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Examining Government Incentives' Impact on Switching Intention and Continued Use of Electric Autorickshaws Through Push-Pull Mooring and Expectation Confirmation Theory

Pushpam T Davis
Department of Management Studies
Kalasalingam Academy of Research and Education, Krishnan Koil, Tamil Nadu
Email: pushpamk10gmail.com
ORCID: 0009-0006-7870-2426

Dr. T Chandrasekar
Department of Management Studies
Kalasalingam Academy of Research and Education, Krishnan Koil, Tamil Nadu
Email: chandrasekar@klu.ac.in

Essa Mariam Joseph
Department of Management Studies
Saintgits Institute of Management, Kottayam, Kerala
Email: essajoseph@gmail.com

Abstract- This research investigates the factors influencing autorickshaw drivers' intentions to transition to electric vehicles and their sustained use in public transport, highlighting a critical advancement in sustainable transportation. Conducted in Kerala, known as "God's Own Country," this study utilizes the Push-Pull-Mooring (PPM) framework combined with the Extended Expectation Confirmation Theory (ECT) to examine how push, pull, and mooring factors impact drivers' switching intentions. It also explores the moderating effect of government incentives and the mediating role of switching intention on continued usage intention. A quantitative approach was adopted, with data collected through a structured questionnaire survey administered to 267 autorickshaw drivers using snow ball sampling technique. Structural equation modeling (SEM) was applied to analyze the data. The findings reveal significant connections between these factors and drivers' intentions to switch to electric autorickshaws. Furthermore, switching intentions are shown to mediate the relationship with continued usage intentions, offering valuable insights into the dynamics of adopting sustainable transportation solutions. This study uniquely integrates the PPM framework with ECT in the context of electric autorickshaws, providing novel insights into drivers' decision-making processes and emphasizing the critical role of government incentives. These findings offer valuable guidance for industry stakeholders and policymakers aiming to promote sustainable transport adoption.

Keywords- Government incentives, public transport, Switching intention, PPM framework, continued usage intention, electric autorickshaws.

1.Introduction

The growth in industrialization and population has led to a surge in energy demands and consumption, which in turn has intensified the reliance on fossil fuels, particularly petrol and diesel, for transportation(Hoang *et al.*, 2022)(Jauhari *et al.*, 2023).This dependence on traditional fuels is a significant contributor to global greenhouse gas emissions, accounting for approximately one-sixth of these emissions, while also being a major source of urban air pollution. Transport accounts for 25% of worldwide carbon dioxide (CO2) emission and is projected to increase up to 50% by 2035.Indian transportation significantly contributes to the country's pollution levels, intensifying the environmental crisis. In response, there is a noticeable shift in India, where rapid urbanization and growing environmental awareness are driving the adoption of eco-friendly products and sustainable practices(Hüttel *et al.*, 2023).The 40% surge in India's electric vehicle sales, reaching 1.75 million units in financial year 2024, underscores this trend and signals a promising outlook for the sector's continued growth (Anand, 2024). The Indian government's initiatives to promote a sustainable future include collaborative efforts among policymakers, consumers, and manufacturers to advance electric vehicle adoption.

Additionally, the elimination of permit requirements for electric autorickshaws and carts has further supported this shift, enhancing accessibility and encouraging wider adoption(Kumar, 2024).

Given that urban areas in India are among the most polluted worldwide, as highlighted in the 2023 World Air Quality Report, the need for sustainable transportation solutions is more pressing than ever(IQAir, 2023). The shift towards electric vehicles, particularly in densely populated cities, has transitioned from a mere trend to a critical requirement for mitigating environmental harm and enhancing air quality. As a result, the Indian market is progressively leaning towards products that meet consumer needs while supporting the country's broader goals of environmental sustainability.

Kerala, often referred to as "God's Own Country," is a state located on India's tropical Malabar coast, boasting nearly 600 kilometers of Arabian Sea shoreline. Renowned for its natural beauty, Kerala was recognized by National Geographic Traveler as one of the 50 destinations of a lifetime and one of the 13 paradises in the world (Tourism, 2021) (Thomas & Prasannakumar, 2016). An analysis of Kerala's air quality over a three-year period from 2018 to 2020 revealed significant reductions in key air pollutants: nitrogen dioxide (NO2) decreased by 48%, nitrogen oxides (NOx) dropped by 53% to 90%, carbon monoxide (CO) declined by 24% to 67%, and particulate matter saw reductions of 24% to 47% for PM2.5 and 17% to 20% for PM10(Thomas et al., 2020). Kerala's commitment to environmental preservation is further exemplified by its leading role in the adoption of electric vehicles (EVs) within India's public transport system.

A notable initiative is Kerala's introduction of the "Kochi Electric Vehicle Project," which aims to replace traditional autorickshaws with electric versions in Kochi. This project not only enhances local air quality and reduces emissions but also supports Kerala's broader goals of advancing sustainable transportation and fostering a greener urban environment(Paul, 2023). This initiative demonstrates an increasing recognition of the need for cleaner and more efficient urban transportation solutions, establishing a benchmark for other Indian cities to follow. By adopting these environmentally friendly alternatives, Kerala is addressing its environmental issues and supporting the national objectives of sustainability and reducing the country's overall carbon emissions(Ramesh and Venkataraman, 2010).Building on Kerala's progressive efforts towards environmental sustainability, our study delves into the adoption and continued usage intention of electric auto-rickshaws in Kerala, particularly focusing on their integration within the Kochi Metro's feeder services(Ali & Dhanuraj, 2024). Using the Push-Pull-Mooring (PPM) framework in conjunction with the Extended Expectancy Confirmation Theory (ECT), we aim to identify and analyze the key factors influencing drivers' decisions to switch to and persist in using electric auto-rickshaws. Drawing from a comprehensive review of existing literature on electric vehicle adoption, this research seeks to address the following questions: What are the primary factors driving autorickshaw drivers to transition to electric vehicles. Moreover, how does the intention to switch mediate the connection between these factors and the intention to continue using electric vehicles, while also accounting for the moderating role of government incentives in strengthening or weakening this relationship?These questions will be thoroughly examined in the course of the study.

Researchers have examined various factors that influence switching intention, including the impact of peerperformance(Wang *et al.*, 2020),how the product contributes to enhancing driver comfort during operation (Rezvani *et al.*, 2017) and the monetary benefit(Sanguesa *et al.*, 2019)that drives switching intention. Some studies conducted qualitative examination(Alkhalisi, 2020), while others applied approaches such as UTAUT2, UTAUT (Singh *et al.*, 2023), technology acceptance theory(Jaiswal *et al.*, 2022), and theory of planned behavior(Michael *et al.*, 2024) in the context of electric vehicles. While existing studies have advanced our understanding of electric vehicles, a gap remains in systematically analyzing why drivers specifically switch to electric auto rickshaws rather than conventional three-wheelers(Hoerler *et al.*, 2023).Current research has not thoroughly examined how factors such as vehicle maintenance costs, permit benefits, drivers' hedonic gratification, their overall health, the availability of charging stations, the management of range anxiety, and the moderating influence of government incentives influence switching intention toward electric auto rickshaws continued usage intentions, particularly considering the growing importance of these factors in contemporary contexts. In particular, few studies have examined consumers' positive attitudes toward electric vehicles beyond electric autorickshaws (Khurana et al., 2020). Therefore, additional empirical exploration is necessary to understand the switching behavior. This study emphasizes the importance of examining both switching behavior and continued usage intention, providing a comprehensive analysis of both pre- and post-adoption phases. This integrated approach is crucial for understanding the factors motivating the transition to electric vehicles and the ongoing

commitment to their use.Therefore, it is crucial to identify the incentives that local governments can provide to promote the continued usage of electric vehicles. This study proposes a combined model integrating the Push-Pull-Mooring (PPM) framework with an Extended Expectancy Confirmation Theory (ECT) framework variables (Bansal et al., 2005)(Wang et al., 2020). This integrated model aims to elucidate the expectations and realities of adopting electric autorickshaws, addressing the existing research gap.

The objectives of this research are threefold: (1) to develop and empirically test an integrated model (PPM-ECT) that identifies the key determinants of switching intention, (2) to examine the mediating role of switching intention in shaping continued usage intention, and (3) to evaluate the moderating role of government incentives in the relationship between switching intention and continued usage intention. This research makes several contributions: first, it identifies seven critical factors that influence the transition to electric autorickshaws, categorizing maintenance costs, and perceived benefits as push factors, while perceived health outcome, hedonic gratification, and the availability of charging stations are classified as pull factors. Additionally, range anxiety is recognized as a mooring factor. By analyzing these factors, the study offers a deeper understanding of the dynamics driving switching behavior. Second, given Kerala's heavy reliance on imported energy and the urgent need to reduce carbon emissions and implement energy-saving policies, developing a framework to minimize carbon emissions is of paramount importance. Third, with the recent large-scale introduction of electric autorickshaws in Kerala, there is an urgent need for a comprehensive framework that analyzes the factors driving drivers' adoption decisions. Additionally, it is important to investigate how government incentives influence drivers who have already switched to electric autorickshaws in determining their continued usage intentions. The proposed model is therefore expected to provide a more detailed explanation and enhanced understanding of these dynamics. Lastly, the research explores significant age-related differences in the adoption intention of electric autorickshaw, further enriching the findings.

The rest of this paper is organized as follows: Section 2 reviews the pertinent literature and introduces the research hypotheses. Sections 3, 4 and 5 detail the methodology, and execution of the three studies, and their respective findings. Finally, Sections 6, 7, and 8 discuss the results and their theoretical and practical implications, and conclude with an outline of the limitations and suggestions for future research.

2. Literature review and hypothesis development

2.1PPM Framework

This study uses the push pull mooring framework, which is basedon migration theory. The movement of individuals from one place to another at a defined time can be traced using the push- pull mooring frame work(Bhattacharyya and Thakre, 2020). The three key components of the PPM framework are push, pull and mooring factors(Azfar *et al.*, 2023). The push factor causes the movement from the current site to the new site whereas thepull factor attracts the user to the new location is the pull factor(Tang and Chen, 2020). To fully understand the concept of migration, scholars have identified mooring factors that explain the conditions and circumstances that facilitate or hinder migration(Azfar *et al.*, 2023).In transportation, the PPM framework is valuable for understanding why drivers might switch from traditional to electric autorickshaws (Liao et al., 2021) (Gungor et al., 2019) (Saari et al., 2021) (Wang et al., 2020). Push factors, such as high maintenance costs and low perceived benefits, drive this switch, while pull factors like perceived health outcomes, hedonic gratification, and charging station availability attract drivers to electric options. Addressing range anxiety is crucial in overcoming one of the main barriers to the adoption of electric vehicles, making it an essential focus as a mooring factor in this study.By integrating the PPM framework with Extended Expectancy Confirmation Theory, this study formulates eight hypotheses to analyze the dynamics influencing drivers' switching intentions and continued usage of electric autorickshaws.

2.2 Maintenance cost

Maintenance cost is a push factor within the PPM framework for this study. Maintenance expenses play a critical role when considering electric autorickshaws as an alternative mode of transportation. Traditional auto rickshaws incur higher maintenance costs, whereas electric autorickshaws are more economical because they have fewer moving parts, less frequent servicing, and a variety of charging infrastructure options. This study suggests that lower maintenance costs can result in overall cost savings. Additionally, addressing cost concerns and creating rules to reduce maintenance

expenditures will help electric-autorickshaws gain market acceptance and adoption(Bhattacharyya and Thakre, 2020) (Zhang et al., 2013). Accordingly, the following hypothesis is proposed:

H1a. Maintenancecost is positively linked with switching intention.

H1b. Switching intention mediates the relationship between the maintenance cost and the continued usage intention of electric autorickshaws

2.3 Perceived benefit

Perceived benefit, identified as the second push factor in this study, emphasizes permit cost as the most significant advantage. This underscores the necessity of a well-designed permit pricing system to effectively manage the uptake of electric autorickshaws(Gungor *et al.*, 2019). Permit structures should be regularly reviewed and revised to ensure that they meet the needs of the transportation sector and sufficiently offset EV expenses.The study is deemed required to evaluate the expenses involved with running electric-autorickshaws and to propose a free price structure for deciding the permit(Yang and Tan, 2019)In a prior study, the influence of permits on EV switching intention was addressed(Liu *et al.*, 2022).The government promotes green transportation by offering zero permit costs for electric autorickshaws, creating a significant benefit(Yang and Tan, 2019). With zero permit costs for electric autorickshaws, drivers can travel without permit restrictions and earn money without spending much on regulatory fees(Gungor *et al.*, 2019).Therefore, the following hypothesis proposed:

H2a. Perceived benefit is positively linked with switching intention.

H2b. Switching intention mediates the relationship between the perceived benefit and the continued usage intention of electric autorickshaws

2.4 Perceived health outcome

Perceived health outcomes were a significant pull factor. Previous research has demonstrated that reduced vibrations in electric autorickshaws are crucial for preventing musculoskeletal issues(Zamparoni Victorino *et al.*, 2023). Traditional autorickshaws often cause constant vibration, leading to lower back pain, neck pain, and other musculoskeletal disorders. Prolonged exposure to vehicular vibrations can adversely affect musculoskeletal health, causing discomfort and long-term health problems. By minimizing these vibrations, electric autorickshaws can help drivers maintain better physical health and lower the risk of developing chronic musculoskeletal conditions. Studies have shown that chronic exposure to high noise levels can increase stress, anxiety, and cardiovascular issues(Remy and Guseva Canu, 2023). Furthermore, cleaner emissions from electric autorickshaws contribute to better respiratory health. Reduced exposure to harmful pollutants, such as particulate matter and nitrogen oxides, decreases the risk of respiratory diseases and enhances overall well-being. These factors collectively make electric autorickshaws a healthier option for drivers, promoting better quality of life and long-term health benefits.Therefore, the following hypothesis was proposed:

H3a. Perceived health outcomesare positively linked with switching intention.

H3b. Switching intention mediates the relationship between the perceived health outcomes and the continued usage intention of electric autorickshaws

2.5 Hedonic gratification

Previous research has not explored the issue of hedonic gratificationwith respect to electric autorickshaws. The findings indicate that factors related to hedonic gratification, such as the comfort and smooth acceleration of electricautorickshaws compared to the heavy vibrations and discomfort of traditional autorickshaws, significantly influence customer choices and attitudes toward electric vehicles. Improving the driving experience with characteristics such as faster acceleration and less noise will help enhance the acceptance and adoption of electric-autorickshaws(Le *et al.*, 2023). Users who have direct experience with EVs fully comprehend the gratification that comes with driving them, demonstrating that practical interaction with the technology is critical for understanding its advantages and influence on user behavior.Hedonic gratification is a key source of motivation that influences both the attitude and intention to use electric-

autorickshaws(Dickinger *et al.*, 2008). This emphasizes the significance of perceived satisfaction as a crucial component in encouraging the adoption of electric vehicles and altering customers' views toward sustainable transportation solutions(Roemer, 2022)Accordingly, The following hypothesis is formulated:

H4a. Hedonic gratification is positively linked with switching intention.

H4b. Switching intention mediates the relationship between the hedonic gratification and the continued usage intention of electric autorickshaws

2.6 Availability of charging station

One of the crucial factors influencing users' decisions to switch to electric autorickshaws is the availability of the charging stations. The presence and ease of access to charging infrastructure significantly affect customers' willingness to transition to electric vehicles (Savari *et al.*, 2023). A well-distributed network of charging stations can ease range anxiety and provide drivers confidence that they can refuel their vehicles when necessary(Guo *et al.*, 2024). The relationship between the availability of charging station and a country's electric vehicle market share emphasizes the necessity of infrastructure development in promoting EV adoption(Falchetta and Noussan, 2021). Higher charger density means more accessibility to charging facilities, which can increase the adoption of electric cars in a specific location(Gupta, Kriti Priya, and Manrai, Rishi, and Goel, 2019)(Higueras-Castillo *et al.*, 2023). The placement of fast-charging stations will also cater towards improving the infrastructure for electric vehicles(Ahmad, 2022). Strategic locations for charging slot can improve efficiency and accessibility for users while reducing costs and environmental implications(Das *et al.*, 2020)(Savari *et al.*, 2023)(Siddique *et al.*, 2021).Consumers prefer charging stations that are conveniently accessible and strategically placed to reduce hassle and wait times(Mishra *et al.*, 2021).Factors like as charging speed, charger accessibility, and the kind of connector utilized all contribute to the ease and utility of charging stations for electric-autorickshaw drivers(Bhattacharyya & Thakre, 2020).Accordingly the following hypothesis has been formulated.

H5a. Availability of charging station is positively linked with switching intention.

H5b. Switching intention mediates the relationship between the availability of charging station and the continued usage intention of electric autorickshaws

2.7Addressing range anxiety

Mitigating range concerns and developing adequate charging infrastructure can facilitate the daily adoption of electric vehicles(Guo *et al.*, 2024). Range anxiety results from customers overestimating how much range they actually need it(Savari *et al.*, 2023). Educating customers about how the range of electric-autorickshaws can meet their everyday needs for transportation can boost the possibility that they will purchase EVs(Hoerler *et al.*, 2023).As different models on the market offer varying amounts of driving range, consumers are sensitive to limited driving range(King *et al.*, 2015)(Zhang *et al.*, 2021). According to earlier research, reducing range anxiety through technological improvements and longer driving ranges will the purchasers to low down the worries and encourage the widespread use of these vehicles(Daziano, 2018)(Noel *et al.*, 2019). Providing drivers with easy charging options along travel routes, the infrastructure can assist reduce range anxiety by placing fast-charging stations strategically where they are most required and accessible. Accordingly, the following hypothesis has been asserted.

H6a. Addressing range anxiety is positively linked with switching intention.

H6b. Switching intentionmediates the relationship between addressing range anxiety and the continued usage intention of electric autorickshaws

2.8. Switching intention

Switching intention refers to the inclination or willingness of individuals to transition from one product, technology, service, or system to another. In a study conducted the technological factors, including driving range, charging time, noise, acceleration, reliability and the contextual factors, price, incentives and the safety is found to have an impact on the switching intention to electric vehicle (Mishra et al., 2021). Another factor that attracts users to electric vehicle is the

government policies and the subsidies provided (Duren et al., 2022) (Higueras-Castillo et al., 2023). A price sensitive approach was used and factors such as habits, routines, and practices were not considered in relation to switching intention (Bellet & Banet, 2023). This study investigates the influence of specific additional factors not addressed the existing literature, instead of focusing on charging time, which has been extensively discussed, and examines the availability of charging stations towards switching intention (Sierzchula, 2014). Moreover, a limited number of studies have been conducted on perceived enjoyment. This study examined the comfort and pleasure derived from using electric auto-rickshaws and their influence on the intention to switch. Unlike traditional auto-rickshaws, which cause more vibration and offer less enjoyment, electric auto-rickshaws provide a smoother, and, pleasurable experience (Melwani et al., 2018)

H8. switching intentionis positively linked with continued usage intention.

2.9 Government incentives

Government incentives serve as a moderating factor that enhances the relationship between switching intention and continued usage intention. Previous research has revealed that government regulations or subsidies have a substantial impact on the uptake of electric vehicles and other sustainable transportationoptions (Allahmoradi et al., 2022)(Sanguesa et al., 2019). Government incentives, both in terms of promoting the adoption of electric-autorickshaws through measures like CO2 taxes and emission limits, and in building a supportive regulatory framework that fosters sustainable transportation choices, have been proven to be a driving force towards switching(Hoerler et al., 2023) (Diamond, 2009). Governments can play a critical role in promoting the use of green transportation by developing and implementing green transportation policies and measures, as well as improving the green transportation system, which have been shown to have a positive impact on people's willingness to switch to EV(Lynn *et al.*, 2012)(Yuniaristanto et al., 2024)(Zhu et al., 2024). Once drivers switch to electric auto rickshaws, the government incentives they receive encourage them to sustain their use of the vehicles over the long term and support their continued usage intention(Nath et al., 2014).The following hypothesis has been proposed.

H7. Government incentives moderate the relation between switching intention and continued usage intention.

2.10 Continued usage intention

Continued usage intention was identified as the dependent variable to be used in the study derived from extended expectation confirmation theory(Chen *et al.*, 2022)(Ojo *et al.*, 2022).To comprehend the factors influencing the continuation intention of electric vehicles, the extended expectation confirmation theory, was explored by combining the conventional expectation confirmation theory with the social comparison theory in the previous literatures (Obeid et al., 2024) (Cruz-Jesus et al., 2023). Regarding electric auto-rickshaws, continuance intention refers to the desire of EV owners to continue using their vehicles as their primary means of public transportation in the future(Cruz-Jesus *et al.*, 2023). Despite the existing research, a comprehensive understanding of continuance intention among electric auto-rickshaw users remains limited. It is crucial for policymakers, researchers, and industry stakeholders to grasp the concept of continuance intention, as it provides insights into users' long-term commitment to a product (Wen et al., 2024)(Obeid *et al.*, 2024). By identifying the elements that impact continuance intention, stakeholders can develop strategies to enhance user satisfaction, address potential barriers to ongoing usage, and promote sustainable adoption of technologies such as electric auto-rickshaws.

Overall, the research model is shown in Figure 1.

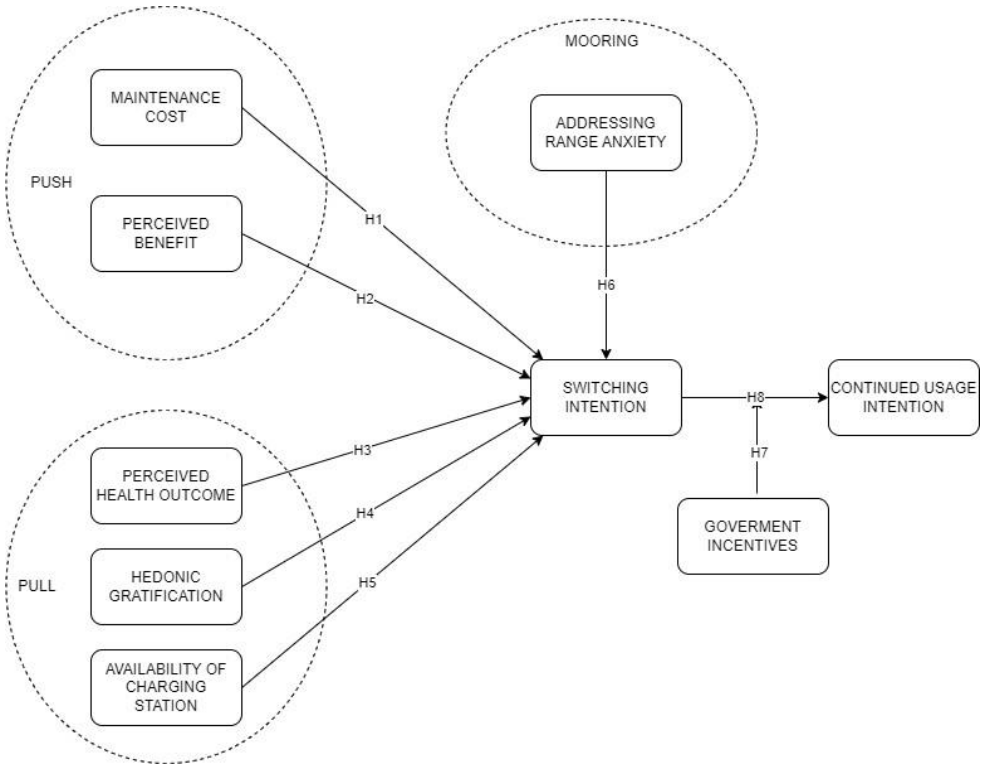

Figure I. Research model

3.Research design

3.1 Questionnaire and data collection

In this study, data on 817 registered electric passenger autorickshaws across 87 Regional Transport Offices (RTOs) in Kerala were obtained from the VAHAN Dashboard, which is part of the Parivahan Sewa portal. This portal, an initiative by India's Ministry of Road Transport and Highways, aims to digitize and streamline vehicle-related processes, thereby providing a credible data source for the study. The collected data were analyzed using Smart PLS 4 software, which utilizes partial least squares (PLS) structural equation modeling (SEM) (Dewi *et al.*, 2020). This methodological approach was chosen to effectively assess the relationships within the conceptual framework. The questionnaire was meticulously reviewed by experts in electric vehicles (EV) to ensure that the language was accessible to electric autorickshaw drivers in Kerala and that the structure was appropriate. Data collection for the conceptual model testing was conducted through a structured questionnaire-based survey in two phases. The initial phase gathered demographic information, including age, driving experience, and whether the respondent was an electric autorickshaw driver for public transport, as detailed in Table II. The second phase focused on collecting data related to the study's constructs, which are outlined in Appendix A. The scale items for the questionnaire were adapted from prior studies, such as(Adi, 2023), (Hu *et al.*, 2021), (Gupta *et al.*, 2021), (Singh *et al.*, 2023), (Falchetta and Noussan, 2021), (Bonges and Lusk, 2016), (Pakdeechoho and Sukhotu, 2018), (Liao *et al.*, 2021) and (Hong *et al.*, 2006). A seven-point Likert scale, ranging from "Strongly disagree" (1) to "Strongly agree" (7), was employed to assess the survey items.

Measure	Item	Frequency	Percentage (%)
Age	18-27	27	10
	28-43	70	26
	44-59	122	46
	Above 60	48	18
Do you have a valid driving license?	Yes	267	100

Have you ever driven an electric vehicle, specifically an electric autorickshaw?	Yes	267	100
Do you own an electric autorickshaw?	Yes	267	100
Do you use your electric autorickshaw for public transport services?	Yes	267	100

Table II. Demographic distribution of respondents (N=267)

The study required a minimum sample size of 109 participants, determined using G*Power, a widely recognized power analysis software for behavioral and social sciences(Faul*et al.*, 2009).This calculation was based on an a priori analysis that considered factors such as the significance level (α) set at 0.05, power (1-β) at 0.99, and effect size (f^2) at 0.15, following the guidelines provided by (Cohen *et al*., 1988). (Cohen et al., 1988)emphasized that studies should be structured to achieve an alpha value of at least 0.05 and a power level of at least 80%. To ensure a higher likelihood of detecting a true effect, we opted for a power level of 0.99, with an effect size (f^2) representing a medium effect.As of June 2024, in total, there were 817 registered electric autorickshaws in Kerala, spread across 87 Regional Transport Offices (RTOs)we employed the snow ball sampling technique, as suggested by(Agrawal & Gupta, 2018) and (Jiang et al., 2022) to select 267 respondents for the survey, which exceeded the minimum requirement. This approach is particularly relevant for electric autorickshaw drivers because it helps reach a dispersed and potentially close-knit group within the transport sector. Additionally, to encourage participation, the drivers who cooperated in completing the questionnaire were compensated with a nominal fee. The nominal fee offered to the drivers as compensation for participating in the survey was equivalent to the minimum charge they typically set for a ride.

4. Result

4.1 Measurement Model

We performed various tests to assess the measurement model, focusing on outer loading, composite reliability (CR), average variance extracted (AVE), and discriminant validity, in line with established guidelines(Si *et al.*, 2024). The findings, which evaluated the reliability and validity of the survey instruments, are presented in Table III. We assessed the validity and reliability of our constructs using composite reliability, Cronbach's alpha, AVE, and factor loadings. Convergent validity was tested through the analysis of AVE and factor loadings. For confirmation of convergent validity, AVE values needed to be greater than 0.50(Roemer *et al.*, 2021) and factor loadings had to exceed 0.60 (Zhang *et al.*, 2022).In addition to reliability and validity assessments, we conducted a discriminant validity (DV) analysis. The Fornell-Larcker criterion was used, indicating that the correlations between variables must be lower than the square roots of their AVE values. Additionally, the Heterotrait-Monotrait (HTMT) ratio of correlations was used to further verify DV, with all results being below 0.85, thereby supporting the DV (Sukhov *et al.*, 2023). Consequently, discriminant validity was confirmed in this study, as detailed in Table IV.

Latent variable		Indicators	Items	References
Push effects	Maintenance Cost	MC1	I am considering switching to an electric autorickshaw due to the potential for lower maintenance costs.	(Adi, 2023)
		MC2	I intend to switch to an electric autorickshaw because of the expected savings in fuel and maintenance expenses.	
		MC3	I have made up my mind to switch to an electric autorickshaw primarily because of the reduced long-term maintenance costs.	

		PB1	Electric autorickshaw is cheaper than some other modes of travel, primarily due to the permit benefits provided by governments	(Hu *et al.*, 2021)
	Perceived Benefit	PB2	Electric autorickshaw is cheaper than conventional autorickshaw,primarily due to the permit benefits provided by governments	
		PB3	Electric autorickshaw is safer than some other modes of travel, particularly in terms of financial safety, because of permit benefits	
	Perceived Health Outcome	PHO1	Using electric autorickshaw has helped me to live healthy life	(Gupta *et al.*, 2021)
		PHO2	Electric autorickshaw has helped me to maintain good health	
		PHO3	After using electric autorickshaw, I feel healthier	
	Hedonic Gratification	HG1	Driving an electric autorickshaw would be pleasant to drive because of smoothness and high acceleration as compared to conventional auto rickshaw	(Singh *et al*., 2023)
		HG2	An electric auto rickshaw would be a very exciting new technology	
Pull effects		HG3	I would prefer to drive an electric auto rickshaw as compared to conventional car	
	Availability of Charging Station	ACS1	I am considering switching to an electric autorickshaw because of the widespread availability of charging stations	(Falchetta & Noussan, 2021)
		ACS2	I intend to switch to an electric autorickshaw because I am confident in the accessibility of charging stations in my area.	
		ACS3	I have made up my mind to switch to an electric autorickshaw in the future, primarily because of the convenience of charging stations being readily available	
Mooring effect	Range Anxiety	RA1	I am considering to use an electric autorickshaw because I believe it will alleviate my concerns about range anxiety	(Bonges & Lusk, 2016)
		RA2	I intend to use an electric autorickshaw because I am confident that advancements in battery technology will address range anxiety	

	RA3	I have made up my mind to use electric autorickshaw in the future, largely to overcome the limitations of range anxiety	
Government Incentives	GI1	The government offers environmental and social certifications or labels for commercial usage of electric autorickshaw	(Pakdeechoho & Sukhotu, 2018)
	GI2	The government provides information or technical assistance for electric autorickshaw users to implement environmental and social practices	
	GI3	The government offers fees or tax exemptions for electric autorickshaw users when environmental and social criteria are met	
Switching Intention	SI1	I am considering switching to electric autorickshaw	(Liao *et al*., 2021)
	SI2	I intend to switch to electric autorickshaw	
	SI3	I make up my mind to switch to electric autorickshaw in the future	
Continued Usage Intention	CUI1	I intend to increase my use of electric autorickshaw in the future	(Hong *et al*., 2006)
	CUI2	I intent to continue my use of electric autorickshaw in the future	

Construct	Cronbach's α	Indicators	Factor loading	AVE	CR
Maintenance Cost	0.913	MC1	0.914	0.852	0.916
		MC2	0.935		
		MC3	0.92		
Perceived Benefit	0.843	PB1	0.819	0.761	0.856
		PB2	0.919		
		PB3	0.876		
Perceived Health Outcomes	0.782	PHO1	0.828	0.697	0.783
		PHO2	0.844		
		PHO3	0.831		
Hedonic Gratification	0.756	HG1	0.901	0.68	0.834
		HG2	0.938		
		HG3	0.788		
Availability of Charging Station	0.888	ACS1	0.892	0.817	0.895
		ACS2	0.925		

		ACS3	0.895		
Addressing Range Anxiety	0.731	ARA1	0.754	0.648	0.755
		ARA2	0.797		
		ARA3	0.86		
Switching Intention	0.914	SI1	0.923	0.854	0.915
		SI2	0.929		
		SI3	0.921		
Government Incentive	0.753	GI1	0.772	0.67	0.764
		GI2	0.867		
		GI3	0.813		
Continued Usage Intention	0.719	CUI1	0.907	0.779	0.74
		CUI2	0.857		

Table III. Measurement model analysis

	ARA	ACS	CUI	GI	HG	MC	PB	PHO	SI	Government Incentive x Switching Intention
ARA										
ACS	0.272									
CUI	0.518	0.506								
GI	0.442	0.351	0.738							
HG	0.324	0.762	0.589	0.395						
MC	0.495	0.249	0.528	0.569	0.256					
PB	0.284	0.463	0.377	0.393	0.585	0.298				
PHO	0.347	0.518	0.477	0.423	0.583	0.418	0.667			
SI	0.445	0.555	0.580	0.325	0.553	0.522	0.354	0.602		
Government Incentive x Switching Intention	0.289	0.088	0.027	0.112	0.061	0.034	0.111	0.031	0.078	

Table IV. Discriminant validity

4.2. Structural model

After confirming the reliability and validity of the measurement model, we proceeded to analyze the structural model to test the hypotheses(Guenther *et al.*, 2023). The push factor of maintenance cost (β = 0.275, P = 0.000) was found to positively influence the switching intention towards electric autorickshaws, thereby supporting H1. However, perceived benefit (β = -0.099, P = 0.100) did not significantly impact switching intention, indicating that H2 is not supported.

Among the pull factors, perceived health outcome (β = 0.246, P = 0.000), hedonic gratification (β = 0.196, P = 0.008), and the availability of charging stations (β = 0.214, P = 0.008) positively impacted switching intention, thus supporting H3, H4, and H5. Regarding mooring factors, addressing range anxiety (β = 0.123, P = 0.020) positively influenced switching intention, supporting H6 (Table V). Conversely, the analysis revealed that the moderator of government incentives (β = 0.017, P = 0.747) did not strengthen the relationship between switching intention and continued usage intention, indicating that H7 is not supported. Figure II illustrates the results of the conceptual model.Additionally, the mediating factor of switching intention had a positive effect on continued usage intention (β = 0.343, P = 0.000). Detailed mediation results are shown in Table VI.

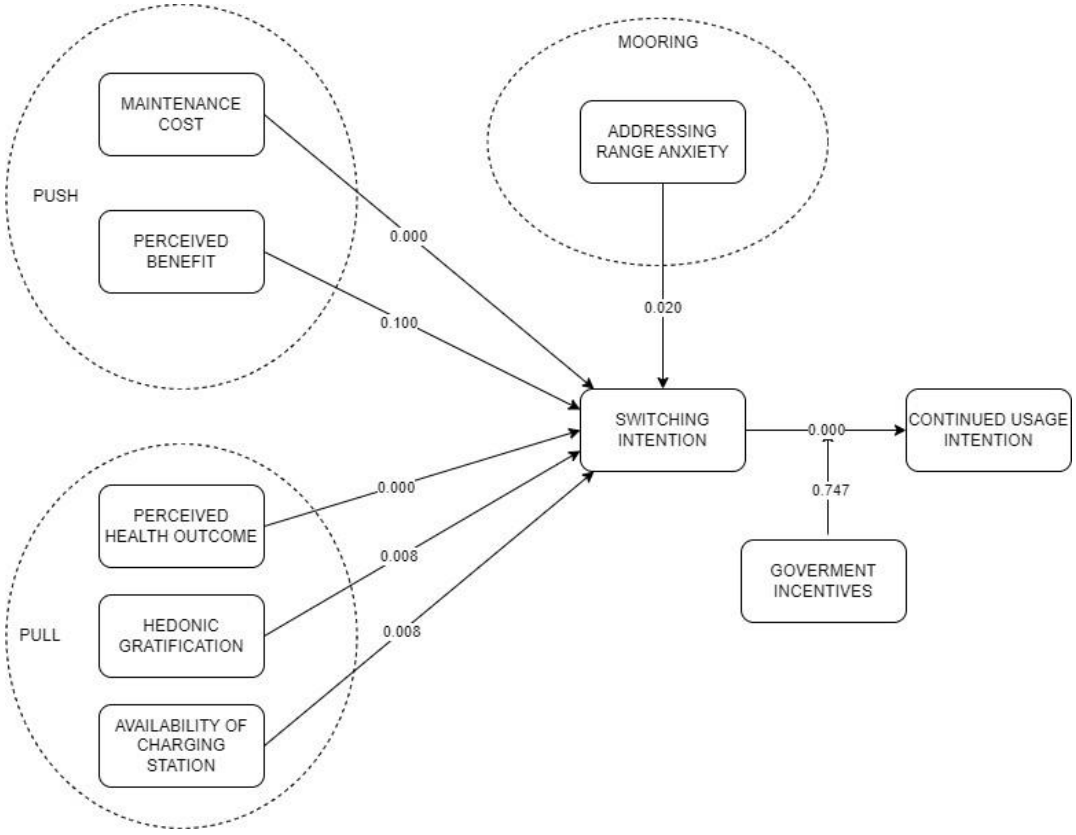

Figure II. Results of the conceptual model

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
ARA → SI	0.123	0.129	0.053	2.322	0.020	Supported
ACS → SI	0.214	0.209	0.081	2.645	0.008	Supported
GI → CUI	0.465	0.463	0.060	7.748	0.000	Supported
HG → SI	0.196	0.200	0.074	2.652	0.008	Supported
MC → SI	0.275	0.276	0.061	4.482	0.000	Supported
PB → SI	-0.099	-0.094	0.060	1.643	0.100	Not Supported
PHO → SI	0.246	0.242	0.067	3.664	0.000	Supported
SI → CUI	0.343	0.339	0.054	6.324	0.000	Supported

Government Incentives x Switching Intention → Continued Usage Intention	0.017	0.025	0.052	0.322	0.747	Not Supported

Table V. Results of hypotheses tested

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
PHO→ SI → CU	0.085	0.082	0.025	3.396	0.001	Supported
ARA → SI → CU	0.042	0.044	0.020	2.155	0.031	Supported
ACS →SI → CU	0.073	0.071	0.030	2.424	0.015	Supported
HG → SI → CU	0.067	0.068	0.029	2.332	0.020	Supported
MC → SI → CU	0.094	0.094	0.027	3.468	0.001	Supported
PB → SI → CU	-0.034	-0.033	0.022	1.549	0.121	NotSupported

Table VI. Mediation result

6.Conclusion and Discussion

According to the World Air Quality Report, India significantly contributes to air pollution, with transportation being a major factor. This highlights the urgent need to shift towards green transport solutions. In response, Indian policymakers are actively formulating and implementing strategies to reduce emissions, with electric vehicles (EVs) becoming a central component of the global goal for zero-emission mobility (Veitch and Rhodes, 2024). Within the realm of public transportation, electric autorickshaws are particularly important for a developing nation like India, with government initiatives playing a key role in their introduction. Understanding drivers' perceptions and reactions to these vehicles is essential. This study, focusing on Kerala as a case study, utilized the integrated PPM-ECT framework to examine the factors that influence drivers' intentions to transition to electric autorickshaws and how these intentions affect their continued usage. The research addresses a gap in knowledge regarding consumer behavior in EV adoption within public transport. The integrated model identified six significant pathways out of eight, emphasizing the key determinants of switching intentions and their influence on ongoing usage.

Our study underscores a significant correlation between maintenance costs and the inclination to switch to electric autorickshaws. Aligned with previous research findings, we found that heightened awareness of maintenance costs encourages drivers to switch to electric autorickshaws due to their lower maintenance expenses(Rabinowitz *et al.*, 2023).Interestingly, this concern about maintenance costs is more pronounced among Gen X drivers compared to millennials, likely due to their extensive experience with conventional autorickshaws. These findings indicate the necessity for age-specific communication strategies that highlight the unique advantages of electric autorickshaws, ensuring the message resonates with different age groups.

In contrast, the findings revealed a negative association between perceived benefit and the intention to switch to electric autorickshaws, suggesting that drivers are not motivated by the permit advantages. Despite these vehicles offering reduced permit fees, tax exemptions, and income tax reductions, they are perceived as more cost-effective compared to traditional fuel-powered autorickshaws. Additionally, electric autorickshaws may receive special permits or exemptions from certain fees and restrictions applicable to conventional vehicles; however, the government has not fully announced or clarified these permit benefits, leaving many drivers unaware of these potential advantages (Sajjad *et al.*, 2020).The results indicate that emphasizing the financial and regulatory incentives alone may not be sufficient to promote the adoption of electric autorickshaws across different demographic groups.

The hypothesis posits that perceived health outcomes positively impact the intention to switch to electric autorickshaws. This stems from the reduced noise and vibration levels of electric vehicles, which can prevent musculoskeletal issues and improve overall driver comfort. Additionally, the smoother driving experience provided by electric autorickshaws enhances comfort during travel. Drivers also notice that in tourist areas, visitors increasingly prefer electric autorickshaws due to the smoother travel experience compared to conventional autorickshaws. As drivers become more aware of these health and comfort benefits, they are more likely to consider transitioning from conventional fuel-powered autorickshaws to electric ones.

The hypothesis suggests that hedonic gratification positively influences the intention to switch to electric autorickshaws. Hedonic gratification refers to the pleasure and satisfaction users experience from the vehicle. This includes various aspects such as enhanced comfort, enjoyment, and an overall positive emotional response. Users report greater comfort due to reduced acceleration vibrations in electric autorickshaws compared to conventional fuel-powered models, leading to increased satisfaction and a stronger preference for electric options (Dickinger *et al.*, 2008). Our findings indicate that individuals who experience this heightened comfort are less likely to return to traditional models, thus favoring the continued use of electric vehicles. This highlights the importance of hedonic gratification in influencing drivers' preferences and its role in the adoption of electric transportation.

Our study reveals a significant positive correlation between the availability of charging stations and the intention to switch to electric autorickshaws. Specifically, respondents located within 5 kilometers of a charging facility were 45% more likely to express a desire to switch compared to those without such proximity. This is feasible primarily in urban areas where charging infrastructure is more readily available. This emphasizes the crucial importance of infrastructure, as convenient charging facilities notably improve the likelihood of switch to electric autorickshaws. As cities expand their charging networks, the importance of supportive infrastructure becomes clear, fostering a 30% increase in electric autorickshaws adoption rates over the past two years alone(Ahmad *et al.*, 2022). These findings underscore the critical need for urban planning to prioritize accessible charging infrastructure to accelerate electric vehicle adoption.

Moreover, the study highlights the critical impact of addressing range anxiety on the switching to electric autorickshaws for daily transportation. Range anxiety, stemming from drivers' overestimation of their actual range needs, significantly influences switching decisions. Educating consumers about the capability of electric autorickshaws to meet daily transportation needs is crucial for boosting electric autorickshaws adoption rates. Previous research underscores that technological advancements and increased driving ranges effectively alleviate range anxiety, thereby promoting broader acceptance of electric autorickshaws(Guo *et al.*, 2024). Our findings emphasize the importance of these factors in shaping drivers' perceptions and intentions towards adopting and switching to electric autorickshaws. Effective strategies to mitigate range anxiety through education and technological improvements are essential for accelerating the widespread use of the product in urban environments.

Additionally, our research findings reveal that there is no significant moderating effect between switching intention and continued usage intention, indicating that hypothesis H7 is not supported. Despite available incentives such as subsidized training, priority parking, vehicle upgrades, insurance reductions, and emergency roadside assistance, they remain underutilized due to driver unawareness, complex application procedures, and ineffective governmental implementation(Gungor *et al.*, 2019). Consequently, drivers fail to fully realize these benefits, while manufacturers primarily benefit during production. Thus, enhancing execution and dissemination is crucial to effectively promote the adoption of electric autorickshaws, despite a robust policy framework.Lastly we identify a mediating effect where initial switching intentions positively predict continued usage intentions among electric autorickshaw users(M Ayyoub *et al.*,

2023). This finding aligns with prior research on adoption behavior, highlighting the pathway through which switching intentions shape long-term usage patterns(Hong *et al.*, 2006)(Obeid *et al.*, 2024)(Gupta *et al.*, 2021). These insights underscore the necessity of fostering clear intentions for future electric autorickshaw usage.

7.Theoretical implications

This study offers several significant theoretical contributions. Firstly, it addresses the need for in-depth research on electric vehicles within the context of emerging green technologies, with a specific focus on the intentions to switch to electric autorickshawsan area that has recently attracted increased scholarly interest. Furthermore, this study establishes a foundation for future research that uses user-generated content to explore not only the drivers of switching intentions but also the factors that influence continued usage. The transition from fuel-powered to electric autorickshaws can offer users greater comfort and financial advantages, making it crucial to understand the underlying reasons for this shift.While existing literature primarily focuses on the switching intentions towards electric vehicles in general,(Yuniaristanto *et al.*, 2024)(Murugan and Marisamynathan, 2022)(Donmez-turan, 2020)it does not specifically address public three-wheeler passenger vehicles, or electric autorickshaws. This study contributes to the literature by offering a detailed understanding of the drivers behind the switching behavior to electric autorickshaws and identifying unique variables that influence drivers' decisions to make the switch. By delving into drivers' switching behaviors towards electric autorickshaws, this study offers a nuanced understanding and identifies unique variables influencing these decisions. Furthermore, while previous research emphasizes sustainable knowledge(Jaiswal *et al.*, 2022), government policies(Mensah *et al.*, 2020), facilitating conditions(Korkmaz *et al.*, 2022), and vehicle performance in private electric vehicle purchases, this study reveals that financial benefits, addressing range anxiety andhealth outcomeplay pivotal roles in driving intentions towards electric autorickshaws. In summary, this research contributes by elucidating key factors influencing the decision to switch to electric autorickshaws, underscoring factors that drive and inhibit this transition, thereby addressing the primary research question comprehensively.

Secondly, this study integrates the PPM model with the Extended Expectation Confirmation Model to explore the drivers' continued usage intentions of electric autorickshaws. Existing research has primarily focused on factors influencing the initial adoption of electric vehicles in general(Singh *et al.*, 2020), whereas this study specifically investigates drivers' intentions to continue using electric autorickshaws and the underlying motivations behind this behavior. Furthermore, considering the moderating role of government incentives provides nuanced insights into the dynamics prompting individuals to switch and how these incentives influence their continued usage intention after making the switch. By examining push, pull, and mooring factors within this framework, the research provides a comprehensive understanding of the decision-making processes involved in sustaining the use of electric autorickshaws.As a result, this research effectively addresses the RQ2 by elucidating the factors influencing drivers' intentions to continue using electric autorickshaws and providing insights into the decision-making dynamics.

8.Practical implications

Our research offers various practical insights and implications for stakeholders within the electric autorickshaw sector. Firstly, our findings reveal that factors such as maintenance costs, perceived benefits like permit advantages, addressing range anxiety, perceived health outcomes, hedonic gratification, and the availability of charging stations significantly influence drivers' intentions to switch to electric autorickshaws and their continued usage intentions. Policymakers can utilize these insights to develop incentive programs that highlight financial savings, specifically targeting drivers by directly communicating precise government incentives to them. Although the government is implementing various initiatives, these efforts often fail to reach the drivers, with benefits instead being absorbed by manufacturers and showroom services, leaving drivers unaware of the intended advantages. Additionally, investing in charging infrastructure and ensuring the widespread availability of charging stations can alleviate range anxiety, making the transition to electric vehicles more appealing. These efforts can indirectly foster the broader adoption of environmentally friendly transport options among drivers, thereby contributing to sustainable urban mobility(Wu *et al.*, 2019).

Secondly, to foster the sustained usage of electric autorickshaws among drivers, industry players can leverage our study's findings to enhance the overall user experience and mitigate potential challenges. Providing comprehensive training programs on the operation and maintenance of electric autorickshaws would empower drivers with necessary skills and

confidence, thereby reducing concerns about vehicle handling and upkeep. Industry stakeholders can also utilize these insights to develop user-friendly interfaces and support systems that cater specifically to the needs and preferences of autorickshaw drivers transitioning to electric vehicles.By proactively addressing these aspects, such as enhancing the user experience through comprehensive training and infrastructure development, industry stakeholders can effectively build trust and satisfaction among both drivers and passengers regarding the reliability and benefits of electric autorickshaws. This holistic approach not only enhances the attractiveness of electric autorickshaws but also contributes significantly to the broader adoption of sustainable transportation solutions. It fosters public confidence in eco-friendly technologies, thereby promoting a more sustainable and environmentally conscious transportation ecosystem overall(Hong *et al.*, 2017).

9.Limitations and future research

Several limitations in our research could suggest avenues for future exploration. First, the cross-sectional design of the study provides insights into drivers' intentions at a specific point in time. Future studies could conduct longitudinal research to track drivers' adoption and continued usage of electric autorickshaws over time. Additionally, such longitudinal research could help to distinguish between short-term and long-term determinants of adoption(Henry *et al.*, 2024), offering deeper insights into the sustainability of electric autorickshaw usage.Second, this study focuses exclusively on adoption patterns in Kerala. Future research could explore adoption rates across different regions with varying levels of infrastructure development and policy support to identify contextual factors influencing adoption(Mishra *et al.*, 2021). Third, as electric autorickshaws are still in the very initial phase, this study serves as an initial exploration. Future studies could build on this foundation to examine the topic in a more advanced and comprehensive manner.Addressing these limitations through future research will provide a more holistic understanding of the factors influencing the switching and sustained usage of electric autorickshaws.

Disclosure statement

The authors reported no potential conflict of interest.

Declaration of generative AI in scientific writing

During the preparation of this work, we the authors used Chat GPT in order to language refinement. After using this tool, we the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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