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Factors Influencing the Adoption Intention of Electric Vehicles (EVs) in Eastern India: A Study from Students' Perspective

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Abstract: - India contributes 7.6% of global greenhouse emission and is the third largest contributor in the world just behind China and USA. Thus, Electric Vehicles (EVs) are highly recommended by Government of India and environmentalists. EV market share of India 6.38%, which is a strong growth as EV automobile sector had 1.75% market share in 2021, but the numbers are relatively too small compared to other two countries which are ahead of India's greenhouse emission. This study focuses on whole EV segment and aims to find out various factors influencing EV Adoption intention in Indian context specifically in the Eastern India as similar studies has been conducted in Maharashtra and southern part of India. This study utilizes models like TAM and TPB. This study also uses factors like Environmental Consciousness, Financial Initiatives, Herd Behaviour and Perceived Risk to understand its impact on EV the Adoption intention among students of Eastern India. This study has adapted a quantitative research approach. This study followed CFA utilising SEM to analyse the relationship between Adoption intention and its forecasters. Among the factors PEoU of TAM and Herd Behaviour were found non-influential while other factors were found as influential behind the Adoption intention of EVs.

Keywords: Electric Vehicles, TAM, TPB, CFA, SEM

I. INTRODUCTION

Age old automobile industry had given a thought on change, considering current the environmental conditions, the industry being a Internal Combustion Engines (ICEs) majority, now turning towards electric vehicles (EVs) [1]. India, had counted on fossil fuels since the emergence of automobile industry in India [2].The automobile sector, had been considered as a great contributor global warming. In 2017 a significant rise of 1.6% global CO_2 was observed [2]. Two-wheeler vehicles, a dominant segment of India's automotive market, covers more than 80% of the market [3]. Electric energy being a way out to pollution, can be used as a solution of country's over-reliance on fuels [4]. The government has been taking initiatives to make India ready for converting their traditional vehicles consumers towards EVs by 2030. [1].

EVs being a new concept in third world countries, the number of consumers is insufficient who owns or uses EVs. This study had focused on intention of adoption of EV's consumers rather than relying on true consumer buying behaviour because of above mentioned reason [5].

This study had adopted technology acceptance model (TAM) by Davis [6] and theory of planned behaviour (TPB) Ajzen, [7] as base theories, because TAM and TPB had been used conventionally in different areas to find out the acceptability of new to world technologies and environment friendly behaviour [8]. Herd behaviour also has a great influence of adoption intention of EVs because there is evidence in previous researches which had supported the theory of the specific social groups being significant on sustainable products' purchasing behaviour [9]

Along with TAM and TPB this study has also adapted the constructs such as Environmental Consciousness (EC), Financial Initiatives (FI), Herd Behaviour (HB) and Perceived risks (PR) to assess their connection with the adoption intention of EVs. The study had a aim to analyse acceptance of EVs in Eastern India with a focus on current drivers and barriers behind its adoption intention [10]

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II. Literature Review, Research Gaps and Objectives of the Study

A. Review of Literature

Tendency of Environmental Conscious consumers to adopt EVs: Sharma et al. [11] had investigated on the terminology "environmental consciousness" for the purpose of identifying the key elements of the term and its precursors. The authors tried to identify a link between "environmental consciousness, its antecedents, components, and behavioural outcome", which might link a relationship between the concept of environmental consciousness and behaviour of pro-environmental consumers.

Malik [12] examined various factors influencing attitude of consumers towards EVs utilising the Theory of Reasoned Action in which environmental attitude, environmental concern and other neurological factors were considered as major influential factors.

Technology Acceptance Model and it's applicability in EV adoption: The technology acceptance model, (TAM) had widely been used for the purpose of studying acceptance of emerging technologies. Davis [6] the mastermind behind TAM created it, inspired by the Theory of Reasoned Action (TRA) as per Masrom [13]. Jones et al. [14] tried to explore the intentions of common people on adapting EVs named FEVER (Future Electric Vehicle Energy networks supporting Renewables). Based on a questionnaire-based survey which took zoo visitors of South England as sample population, using TAM. The outcome of the survey indicated the sample population was prepared to adapt to FEVER. Kaur et al. [15] using TAM had studied policies and other factors required to push the adoption and hype of EVs in India as well as the potential to setup EVs in India. Authors' aim was to study the effects knowledge of consumer on EV, perceived risk, perceived usefulness, and current financial incentive policies on consumers' EV adoption intention.

Theory of Planned Behaviour: TPB being a theory, social psychological in nature it considering the interplay of behavioural, normative, and control beliefs explains human behaviour. Icek Ajzen was the pioneer behind creation of this theory, this theory has been accepted by most to use in numerous situations for predicting and figure out the behavioural aspects of Human. TPB had identified, three kind of beliefs that are the determinants of behaviour: Behavioural beliefs, Normative beliefs and Control beliefs.

Shalender et al. [16] used the TPB model as an extended version in for the prediction of EV's adoption intention. The study proved that attitude, subjective norm, perceived behavioural control, moral norm, and environmental concern had a positive relationship among buyers' adoption intention. The result of the study had even suggested that the TPB model at its extended version was suitable for the prediction of the adoption intention of the buyers towards the EVs.

Financial Initiatives for boosting up the EV adoption: Governments of various countries have taken financial and non-financial initiatives to boost up the market of EVs all over the world. Münzel et al [17] reviewed the financial incentives' effect on purchase behaviour of EVs using econometric studies and performing data analysis on sales of EVs in 32 countries of the European continent from the year 2010 to 2017. The review had kept a keen focus on the analysis using econometric scale on data of empirical EV market. EV being a relatively new introduction in automotive world, only a few studies had been carried out, so the had also included However, due to the introduction of EVs being relatively new and the limited number of such studies other alternatives, namely hybrid electric vehicles (HEV) and flex-fuel vehicles, as there is evidence of them having same disadvantages while entering, similar to EVs.

Earlier Hemim et al. [18] had identified antecedents in his article which could be the potential pre-existing factors, requiring empirical tests for generalization, for determining the validity between relationships of pre-existing factors and EV promotion in countries which are developing.

Verma et al. [2] conducted a study for identifying factors responsible for affecting buying decision of EVs among the population of Bangaluru. Accordingly, a questionnaire was developed which considered perception of the consumers and requirements which influenced propagation of EVs among population. The study identified the key factors, financial incentives and perceived environmental benefits motivating consumers to adopt EVs.

Deka et al. [19] analysed possible behavioural techniques for formulating methods of EV adoption in future. Authors proclaimed that pro-environmentalist attitude directly had no links to adoption intention EVs. Rather

above said attitude with the help of herd behaviour was needed to be triggered for igniting the adoption intention of EVs.

Higueras-Castillo et al. [20] conducted a cross-cultural study which offered insights on affecting variables in adoption intention of EVs. They conducted this study in Spain and India, adopting UTAUT2 and VBN theory. The results of the study identified judgements and views of the society and pleasure and enjoyment as key factors behind adoption intention of EVs in those regions.

B. Research Gaps, Research Question and Research Objective

The existing literature pointed out that there had been studies that tried to figure out the drivers of EV adoption in India, but in small scale and in some selected parts of India. However, the adoption intention of peoples of Eastern India had yet not been explored. This study intended to explore and confirm associating factors.

Research Question: What are the existing factors that might drive young grad, post grad and doctoral students over Eastern Indian to adopt EVs?

Research Objective: To confirm the existing factors derived from previous studies in same domain, if the same factors are applicable for adoption intention of EVs of Eastern India.

III. HYPOTHESIS DEVELOPMENT

Based on the previous literature and adapting present study's circumstances, following hypothesis has been developed for this research work.

Proposed Hypothesis-

HI_1 EC has positive influence on adoption intention of EVs.

HI_2. PEoU has positive influence towards adoption intention of EVs.

HI_3. PU has positive influence towards adoption intention of EVs.

HI_4 Personal Attitudes influences adoption intention of EVs.

HI_5 Subjective Norms positively influences adoption intention of EVs.

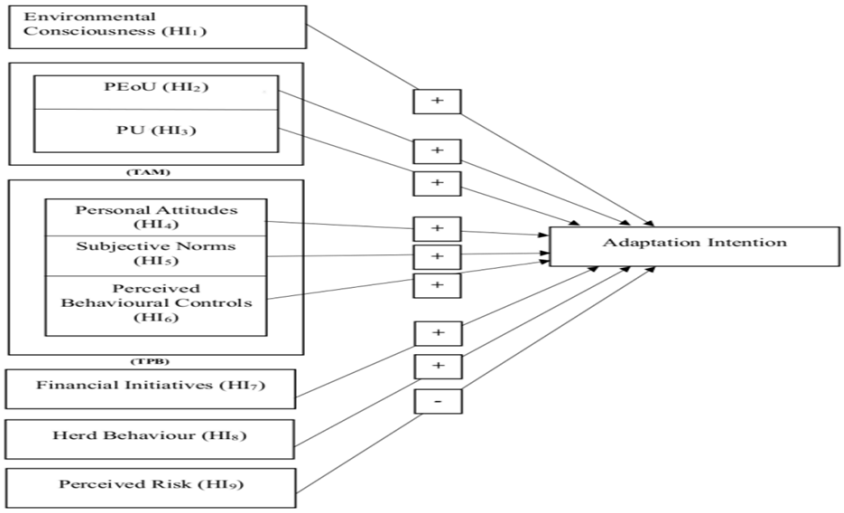
HI_6 Perceived Behavioural Controls positively influence adoption intention of EVs.

HI_7 FI positively influences adoption intention of EVs.

HI_8 HB positively influences adoption intention of EVs.

HI_9 PR negatively influences adoption intention of EVs.

Figure 1 *Proposed Conceptual Model*



Note: '+' denotes positive relationship and '-'denotes negative relationship

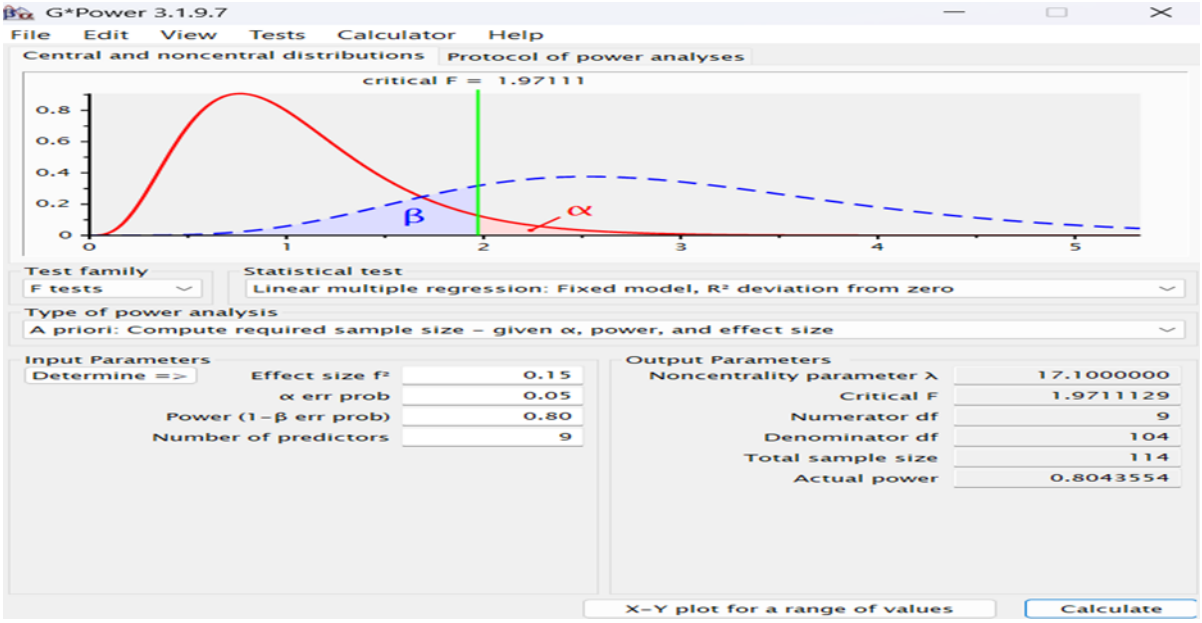
IV. METHODOLOGY OF RESEARCH

Generally, research methodology had always been a systematic way of solving a problem which requires research. Researchers while proceeding with their researches usually adopts various process, methods, logics and steps, all of these before mentioned sections had always been mentioned in the Research Methodology of a Research Paper (Kothari, 2004). Previous, sustainable consumption researches had widely adopted survey research models [9]. This study had followed the same path. This study had gathered primary research data through e-survey with the help of Google Forms. This study followed a quantitative research approach with self-administrated questionnaire. Researchers having a proven bunch of hypothesised factors, having responses gathered in form of responses from surveys can use Confirmatory Factor Analysis (CFA) to examine the fit of previously proven factors in new scenarios [22]. This study adopted the same approach using constructs borrowed from previous proven studies and analysing through the CFA method, using softwares like IBM SPSS Statistics 29 [23] and SmartPLS 4 [24].

A. Determination of Sample Size and Data collection

The sampling of target population was firstly predicted using G*power software before data collection. The G*Power software had widely been used to predict sample size using various statistical methods (F, t, $\chi 2$, z, and exact tests) [25]. This study has chosen F test keeping 9 predictors and has used "Liner multiple regression: Fixed model, R^2 deviation from zero" for the statistical test. As a result, G*Power 3.1.9.7 had predicted the required total sample size, 114.

Figure 2 *Sample size computation through G*power. Source: Generated from G*power software by the author.*



After the questionnaire was designed, a survey was carried out for collecting the data considering sample size predicted by G*Power software, to test the proposed hypotheses. The required data were collected from various Post Graduate, Under Graduate and Doctoral students who belong to different colleges, universities and educational institutions of Eastern India i.e. Bihar, Jharkhand, Odisha and West Bengal. This survey was conducted through a cloud-based questionnaire spreading platform named Google Forms. Total 122 responses were gathered by this survey, though there was no response limit in Google Forms. Table 4.1 provides the characteristics of the sample data.

Table 1 *Summary of Sample Characteristics*

Sample Characteristics	Category	Count	Percentage
Gender	Female	50	41.0%
	Male	72	59.0%
Age Group (In years)	18-30	116	95.1%
	30-42	4	3.3%

	42-54	1	0.8%
	More than 54	1	0.8%
Currently Enrolled in	Doctoral Program	9	7.4%
	Postgraduate Program	82	67.2%
	Undergraduate Program	31	25.4%
Annual Income of family.	Less than Rs 1,00,000	41	33.6%
	Rs 1,00,000 - Rs 5,00,000	57	46.7%
	Rs 5,00,000 - Rs 10,00,000	13	10.7%
	More than Rs 10,00,000	11	9.0%
Owned or used ICE (traditional fuel gas vehicles) previously.	No	46	37.7%
	Yes	76	62.3%
Owned or used EV (Electric Vehicle) previously.	No	100	82.0%
	Yes	22	18.0%
Part of Eastern India	Bihar	9	7.4%
	Jharkhand	3	2.5%
	Odisha	4	3.3%
	West Bengal	106	86.9%

Source: Primary survey (May 2024 – June 2024), table constructed using IBM SPSS 29

B. Measurement

A two-part questionnaire was used to gather necessary data; the first part consisting questions related to socio-demographic factors, and in the second part to understand the consumer's choice while thinking about adopting an EV by letting them grade the importance of given variables using a five-point Likert scale which ranged from *"Strongly Agree" (5) to "Strongly Disagree" (1)* [26,27]. Naturally, the first part consisted the basic information of the sample population as mentioned in table 1 which includes gender, age group, program currently enrolled in, annual income of family, if previously owned or used ICE vehicles, if previously owned or used EV, part of Eastern India they belong to. Whereas the items in the second part of the questionnaire was derived keeping in mind the factors which might influence or act as a barrier in adoption intention of EVs using constructs of environmental consciousness (EC), perceived ease of use (PEoU), perceived usefulness (PU), personal attitudes (PA), subjective norms (SN), perceived behavioural controls (PBC), financial initiatives (FI), heard behaviour (HB), perceived risk (PR). Those constructs were adapted from previous defined studies as mentioned in Table 2.

Table 2 *Constructs and Sources*

Constructs	Statements	Source
Environmental consciousness (EC),	$EC_{1:}$ Environmental regulations set by government will encourage me to buy an EV in near future. $EC_{2:}$ Buying an EV will result in less carbon emission.	[28]
Perceived Ease of Use (PEoU),	$PEoU_{1:}$ Using an EV is easy compared to ICE (Traditional Fuel Gas vehicle). $PEoU_{2:}$ Buying an EV will provide me with favourable technological driving assistance.	[28]
Perceived Usefulness (PU),	$PU_{1:}$ I will be less dependent on fossil fuels if I purchase an EV	[29]
Personal Attitudes (PA),	$PA_{1:}$ I want to adopt an EV because of the rising in fuel prices.	[28]
Subjective Norms (SN)	$SN_{1:}$ Overall cost of owning a EV is low	[30]

Perceived Behavioural Controls (PBC)	$PBC_{1:}$ My EV purchasing decision will contribute in building a healthy and sustainable environment.	[31]
Financial Initiatives (FI)	$FI_{1:}$ Initiatives by government (subsidies, tax exemptions) ignites my mind to purchase an EV.	[32]
Heard Behaviour (HB)	$HB_{1:}$ The information from my close friends and relatives will play a reference for my EV buying decisions. $HB_{2:}$ I will follow advertisements before buying an EV. $HB_{3:}$ I will follow social blogs and forums before buying an EV.	[33,34]
Perceived Risk (PR).	$PR_{1:}$ The initial purchase cost would not have a negative effect on my EV purchasing intention. $PR_{2:}$ Comparatively less number of charging stations of EVs will not be a matter to worry upon. $PR_{3:}$ I will purchase an EV in future regardless of the high charging time. $PR_{4:}$ Driving range of EVs will not bother purchasing intentions. $PR_{5:}$ Inferior power delivery of EVs will not be something for me to worry about	[31]

Prior to the survey, a demo survey was conducted to test the instruments. The demo survey included 10 respondents, in which nine were students and one Assistant Professor of Department of Business Administration, The University of Burdwan who have knowledge about EVs and previous experience of using / owning / riding ICEs and EVs both.

C. Procedure

The procedure in which raw data can be converted into a state which can be accurately analysed, is referred as Data preparation. The raw data collected through a cloud-based questionnaire spreading platform named Google Forms was firstly converted into google sheets then downloaded into PC inform of excel workbook (.xlsx). Later the data of five-point Likert scales were assigned values with the help of "find and replace" function of MS Excel, e.g. of values, "Strongly Disagree" was assigned with the value (1) and "Strongly Agree" with (5). Following it the data was dispatched into IBM SPSS Statistics 29 and SmartPLS 4 for further statistical analysis. The method of analysis to be followed is CFA (Confirmatory Factor Analysis).

D. Ethical Consideration

Before distribution of the Google Form link, a text message through the survey was sent seeking for the consent and willingness of the population for participation in the study. The responses were assured to be confidential and aim and objectives the study was briefly explained. After receiving the nod of approval from the probable respondents, the survey was conducted.

V. Analysis and Interpretation

SmartPLS 4 software was used throughout the study for the purpose of path analysis and SEM. Ireland [35] stated that doing good empirical research with conceptualised framework and competing frameworks to observe the better fit, that's the best way of validation of a conceptual model, SEM had always been an ideal method for this purpose. This portion of the study deals with the CFA, reliability of the model, testing of hypotheses and validity of the model using SEM.

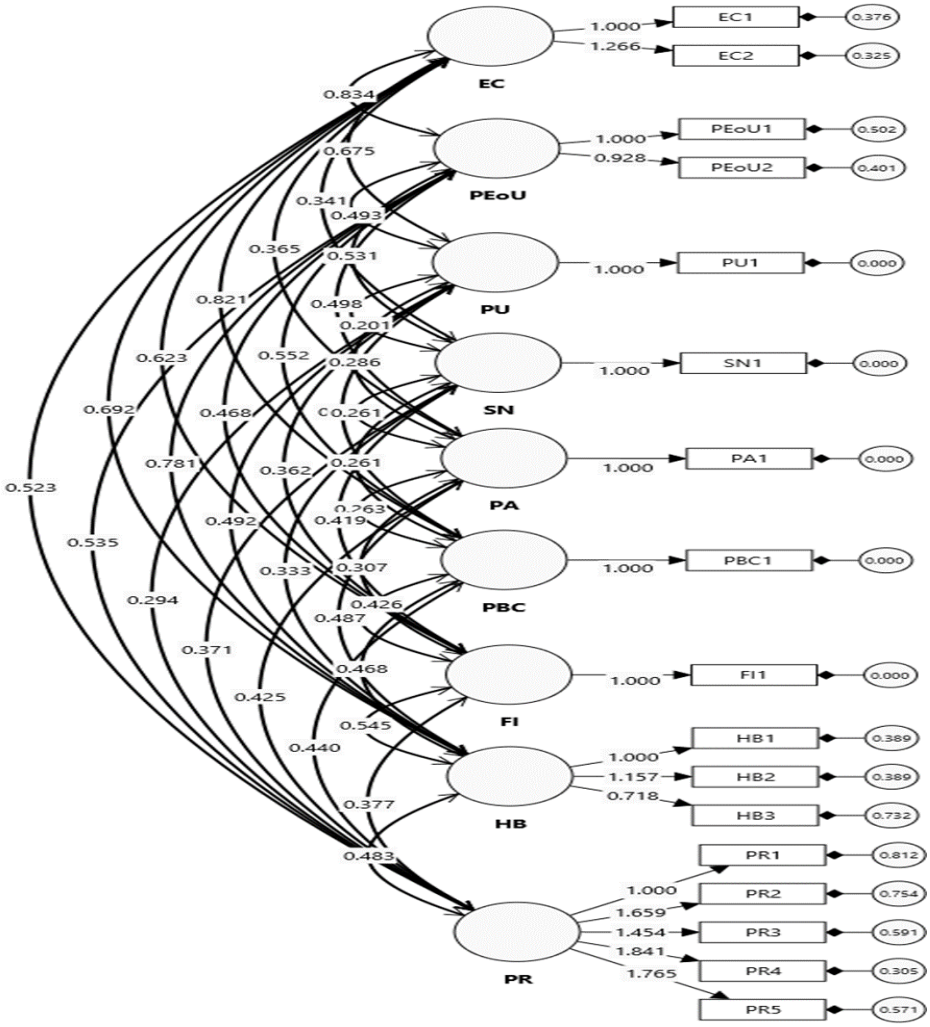


Fig 3 *Path Analysis, SEM using SmartPLS 4*

This study utilizes the CB-SEM method. The conceptual model, used for this study consisted of EC, PEoU, PU, PA, SN, PBC, FI, HB and PR as constructs. The proposed conceptual model is validated with help SmartPLS 4 software.

Table 3 *Construct reliability and validity*

Constructs	CFA Loadings	Cronbach's alpha	CR	AVE
EC		0.732	0.739	0.582
EC1	0.712			
EC2	0.810			
FI	1.000	1.000	1.000	1.000
HB		0.714	0.726	0.478
HB1	0.745			
HB2	0.791			
HB3	0.504			
PA	1.000	1.000	1.000	1.000
PBC	1.000	1.000	1.000	1.000
PEoU		0.666	0.665	0.499
PEoU1	0.700			
PEoU2	0.713			
PR		0.841	0.849	0.529

PR1	0.510			
PR2	0.714			
PR3	0.711			
PR4	0.872			
PR5	0.781			
PU	1.000	1.000	1.000	1.000
SN	1.000	1.000	1.000	1.000

Note: CR = Composite Reliability; AVE = Average variance extracted)

In prior to evaluation of the measurement model, a display of reliability and validity of the study had always been required. Three measures, generally used for testing the performance are CR (Composition reliability), AVE (Average variance extracted), and VIF (Variance Inflation Factor) [36]. This study has assessed the CR and AVE in table 5.1 though VIF values are unavailable for this study. Previous studies using CFA had CR values greater than 0.7, AVE values above 0.5 [37]. According to table 5.1 except PEoU and HB the proposed model satisfies the validity criterion.

Table 4 *Discriminant validity Fornell-Larcker criterion*

Discriminant Validity										
Convergent Validity										
Constructs	AVE	EC	FI	HB	PA	PBC	PEoU	PR	PU	SN
EC	0.582	**0.763**								
FI	1.000	0.623	**1.000**							
HB	0.478	0.692	0.545	**0.692**						
PA	1.000	0.365	0.307	0.487	**1.000**					
PBC	1.000	0.821	0.426	0.468	0.263	**1.000**				
PEoU	0.499	0.834	0.468	0.781	0.498	0.552	**0.707**			
PR	0.529	0.523	0.377	0.483	0.425	0.440	0.535	**0.728**		
PU	1.000	0.675	0.362	0.492	0.286	0.451	0.493	0.294	**1.000**	
SN	1.000	0.341	0.419	0.333	0.261	0.261	0.531	0.371	0.201	**1.000**

Note. Correlations among constructs are represented by off-diagonal values.

For assessing the measurement model's quality, a comparison between correlation coefficient and square root of the AVE can be used [36]. Here, generally in Fornell-Larcker criterion the square root of AVE if gets higher that all other values of table, the level of discriminant validity is considered as satisfactory [38]. In above table discriminant validity of all the other factors are satisfactory except PEoU (SQR of AVE are highlighted with typographic style).

Table 5 *Model fit indices*

Items	Estimated model	Cut-off	Conclusion	Cut-off Source
Chi-square	147.850	Hypersensitivity of chi-square	Acceptable	[39]
DF	88.000	The smaller is better	Acceptable	[40]
ChiSqr/DF	1.680	<3	Good Fit	[41]
RMSEA	0.075	<0.08	Good Fit	[42]
GFI	0.887	>0.8 Acceptable; >0.9 Good fit	Acceptable	[43]
AGFI	0.804	>0.8 Acceptable; >0.9 Good fit	Acceptable	[43]
SRMR	0.055	<0.08	Good Fit	[44]

TLI	0.889	>0.79 Acceptable; >0.9 Good fit	Acceptable	[42]
CFI	0.928	>0.9	Good Fit	[42]

Note. DF = degrees of freedom; CMIN/DF = Chi-Square to degrees of freedom ratio; RMSEA = root mean square error of approximation; GFI = goodness of fit index; AGFI = adjusted goodness of fit index; SRMR = standardized root mean square residual; TLI = Tucker-Lewis index; NNFI = non-normed fit index; CFI = comparative fit index.

18 model fit indices can be generated using SmartPLS, among all, necessary ones, Chi-square, DF, ChiSqr/DF, RMSEA, GFI, AGFI, SRMR, TLI, CFI are enough for the evaluation the fitness with regard to preset criteria set by previous researches n SEM. The most difficult task is to determine fit indices benchmark, the reference values are sometimes influenced by the size of the samples [36]. Table above shows the model fit index and it's suggested cut-off values, which ultimately determines the acceptability of the model.

Table 6 *Hypothesis testing*

Hypotheses	Result
HI_1 EC has a positive influence on adoption intention of EVs.	Significant
HI_2. PEoU has positive influence towards adoption intention of EVs.	Not Significant
HI_3. PU has positive influence towards adoption intention of EVs.	Significant
HI_4 Personal Attitudes influences adoption intention of EVs.	Significant
HI_5 Subjective Norms positively influences adoption intention of EVs.	Significant
HI_6 Perceived Behavioural Controls positively influence adoption intention of EVs.	Significant
HI_7 FI positively influences adoption intention of EVs.	Significant
HI_8 HB positively influences adoption intention of EVs.	Not Significant
HI_9 PR negatively influences adoption intention of EVs.	Significant

Source: Own Elaboration

As Mentioned earlier PEoU and HB fails to satisfy the criterion of both construct validity and reliability, and discriminant validity of the factors. On the other hand, all the other factors i.e., EC, PU, PA, SN, PBC, FI and PR satisfy the criterion of the followings. Due to the lacking of the beta estimate, this study follows the model implemented by Bharadwaj et al. [45]. So, according to the findings HI_1, HI_3, HI_4, HI_5, HI_6 and HI_7 can be claimed as significant and main drivers behind the emergence of the intention adoption of EVs in Eastern India. Whereas, Perceived Ease of Use and Herd Behaviour does not play any role in this matter. HI_9, is exceptional, it indicates that Perceived Risks has negative influence towards adoption intention of EVs, which can be interpreted as the barrier behind the adoption intention of EVs.

VI. Limitations of the Study and Future Scope of the Study

The first limitation of this study was conducted among students of Eastern India but, no data was gathered from Andaman and Nicobar Islands due time and connectivity constraints. Secondly, the responses were unevenly collected, maximum respondents were from West Bengal and post graduate students, which can lead to biased responses again this was due to lack of time and connectivity while collecting responses and relying on family and friends for the distribution of questionnaire through google forms. Lastly, the SmartPLS 4 failed to generate beta estimate so we had to follow the hypothesis testing model by Bharadwaj et al. [45].

Adequate evenly samples can be taken to pursue similar type of research work, and this study can be used as a reference for research in similar field.

VII. Conclusion and Discussion

This study had used the theories like, TAM and TPB to analyse various social, behavioural and other determinants on EV adoption intention among students of Eastern India. The study followed the CFA technique and a total of nine constructs were used i.e., EC, PEoU, PU, PA, SN, PBC, FI, HB and PR. Perceived Ease of Use (PEoU) and Herd Behaviour (HB) were not at all influential in the study, while all other factors were found highly influential in the research. The research concluded that Perceived Risk (PR) had a direct negative relationship with the adoption intention of students. These findings were crucial as they may provide a base for future EV centric

policymaking and marketing initiatives [36]. The product managers, marketing heads and policy makers may get a valuable insight of the market or the wants and disliking of the probable future youth consumers.

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