EV transition while minimizing adverse effects on the automotive industry at large (Lieven, 2015).

As of now, EV sales in India account for less than 3% of total sales, with two-wheelers and three-wheelers dominating the market (PWC, 2019); (SIAM, 2020). By modeling purchase intentions towards 2 Wheeler EVs among customers in Delhi/NCR, this research seeks to pave the way for increased adoption of cleaner transportation alternatives, promoting a greener and more sustainable future for the nation and achieving the government target of 30% by 2030 i.e 30% penetration of EVs by the year 2030. By fostering a greater understanding of consumer preferences and challenges, this study aims to contribute to the formulation of informed and effective policies that will drive the widespread adoption of 2 Wheeler electric vehicles, ultimately leading to a healthier and more environmentally conscious society.

The significance of this research lies in its potential to inform policy interventions, business strategies, and environmental initiatives tailored to the unique needs of Delhi/NCR. By comprehending the factors that underpin purchase intentions, stakeholders can design targeted marketing campaigns, incentivize the adoption of 2 Wheeler EVs, and overcome potential barriers to widespread acceptance. Such initiatives hold the key to curbing vehicular emissions, improving air quality, and safeguarding public health in the region.

In conclusion, as Delhi/NCR grapples with the adverse effects of escalating vehicle usage, modeling purchase intentions towards 2 wheeler electric vehicles emerges as a pivotal step towards a more sustainable and environmentally conscious future. By embracing cleaner and greener mobility solutions, the region can mitigate air pollution, reduce dependence on fossil fuels, and foster a healthier and more livable urban environment for its residents. This research's findings have the potential to catalyze transformative change, paving the way for a more sustainable and resilient transportation ecosystem in Delhi/NCR and beyond.

II. Literature review

Researchers have extensively investigated EV markets in various geographical locations and identified potential barriers to their implementation (O'Neill et al., 2018; Haddadian et al., 2015). Gong et al. (2020) studied the impact of government incentives on Battery Electric Vehicle (BEV) market penetration in Australia, highlighting the role of policy support in encouraging EV adoption. Shafiel et al. (2017) developed a simulation-based model to assess different scenarios aimed at reducing greenhouse gas emissions in New Zealand, indicating the importance of environmental concerns in EV adoption decisions. Kiani (2017) examined the impact of EV market penetration on greenhouse gas emissions in the United Arab Emirates, underscoring the potential environmental benefits of EVs. Similarly, Song et al. (2018) conducted a comparative analysis between conventional diesel vehicles and EVs in Macau, emphasizing the reduction in greenhouse gas emissions with EV adoption.

Governments and local agencies have been suggested with proposals and recommendations to overcome barriers to EV adoption (Wikstrom et al., 2016; Kester et al., 2018). However, the overwhelming impact of barriers often leads to lower consumer acceptance, necessitating further research to devise policy support tailored to the local and regional level (Biresselioglu et al., 2018). Berkeley et al. (2018) highlighted the interrelatedness among studied EV barriers, emphasizing the need to focus on an abridged set of barriers based on the strength of association among them to reduce complexity.

Cross-cultural findings in the EV adoption context are also crucial, as consumer preferences vary based on symbolic, environmental, economic, and pro-societal benefits, varying from country to country and culture to culture (Axsen et al., 2015; Kaptan Journal Pre-proof et al., 2013; Spencer et al., 2015; Wang et al., 2016). However, literature capturing this widespread gamut of factors related to EV adoption remains limited, leaving room for further investigation (Spencer et al., 2015; Wang et al., 2016). In response to this gap, the current study aims to explore the comprehensive gamut of antecedents, consequences, mediators, and moderators related to EV adoption across different countries and cultures.

An integrative review, known for its usefulness in multiple disciplines, would be suitable for comprehending the development of the emerging topic of EV adoption in the Delhi/NCR region (Torraco, 2016; Alcayaga et al., 2019). Integrative reviews have been successful in fields such as psychology, information systems, human resource development, medicine, biology, and management (Galvan and Galvan, 2017; Bandara et al., 2011; Rastogi et al., 2018; Morgan et al., 2015; Pautasso, 2013; Wilding et al., 2012).

Recently, Alcayaga et al. (2019) used an integrative literature review to explore interrelationships among concepts in the smart-circular system, leading to the development of a conceptual framework.
Considering the environmental benefits of EVs, the Indian government announced the National Electric Mobility Mission Plan (NEMMP) 2020 in 2013, aiming for 30% EVs in India by 2030 (DHI, 2017). Under NEMMP 2020, the government extended the Faster Adoption and Manufacturing of Electric Vehicles (FAME) program with a substantial budget (PIB, 2018). However, the share of EVs in the Indian automobile market remains insignificant, necessitating a deeper understanding of factors influencing purchase intentions in the Delhi/NCR region.
Many past studies have investigated EVs from customers' buying perspectives, exploring whether specific lifestyles lead to EV adoption (Ozaki and Sevastyanova, 2011; Gallagher and Muehlegger, 2011; Graham-Rowe et al., 2012; Schuitema et al., 2013; Kormos and Gifford, 2014). Others have emphasized the role of retail price and fuel cost in shaping customers' buying intentions (Sovacool and Hirsh, 2009; Axsen et al., 2010; Egbue and Long, 2012; Jansson et al., 2017). Some studies have analyzed the influence of maintenance cost and availability of charging points and purchase incentives on customers' adoption behavior (Zhang et al., 2011; Dhar et al., 2015; Noel et al., 2017; Graham-Rowe et al., 2012; Krupa et al., 2014; Dhar et al., 2015).
In a comprehensive study, Egbue and Long (2012) and Zhang et al. (2013) identified performance aspects, environmental concerns, financial incentives, and psychological needs as major factors affecting customers' purchase intentions.

III. Conceptual model and hypothesis Development

Ease of Use

The perceived ease of use (PEU) of a product refers to how easily it may be used or mastered. According to Davis (1989), people prefer to use relatively simple items. Contrary to Perceived Use, which has a large impact on Behavioural Intention, PEU occasionally only has a small or negligible impact on BI (Chen, 2016a). Other studies have shown that PEU has a considerable and strong impact on attitude and behaviour intention (Park et al., 2015; Kaplan, Moraes Monteiro, Anderson, Nielsen, & Medeiros Dos Santos, 2017). Furthermore, it has been shown that PEU influences BI through causal pathways, which indicates that in addition to having a direct impact on BI, PEU also influences BI indirectly through the moderating effect of PU (Hsu, Chen, & Lin, 2017).
H1: Ease of Use positively affects the Attitude to purchase electric Vehicles by customers of Delhi/NCR

Perceived Economic Benefit

Comparing the price of EVs to a comparable conventional vehicle, the high cost of EVs serves as a barrier to adoption. According to studies, the incentives provided help people accept EVs. Assertedly, lower operating and maintenance expenses promote the adoption of BEVs. Odeck and Aasness (2015). In their 2011 analysis of the advantages of hybrid vehicles in the USA, Beresteanu and Li came to the conclusion that income tax breaks contributed to an increase in the market share of HEVs. In their study, Wang and González (2013) compared the energy expenses for little electric buses. Other fuel vehicles have an energy cost that was eight times more than that of EVs. Lower operating costs are the result of decreased energy consumption and power tariff. As a result, the total cost of ownership is lower and makes up for the premium price of an EV. Long-distance consumers stand to gain more than short-distance everyday consumers. (Adepetu & Keshav, 2015; Barth et al., 2016; Lieven, Mühlmeier, Henkel, & Waller, 2011) Lower operating costs encourage the adoption of EVs. The study's conclusion is that adoption of EVs is influenced by economic incentives.
H2: Perceived economic benefit positively affects the Attitude to purchase electric Vehicles by customers of Delhi/NCR.

Environmental Cognition

According to Dunlap and Jones (2002), environmental concern is "the degree to which individuals are aware of environmental issues, support efforts to resolve them, and/or express the willingness to contribute individually to resolve them." According to Van Doorn and Verhoef (2011), consumer concerns about the environment have grown, and this suggests that consumers are willing to pay more for sustainable products. The effect of environmental concern on adoption intention and consumption has been well-documented in the literature on the adoption of green products (Hansla, Gamble, Juliusson, & Gärling, 2008; Paul et al., 2016; Yadav & Pathak, 2016). Furthermore, Hartmann and Apaolaza-Ibáez (2012) found a strong beneficial influence of environmental concern on specific brand owners' intentions to make green purchases. Additionally, people who are more concerned about the environment are more likely to buy eco-friendly goods (Yadav & Pathak, 2016). Similar to this, Sang and Bekhet (2015) found that consumers' decisions to buy EVs were positively influenced by their concern for the environment. According to other research (Corral-Verdugo, Frias-Amenta, & Gonzalez-Lomel, 2003), environmental concerns have a major influence on a firm's decision to adopt green technology. Similar to this, EV vendors can want to sell EVs because of their environmental concerns. The following theory is put out in light of the discussion above:
H3: Environmental cognition positively affects the Attitude to purchase electric Vehicles by customers of Delhi/NCR

Government Subsidy

Riesz et al. suggested that a subsidy is an effective policy and financial incentives can promote the adoption of EVs. Research from Norway, New Zealand, and Canada found that financial incentives and low prices can effectively encourage the adoption of EVs. Yuan et al. suggested that the monetary subsidy plays a significant role in the diffusion of EVs; the Chinese EV market is deeply influenced by subsidies rather than technology.
H4: Government Subsidy positively affects the Attitude purchase electric Vehicles by customers of Delhi/NCR

Subjective Norms

According to Liao 2021, Subjective Norms is the normative beliefs, which are induced by social pressure from the decision of specific behaviour. Subjective norm refers to the perceived social pressure to perform or not to perform the behaviour (Ajzen, 1991).
H5: Subjective Norms positively affects the Attitude to purchase electric Vehicles by customers of Delhi/NCR

Attitude

According to Ajzen (1991), attitude describes how much a person thinks favourably or negatively about the behaviour in question. According to earlier research, people are more likely to buy EVs if they have a favourable attitude towards them (He and Zhan, 2018). Additionally, it makes natural sense to assume that consumer sentiments towards EVs will improve once legislative measures have lowered the cost of EVs. The consistency of policy mixes, however, predominantly exhibits a substituting effect rather than a reinforcing effect on the favourable link between consumer attitudes and purchase intentions, according to our argument in this research. Because of the influence of numerous other elements, such as contextual circumstances, consumer attitudes frequently do not necessarily translate into buying behaviour, despite the fact that attitudes towards consumers and behaviour are actually associated (Bettencourt et al., 2001). According to Liao 2021, Attitude is the consequential beliefs, which result from the perceived impacts on performing a specific behaviour.

H6: Attitude positively affects the behavioural Intentions to purchase electric Vehicles by customers of Delhi/NCR

User Safety

Challenges that EV is facing include worries about resilience and public safety. This is a result of the higher safety hazards associated with the storage of energy in batteries, which might explode owing to overcharging and heating. The risk is larger for new battery types like lithium batteries since they have a higher energy density. This occurs when the temperature rises as a result of the flow of electricity, and the high temperature then affects the temperature of neighbouring cells, causing an explosion or fire. Consequently, because they have batteries inside, EVs are said to be weather-sensitive. Batteries' ageing processes are also a significant safety concern. Tiny lithium ions form dendrites, a structured fibre, on the carbon anodes of a battery as it ages, which could catch fire. Short circuits that happen after it starts might cause an abrupt rise in temperature and even breakdowns. Numerous experts have emphasised that the volume and size of the battery pack directly affect the risk of fire in EVs' battery cells and control systems. Therefore, these safety concerns have a detrimental impact on the uptake of EVs.

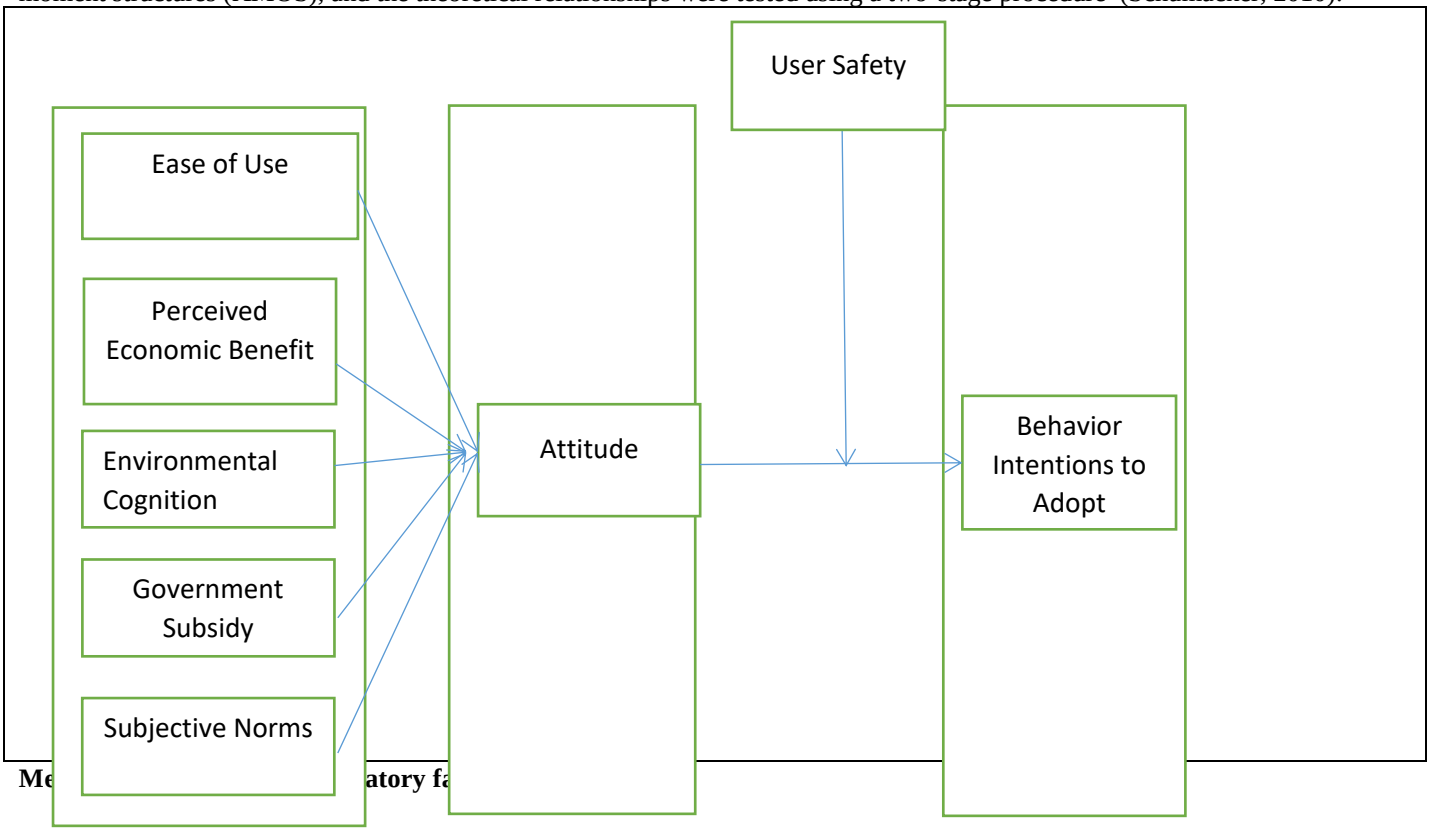
H7: User Safety moderated the relation between Attitude and Behaviour Intentions to purchase electric Vehicles by customers of Delhi/NCR

IV. Research Method

To put the theoretical model to the test, citizens of India's capital city, New Delhi and NCR, were surveyed. The convenience sample method was used, and a structured questionnaire was distributed to 450 residents of Delhi NCR. Questionnaire was distributed outside the showrooms of leading electric car sellers and approach individual consumer who walk out from the showroom after consulting the sales representative or sales admin. The reason of choosing individual consumer who visit showroom is because the probability of an individual intent to purchase a hybrid car is higher for those who went to showroom. Consumers who visited the showroom are not curious buyers (Capgemini, 2011). The participants' average age was 35 years. Only 69% of the respondents had graduated, while 12% had not matriculated and the remaining respondents had never attended school.

Normality

The variables' univariate normality was examined using the Skewness-Kurtosis approach (Hair et al., 2010); (Byrne, 2010). The SPSS-12 software (a social sciences software suite) was used to calculate each of these. All calculated values were found to fall within the suggested range. The study model's hypotheses were assessed using the statistical software analysis moment structures (AMOS), and the theoretical relationships were tested using a two-stage procedure (Schumacker, 2010).



Me atory fa

The parameters of the model were estimated in this work using the maximum likelihood method, and the validity and reliability of the data collected were assessed using confirmatory analysis (CFA). All analyses were built around the variance-covariance matrices (Hair et al., 2010). Using standardized loadings, the convergent and discriminant validity of the measurement model were evaluated. To ensure the model's fitness, all important and necessary fit indices were assessed (Hair et al., 2010), (Isaac, 2010). The model's different causal connections were shown to be significant when path coefficient analysis was conducted. The conclusions of the research model's hypothesis and path coefficients are shown in Table 1, together with the outcomes of the path analysis. The moderating effect of user safety is presented in table 2.

Hypotheses	**Path**	**Standardized direct Effect**	**Critical Ratio**	**Result**
H1	EoU→ATT	0.237	12.54 ***	Accepted
H2	PEB→ATT	0.539	16.83***	Accepted
H3	EC→ATT	0.122	25.36***	Accepted
H4	GS→ATT	0.448	11.83***	Accepted
H5	SN→ ATT	0.482	14.64***	Accepted
H6	ATT →BI	0.346	2.342***	Accepted

Notes: *p<0.001, **p<0.001, ***p<0.001

Table 1: Path Coefficients and result of the analysis

Variable	**Standardized β**	**t statistic**	**p-value**
Step I: Main variables			
US	-.446	21.109	.000
ATT	.165	4.7342	.000
Step II: Two-way Interaction terms			
SI X ATT	0.0621	1.892	.000
ΔR^2	0.044		
ΔF	3.241		
Dependent variable: BI			

Table 2: Results of Moderating Effect test with User Safety

V. Discussion

The results of the data analysis shows that all the major Hypothesis of the study were acceptable. The strongest relationship was found between economic benefits and attitude with beta value (β= 0.539, p<0.001). This shows that the most important reason for popularity of electric vehicle among the customer of in Delhi NCR is its operational cost that is negligible. Therefore, the companies should keep in mind the fact and design the vehicles accordingly. The next important relationship was found between subjective norms and attitude with beta value (β= 0.482, p<0.001). There is a strong impact of a customer's friend circle and relatives on the buying intentions of electric vehicle on individuals. Government subsidy was the third important factor analyzed in the study with beta value (β= 0. 0.448, p<0.001). The government subsidiary will basically reduce the purchase cost that will positively affect the buying intentions of the customer. The ease of use was another factor significant in the study that was explored in the study (β= 0.237, p<0.001). The last important construct that was explored was environment cognition. The results shows that this construct with lowest beta value and found significant in the study. The beta value was found out to be (β= 0.122, p<0.001). Besides the direct relationships the study also looked into the moderating effect of some important study variables like user safety on relationship between attitude and behavioral intention to adopt. The effect was found to be positive and statistically significant. Therefore, it can be said that security measures taken by the electric vehicle company positively affect the purchase intentions of the customer.

VI. Conclusion

The purpose of this study was to modeling the customers' purchasing intentions towards Electric 2 Wheeler Vehicles in the Delhi/NCR region. The hypothesis of the study were tested as per the Stimulus – Organism - Response (SOR) theory Framework. The research was carried out via a well-designed structured questionnaire consisting of 41 items, each rated on a five-point Likert scale. The study's findings unequivocally indicate that perceived economic benefit, subjective norms and government subsidy are the three strongest factors that affects the attitude of the customer to buy and EV. While the impact of other factors such as ease of use and environmental cognition are also noteworthy. The study also measures the effect of moderating factor i.e User Safety on Attitude and Behaviour Intention to purchase EV and the same was found statistically significant.

The study possesses several shortcomings as well. This study was done on a sample of respondents from the Delhi-NCR region, which limits its generalizability. Additionally, this study used Convenient Sampling Method, limiting its ability to offer a comprehensive understanding and insight into customers' intentions. This phenomenon occurs due to the potential for customers' intentions to evolve over time, coupled with the existence of a temporal gap during which consumers may execute their intended actions.

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