Adoption of Electric Vehicles in Kathmandu Valley

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Abstract

This study examines the adoption of electric vehicles in Kathmandu Valley. Adoption of electric vehicles is the dependent variable. The selected independent variables are price of electric vehicles, environmental awareness, financial incentives, reliability of EVs and charging facility. The primary source of data is used to assess the opinion of respondents regarding price of electric vehicles, environmental awareness, financial incentives, reliability of EVs, charging facility and adoption of vehicles. The study is based on primary data of 131 respondents. To achieve the purpose of the study, structured questionnaire is prepared. The correlation and multiple regression models are estimated to test the significance and importance of the adoption of electric vehicles in Kathmandu Valley.

The study showed a positive impact of price of electric vehicles on adoption of electric vehicles. It indicates that affordable price of electric vehicles leads to influence adoption of electric vehicles. Similarly, the study showed a positive impact of environment awareness on adoption of electric vehicles. It indicates that increase in awareness of electric vehicles lead to increase in adoption of electric vehicles. Likewise, the study showed a positive impact of financial incentives on adoption of electric vehicles. It indicates that financial incentives provided from government level leads to increase in adoption of electric vehicles. Further, the study showed a positive impact of reliability of EVs on adoption of electric vehicles. It indicates that higher the reliability of EVs, higher would be the adoption of electric vehicles. In addition, the study showed a positive impact of charging facility on adoption of electric vehicles. It indicates that availability of charging facility leads to increase in adoption of electric vehicles.

Keywords: price of electric vehicles, environmental awareness, financial incentives, reliability of EVs, charging facility, adoption of vehicles

1. Introduction

The adoption of Electric Vehicles (EVs) is a crucial step toward reducing greenhouse gas emissions, minimizing dependence on fossil fuels, and promoting sustainable transportation. EVs offer significant environmental and economic benefits, such as zero tailpipe emissions, lower operational costs, and compatibility with renewable energy sources (Egbue and Long, 2012). The adoption of electric vehicles (EVs) is increasingly recognized as a vital strategy for cities aiming to reduce greenhouse gas emissions, improve air quality, and transition to sustainable urban mobility. EVs, with their zero tailpipe emissions and compatibility with renewable energy sources, offer a promising alternative to conventional vehicles powered by fossil fuels (Bakker and Trip, 2013). The adoption of electric vehicles (EVs) has emerged as a significant strategy to combat climate change and reduce greenhouse gas emissions (Tran *et al.,* 2012). The adoption of electric vehicles (EVs) has become a critical area of scholarly research, reflecting the growing interest in sustainable transportation solutions. Despite the significant body of research, there has been a lack of comprehensive reviews that synthesize and integrate these findings (Kumar and Alok, 2020). Lim *et al.* (2015) argued mass adoption of electric vehicles (EVs) is heavily influenced by consumer behavior, particularly concerns like range anxiety and resale anxiety. Range anxiety refers to the fear that an EV's driving range may not meet a consumer's needs, while resale anxiety involves concerns about the rapid depreciation of EVs' resale value. The reviews include global EV adoption and charging station business models, highlighting their potential application in

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Brazil. Promising approaches, such as EV sharing, offer advantages like affordable access to advanced technology, reduced traffic congestion, and user convenience by eliminating concerns about charging and maintenance (Bitencourt *et al*., 2023).

Daziano and Chiew (2012) examined the electric vehicles rising from the dead: Data needs for forecasting consumer response toward sustainable energy sources in personal transportation. The study revealed that data-driven forecasting of consumer preferences, identifying economic, environmental and technological factors influencing electric vehicle adoption for sustainable personal transportation. Similarly, Mohseni and Stevie (2009) assessed electric vehicles: Holy Grail or fool's gold. The study concluded that EVs could be a "holy grail" for sustainable transportation but require significant effort and investment to achieve their full potential. Likewise, Ruoso and Ribeiro (2022) analyzed the influence of countries' socioeconomic characteristics on the adoption of electric vehicle. The study concluded that tailored policy frameworks that consider a country's unique socioeconomic context are essential for fostering the adoption of EVs on a global scale. Further, Becker *et al.* (2009) assessed the electric vehicles in the United States: A new model with forecasts to 2030. The study emphasized that policy incentives, battery advancements, charging infrastructure and collaboration are key drivers for widespread U.S. electric vehicle adoption by 2030. In addition, Sahoo *et al.* (2022) investigated the consumer motives and attitude towards adoption of electric vehicles in India: Policy implications for stakeholders. The study found that environmental concerns, cost savings, and technology appeal are primary motives that influencing Indian consumers' positive attitudes toward electric vehicle adoption.

Franke and Krems (2013) analyzed interacting with limited mobility resources: Psychological range levels in electric vehicle use. The study concluded that most users are satisfied with the range, utilizing 75-80% of available range comfortably and that certain psychological traits positively influenced range satisfaction and utilization. Similarly, Ahmed *et al.* (2021) examined the role of artificial intelligence in the mass adoption of electric vehicles. The study showed that AI plays a significant role in overcoming adoption barriers by optimizing EV performance, improving charging efficiency and facilitating smart grid integration thereby increasing the viability and appeal of EVs. Likewise, Langbroek *et al.* (2016) explored the effect of policy incentives on electric vehicle adoption. The study concluded that access to charging infrastructure, adjacency to major cities and higher regional incomes have the strongest predictive power for BEV sales while incentives like toll exemptions and bus lane access showed limited statistical significance at the municipal level, possibly due to spillover effects from nearby major cities.

He and Zhan (2018) investigated how to activate moral norm to adopt electric vehicles in china? An empirical study based on extended norm activation theory. The study concluded that personal norms positively influence EV adoption intention. Similarly, De Rubens *et al.* (2020) analyzed the market case for electric mobility: investigating electric vehicle business models for mass adoption. The study showed that the unfavorable business case for EVs driven by outdated industry practices and market structures, impedes their widespread adoption. Likewise, Goncearuc *et al.* (2024) assessed the barriers to widespread adoption of vehicle-to-grid: A comprehensive review. The study revealed that addressing these barriers systematically is essential for the widespread adoption of V2G technology, which can unlock energy flexibility and support sustainable energy systems. Further, Habib *et al.* (2018) investigated the comprehensive study of implemented international standards, technical challenges, impacts and prospects for electric vehicles. The study concluded that

EVs significantly contribute to greener transportation and climate change mitigation, their massive deployment presents challenges such as grid strain, infrastructural inadequacies, and standardization issues. In addition, Alanazi (2023) examined the electric vehicles: Benefits, challenges and potential solutions for widespread adaptation. The study concluded that EV adoption can significantly reduce carbon emissions and air pollution but faces challenges such as limited infrastructure and range anxiety.

Muratori *et al.* (2021) investigated the rise of electric vehicles-2020 status and future expectations. The study highlighted a positive outlook for EV adoption driven by advancements in technology, infrastructure and supportive policies while identifying technology, regulatory, societal and business-model barriers that need to be addressed to facilitate a global transition to sustainable transportation solutions. Similarly, Yong *et al.* (2015) examined the review on the state-of-the-art technologies of electric vehicle its impacts and prospects. The study concluded that EV adoption offers substantial environmental and economic benefits. Likewise, Shetty *et al.* (2020) investigated the barriers to widespread adoption of plug-in electric vehicles in emerging Asian markets: An analysis of consumer behavioral attitudes and perceptions. The study found that economic benefits, functional attributes and consumer awareness significantly impact EV purchase behavior. Further, Singh *et al.* (2020) analyzed the review and simple meta-analysis of factors influencing adoption of electric vehicles. The study concluded that factors influencing EV adoption has grown significantly in the past decade, providing insights into key determinants and theoretical models.

In the context of Nepal, Adhikari *et al.* (2020) analyzed identification and analysis of barriers against electric vehicle use. The study concluded that the framework is a robust tool for evaluating EV adoption challenges and can be adapted for use in other countries, considering their specific contexts. Similarly, Yadav *et al.* (2024) examined enhancing urban mobility: Comparative analysis of improvement priorities for conventional and electric buses in Kathmandu city. The study showed that addressing these attributes can enhance rider satisfaction and support the broader goals of urban livability and sustainable transportation systems. Likewise, Sapkota *et al.* (2021) assessed the business model for financially sustainable electric vehicle charging station using EV charging financial analysis tool. The study concluded that collaboration among stakeholders and integration of indirect revenue sources alongside government subsidies are critical for the successful adoption and sustainability of EV charging stations in Nepal. Further, Paudel *et al.* (2019) analyzed the effect of policies, vehicle attributes and charging infrastructure on electric vehicles diffusion in Kathmandu Valley of Nepal. The study revealed that the developed EV diffusion model, tailored to Nepal's social structure, effectively predicts market growth and provides actionable insights for promoting EV adoption through targeted policies and infrastructure development.

The above discussion shows that empirical evidence vary greatly across the studies on the adoption of electric vehicles. Though there are above mentioned empirical evidence in the context of other countries and in Nepal, no such findings using more recent data exist in the context of Nepal. Therefore, in order to support one view or the other, this study has been conducted.

The major objective of this study is to examine the adoption of electric vehicles in Kathmandu Valley. Specifically, it examines the relationship of price of electric vehicles, environmental awareness, financial incentives, reliability of EVs and charging facility with

adoption of electric vehicles in Kathmandu Valley.

The remainder of this study is organized as follows: section two describes the sample, data, and methodology. Section three presents the empirical results and final section draws the conclusion.

2. Methodological aspects

The study is based on the primary data which were collected from 131 respondents through questionnaires. The study employed convenience sampling method. The respondents' views were collected on price of electric vehicles, environmental awareness, financial incentives, reliability of EVs, charging facility and adoption of electric vehicles. This study is based on descriptive as well as causal comparative research designs.

The model

The model used in this study assumes that adoption of electric vehicles depends upon price of electric vehicles**,** environmental awareness**,** financial incentives**,** reliability of electric vehicles and charging facility**.** Therefore, the model takes the following form:

Adoption of electric vehicles = *f* (price of electric vehicles**,** environmental awareness**,** financial incentives**,** reliability of electric vehicles**,** and charging facility)

More specifically,

$AEV = \beta_0 + \beta_1 PEV + \beta_2 EA + \beta_3 FI + \beta_4 FI + \beta_5 CF + e$

Where,

AEV = Adoption of electric vehicles

PEV = Price of electric vehicles

EA = Environmental awareness

FI = Financial incentives

REV = Reliability of electric vehicles

CF = Charging facility

Adoption of electric vehicles was measured using a 5-point Likert scale where the respondents were asked to indicate the responses using 1 for strongly disagree and 5 for strongly agree. There are 5 items and sample items include "Adoption of electric vehicles depends on price of electric vehicles", "Financial incentives affect adoption of electric vehicles" and so on. The reliability of the items was measured by computing the Cronbach's alpha ($\alpha = 0.852$).

Price of electric vehicles were measured using a 5-point Likert scale where the respondents were asked to indicate the responses using 1 for strongly disagree and 5 for strongly agree. There are 5 items and sample items include "The price significantly impacts adoption and decision-making process", "Price plays valuable insights and advice regarding adoption options" and so on. The reliability of the items was measured by computing the Cronbach's alpha ($\alpha = 0.790$).

Environmental awareness was measured using a 5-point Likert scale where the

respondents were asked to indicate the responses using 1 for strongly disagree and 5 for strongly agree. There are 5 items and sample items include "Environmental awareness heavily influence choice of adopting electric vehicles", "I believe that environment plays a significant role in decision-making process" and so on. The reliability of the items was measured by computing the Cronbach's alpha ($\alpha = 0.800$).

Financial incentives were measured using a 5-point Likert scale where the respondents were asked to indicate the responses using 1 for strongly disagree and 5 for strongly agree. There are 5 items and sample items include "I consider incentives when deciding on adoption of electric vehicles", "I believe financial incentives lead to fulfilling buying behavior" and so on. The reliability of the items was measured by computing the Cronbach's alpha ($\alpha = 0.887$).

Reliability of electric vehicles were measured using a 5-point Likert scale where the respondents were asked to indicate the responses using 1 for strongly disagree and 5 for strongly agree. There are 5 items and sample items include "Reliability is important to me when considering adoption of electric vehicles", "I would prioritize reliability over adoption of electric vehicles" and so on. The reliability of the items was measured by computing the Cronbach's alpha ($\alpha = 0.854$).

Charging facility was measured using a 5-point Likert scale where the respondents were asked to indicate the responses using 1 for strongly disagree and 5 for strongly agree. There are 5 items and sample items include "Charging' opinions heavily influence my adoption decisions", "I make adoption decisions-based charging facility, regardless of peer opinions" and so on. The reliability of the items was measured by computing the Cronbach's alpha ($\alpha = 0.836$).

The following section describes the independent variables used in this study along with the hypothesis formulation.

Price of electric vehicles

The price of electric vehicles (EVs) refers to the cost associated with purchasing an electric vehicle, including its base price, additional features, and the costs related to ownership such as charging infrastructure, maintenance, and potential government incentives or subsidies. Soltani-Sobh *et al.* (2017) examined the electric vehicles adoption over the United States. The study indicated that higher electricity prices have a discouraging effect on EV adoption. Similarly, Zhou e*t al.* (2021) investigated the motivational mechanism behind taxi driver's adoption of electric vehicles for living: Insights from China. The study concluded that the price of EVs significantly influences the adoption decisions of taxi drivers. Likewise, Kurniawan and Sidi (2024) assessed the role of environmental awareness, innovation and price in encouraging interest in buying electric vehicles. The study revealed a positive perception of the price of electric vehicles is a critical factor in increasing their adoption. Based on it, this study develops the following hypothesis:

H_1: There is a positive relationship between price of electric vehicles and adoption of electric vehicles.

Environmental awareness

Environmental awareness refers to how much consumers understand and value the ecological benefits of adopting EVs. Moyo and Masuku (2018) examined the effects of

environmental knowledge and awareness on the purchase intention of new energy vehicles in the Southern part of China. The study indicated that environmental awareness plays a significant role in influencing the purchase intention of New Energy Vehicles. Similarly, Malik and Sharma (2022) assessed the role of community college and student responses towards awareness on electric vehicles as a solution to environmental problems. The study revealed that higher environmental awareness could potentially lead to greater demand for EVs. Based on it, this study develops the following hypothesis:

H_2: There is a positive relationship between environmental awareness and adoption of electric vehicles.

Financial incentives

Financial incentives refer to monetary rewards or benefits provided to encourage a particular behavior or action. Zhang *et al.* (2014) examined the policy incentives for the adoption of electric vehicles across countries. The study indicated that effective policies particularly financial incentives are crucial for promoting the adoption of electric vehicles. Similarly, Meisel and Merfeld (2018) assessed the economic incentives for the adoption of electric vehicles: A classification and review of e-vehicle services. The study concluded that policy measures should go beyond direct subsidies and include support for service-based models that maximize the economic potential of EVs. Likewise, Shah (2022) analyzed the financial incentives for promotion of electric vehicles in India-an analysis using the environmental policy framework. The study revealed that financial incentives are a significant factor in promoting the adoption of electric vehicles (EVs) in India. Based on it, this study develops the following hypothesis:

H_3: There is a positive relationship between financial incentives and adoption of electric vehicles.

Reliability of EVs

The reliability of electric vehicles (EVs) refers to how consistently and dependably an EV performs over time, especially in comparison to traditional internal combustion engine (ICE) vehicles. Alotaibi *et al.* (2022) examined the identification of potential barriers to electric vehicle adoption in oil-producing nations: The case of Saudi Arabia. The study indicated that the adoption of electric vehicles (EVs) in Saudi Arabia is significantly influenced by reliability concerns. Similarly, Pamidimukkala *et al.* (2023) assessed the adoption of electric vehicles: A state-of-art review. The study concluded that reliability of electric vehicles (EVs) specifically regarding driving range, battery life and access to reliable charging infrastructure are a critical determinant of EVs adoption. Likewise, Fesli and Özdemir (2024) investigated the comprehensive review of technologies, integration, adoption, and optimization. The study revealed that the reliability of electric vehicles (EVs) particularly in relation to charging infrastructure, battery life and integration with power systems are fundamental factor influencing their adoption. Based on it, this study develops the following hypothesis:

H_4: There is a positive relationship between reliability of EVs and adoption of electric vehicles.

Charging facility

A charging facility refers to a location or infrastructure where electric vehicles (EVs) can be recharged. Li *et al.* (2020) indicated that the availability and accessibility of charging

facilities are crucial factors in the adoption of electric vehicles (EVs). Similarly, Murugan *et al.* (2022) investigated the influencing factors to adopt public electric vehicle charging facility at existing fueling station: A study based on users perceptive. The study concluded that the presence and accessibility of charging infrastructure are pivotal in boosting consumer confidence and willingness to adopt electric vehicles (EVs). Likewise, Choi *et al.* (2023) revealed that the availability and expansion of charging infrastructure particularly public charging stations play a significant role in driving the adoption of electric vehicles (EVs). Based on it, this study develops the following hypothesis:

H_5: There is a positive relationship between charging facility and adoption of electric vehicles.

3. Results and discussion

Correlation analysis

On analysis of data, correlation analysis has been undertaken first and for this purpose, Kendall's Tau correlation coefficients along with mean and standard deviation has been computed and the results are presented in Table 1.

Table 1

Kendall's Tau correlation coefficients matrix

This table presents Kendall's Tau coefficients between dependent variable and independent variables. The correlation coefficients are based on 131 observations. The dependent variable is AEV (Adoption of electric vehicles). The independent variables are PEV (Price of electric vehicles), EA (Environment awareness), FI (Financial incentives), REV (Reliability of EVs) and CF (Charging facility).

Variables	Mean	S.D.	AEV	PEV	EA	FI	REV	CF
AEV	4.104	0.719	1					
PEV	3.973	0.722	0.527**	1				
EA	3.928	0.665	0.575**	0.571**	1			
FI	4.006	0.718	0.695**	0.618**	0.564**	1		
REV	3.968	0.705	0.644**	0.494**	0.557**	0.631**	1	
CF	4.026	0.632	0.502**	0.581**	0.562**	0.491**	0.495**	1

Notes: The asterisk signs (**) and (*) indicate that the result are significant at one percent and five percent levels respectively.

Table 1 shows the Kendall's Tau correlation coefficients of dependent and independent variables. The study shows that price of electric vehicles is positively correlated to adoption of electric vehicles. It indicates that affordable price of electric vehicles leads to influence adoption of electric vehicles. Similarly, environment awareness is positively correlated to adoption of electric vehicles. It indicates that increase in awareness of electric vehicles lead to increase in adoption of electric vehicles. Likewise, financial incentives is positively correlated to adoption of electric vehicles. It indicates that financial incentives provided from government level leads to increase in adoption of electric vehicles. Further, reliability of EVs is positively correlated to adoption of electric vehicles. It indicates that higher the reliability of EVs, higher would be the adoption of electric vehicles. In addition, charging facility is positively correlated to adoption of electric vehicles. It indicates that availability of charging facility leads to increase in adoption of electric vehicles.

Regression analysis

Having indicated the Kendall's Tau correlation coefficients, the regression analysis has been carried out and the results are presented in Table 2. More specifically, it shows the regression results of price of electric vehicles, environmental awareness, financial incentives, reliability of electric vehicles and charging facility on adoption of electric vehicles in Kathmandu Valley.

Table 2

Estimated regression results of price of electric vehicles, environmental awareness, financial incentives, reliability of electric vehicles and charging facility on adoption of electric vehicles

The results are based on 131 observations using linear regression model. The model is $A = \beta_0 + \beta_1 PEV + \beta_2 EA + \beta_3 FI + \beta_4 REV + \beta_5 CF + e$ where the dependent variable is AEV (Adoption of electric vehicles). The independent variables are PEV (Price of electric vehicles), EA (Environment awareness), FI (Financial incentives), REV (Reliability of EVs) and CF (Charging facility).

Models	Intercepts	Regression coefficients of					Adj.R^2_bar	SEE	F-value
		PEV	EA	FI	REV	CF			
1	1.103 (4.784)**	0.755 (13.229)**					0.572	0.470	175.019
2	0.868 (3.535)**		0.824 (13.370)**				0.578	0.467	178.751
3	1.140 (4.720)**			0.740 (12.469)**			0.543	0.486	155.465
4	1.006 (4.320)**				0.781 (13.511)**		0.583	0.464	182.547
5	0.708 (2.587)**					0.843 (12.556)**	0.546	0.484	157.646
6	0.603 (2.601)**	0.417 (4.978)**	0.470 (5.163)**				0.643	0.429	118.244
7	0.347 (1.536)	0.255 (2.919)**	0.375 (4.247)**	0.318 (4.247)**			0.686	0.403	95.610
8	0.216 (0.995)	0.241 (2.899)**	0.264 (2.974)**	0.170 (2.110)*	0.306 (3.797)**		0.716	0.383	82.889
9	0.025 (0.110)	0.140 (1.609)	0.185 (2.063)*	0.149 (1.896)	0.300 (3.848)**	0.263 (3.053)**	0.733	0.371	72.554

Notes:

i. Figures in parenthesis are t-values.
ii. The asterisk signs (**) and (*) indicate that the results are significant at one percent and five percent level respectively.
iii. Adoption of electric vehicles is the dependent variable.

Table 2 shows that the beta coefficients for price are positive with adoption of electric vehicles. It indicates that price of electric vehicles has a positive impact on adoption of electric vehicles. This finding is consistent with the findings of Zhou e*t al.* (2021). Similarly, the beta coefficients for environmental awareness are positive with adoption of electric vehicles. It indicates that environmental awareness has a positive impact on adoption of electric vehicles. This finding is consistent with the findings of Moyo and Masuku (2018). Likewise, the beta coefficients for financial incentives are positive with adoption of electric vehicles. It indicates that financial incentives have positive impact on adoption of electric vehicles. This finding is consistent with the findings of Zhang *et al.* (2014). Further, the beta coefficients for reliability of EVs are positive with adoption of electric vehicles. It indicates that reliability of EVs have positive impact on adoption of electric vehicles. This finding is consistent with the findings

of Alotaibi *et al.* (2022). In addition, the beta coefficients for charging facility are positive with adoption of electric vehicles. It indicates that charging facility has a positive impact on adoption of electric vehicles. This finding is similar to the findings of Choi *et al.* (2023).

4. Summary and conclusion

Adoption of electric vehicles (EVs) is a crucial factor in promoting sustainable transportation, reducing carbon emissions, and enhancing environmental consciousness. Various elements influence the adoption of EVs, including the availability of charging infrastructure, government incentives, vehicle reliability, and affordability. A well-established charging network significantly contributes to the adoption of EVs. When individuals feel confident in the accessibility and convenience of charging facilities, they are more likely to transition to EVs. Reliable infrastructure, combined with financial incentives such as subsidies and tax benefit, promotes EV adoption by reducing barriers and fostering a sense of trust and long-term feasibility in sustainable transportation solutions.

This study attempts to examine the adoption of electric vehicles in Kathmandu Valley. The study is based on primary data of 131 respondents.

The major conclusion of the study is that price of electric vehicles, environmental awareness, financial incentives, reliability of EVs and charging facility have positive impact on adoption of electric vehicles. The study also concludes that environmental awareness followed by reliability of EVs is the most influencing factors that influence the adoption of electric vehicles in Kathmandu Valley.

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