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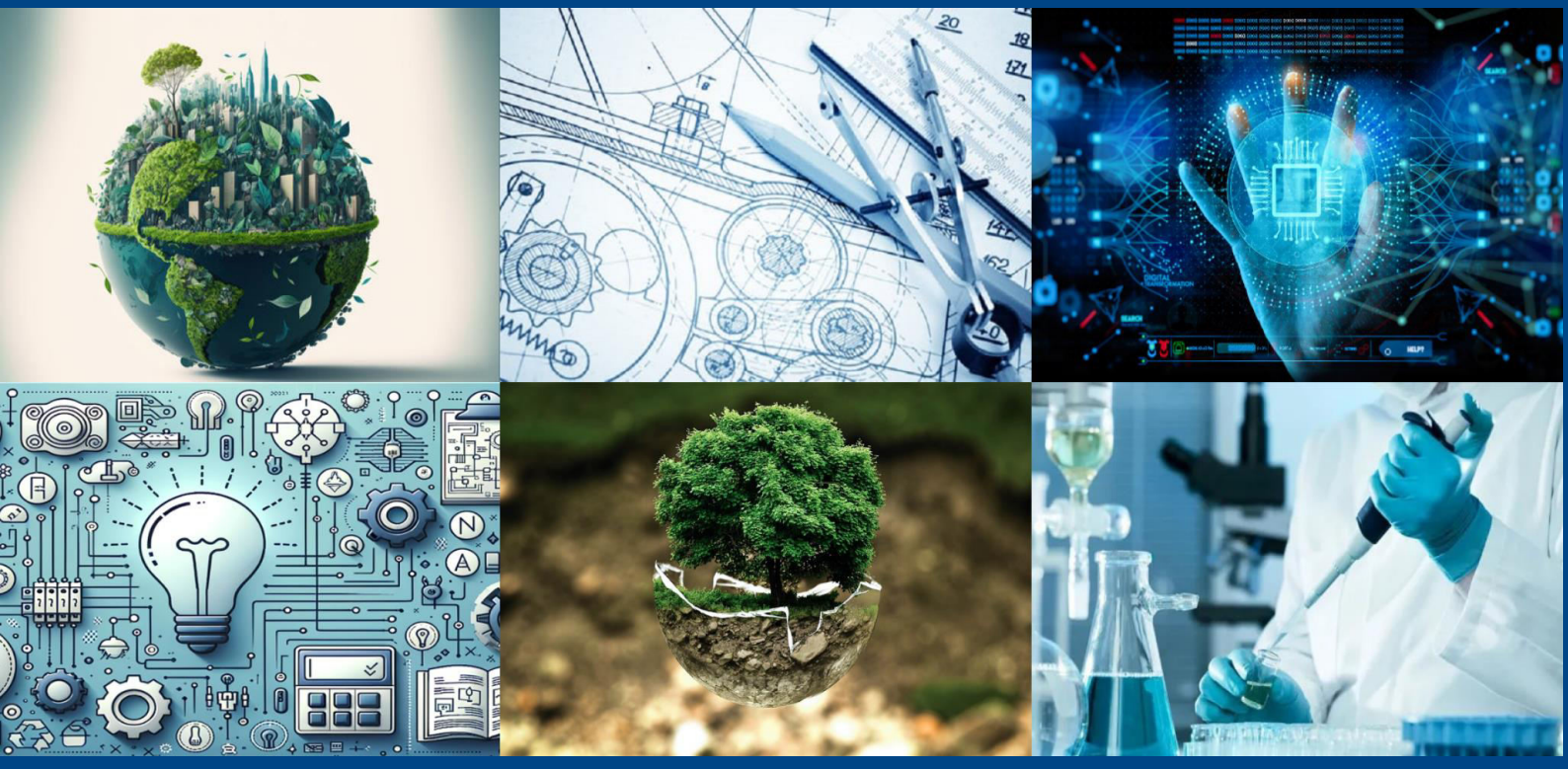

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Factors Influencing EV Adoption in Urban vs Rural Areas

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ABSTRACT: The adoption of electric vehicles (EVs) is influenced by multiple factors, including infrastructure availability, consumer perceptions, and socio-economic conditions. However, adoption rates differ significantly between urban and rural areas due to disparities in charging infrastructure, government incentives, and driving behaviours. This research applies the Unified Theory of Acceptance and Use of Technology (UTAUT) model to examine the key factors affecting EV adoption in urban and rural settings. The study explores how performance expectancy, effort expectancy, social influence, and facilitating conditions shape consumer decisions in different geographic contexts. The findings suggest that urban areas have higher adoption rates due to better infrastructure and social acceptance, whereas rural areas face barriers such as range anxiety and limited-service networks. The paper concludes with policy recommendations to bridge the urban-rural EV adoption gap.

KEY WORDS: EV Adoption, Urban Vs Rural, UTAUT Model

I. INTRODUCTION

The transition from internal combustion engine (ICE) vehicles to electric vehicles (EVs) is a crucial step toward sustainable mobility. EVs offer significant environmental and economic benefits, including reduced greenhouse gas emissions and lower fuel costs (Breetz, McCormack, & Weis, 2018). Governments worldwide are promoting EV adoption through financial incentives, infrastructure development, and regulatory policies (Sierzchula et al., 2014). However, despite these efforts, the rate of EV adoption varies widely between urban and rural areas, highlighting the need for a contextual understanding of adoption barriers and enablers (Hardman, Shiu, & Steinberger-Wilckens, 2017).
Urban areas typically have dense charging networks, shorter travel distances, and higher exposure to EV-related policies and marketing efforts (Javid & Nejat, 2017). These factors create a favourable environment for EV adoption. In contrast, rural areas face challenges such as limited charging infrastructure, longer travel distances, and lower population density, which reduce the feasibility of owning an EV (Nykvist & Nilsson, 2015).

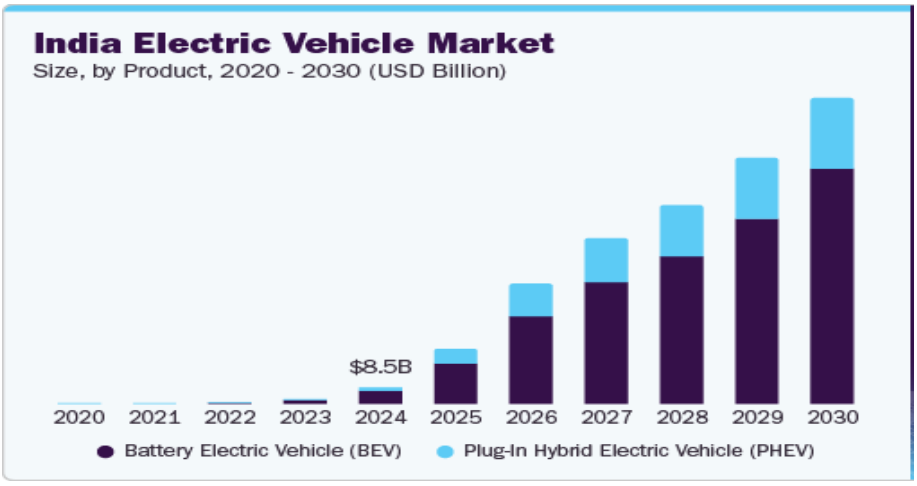

Fig. 1

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To analyse these disparities, this study applies the Unified Theory of Acceptance and Use of Technology (UTAUT) model, developed by Venkatesh et al. (2003). The UTAUT model identifies four key constructs influencing technology adoption:

Performance Expectancy – The perceived benefits of EVs, such as cost savings, energy efficiency, and environmental impact (Sierzchula et al., 2014).

Effort Expectancy – The ease of driving, charging, and maintaining an EV, which differs between urban and rural settings (Caperello & Kurani, 2012).

Social Influence – The impact of peer recommendations, cultural norms, and media trends on EV adoption (Börjesson & Mattsson, 2017).

Facilitating Conditions – The availability of charging stations, government incentives, and service networks that enable EV adoption (Sovacool, Axsen, & Sorrell, 2018).

This study aims to analyze how these factors affect EV adoption in urban and rural areas, offering insights for policymakers and industry stakeholders to promote equitable EV adoption across different geographic regions.

(Unified Theory of Acceptance and Use of Technology) UTAUT MODEL

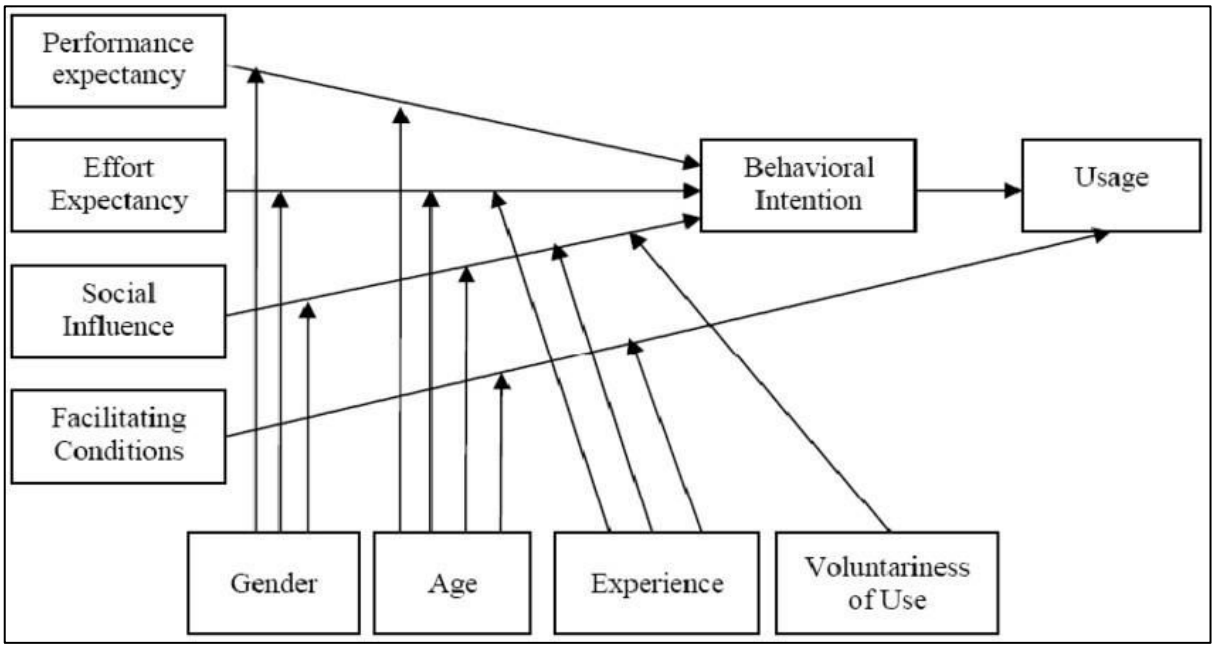

Fig. 2

II. LITERATURE REVIEW

Performance Expectancy and EV Adoption

Performance expectancy refers to the extent to which individuals believe using an EV will benefit them. Urban consumers often perceive EVs as cost-effective and environmentally friendly, benefiting from government subsidies and low operational costs (Breetz et al., 2018). Rural consumers, however, are more concerned with range limitations, battery life, and vehicle performance on rough terrain, making them hesitant to switch from ICE vehicles (Javid & Nejat, 2017).

Effort Expectancy: Usability and Convenience

Effort expectancy focuses on the ease of use associated with EVs. Urban EV users experience greater convenience due to well-developed charging infrastructure and shorter commutes (Hardman et al., 2017). In rural areas, the lack of

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charging stations and longer distances between destinations make EV ownership more challenging (Caperello & Kurani, 2012).

Social Influence: Cultural and Peer Effects

Social influence plays a crucial role in shaping consumer preferences. Urban consumers are more likely to be influenced by peer recommendations and social media trends, where EVs are often portrayed as a status symbol and a sustainable lifestyle choice (Börjesson & Mattsson, 2017). Rural consumers, on the other hand, tend to rely on community recommendations and personal experience, making them less susceptible to media-driven EV adoption trends (Sovacool et al., 2018).

Facilitating Conditions: Infrastructure and Policy Support

Facilitating conditions refer to external enablers that support EV adoption, including charging infrastructure, government incentives, and vehicle servicing options. Urban areas benefit from dense charging networks, government subsidies, and access to specialized EV service centers (Nykvist & Nilsson, 2015). Rural areas, however, face limited charging availability, fewer incentives, and higher service costs, making EV ownership less practical (Sierzchula et al., 2014).

III. RESEARCH METHODOLOGY

Research Design

This study follows a qualitative research design to analyze the factors influencing electric vehicle (EV) adoption in urban and rural areas. A comparative approach is used to examine the differences in adoption trends between these two geographic contexts. The Unified Theory of Acceptance and Use of Technology (UTAUT) framework serves as the foundation for identifying key determinants such as performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003).

By employing a descriptive research design, this study aims to provide a detailed understanding of EV adoption trends without manipulating variables. The research is based on secondary data sources, including government reports, industry publications, and peerreviewed studies, ensuring a comprehensive analysis of EV adoption factors across different regions.

Research Tool

Given the nature of this study, document analysis is the primary research tool. This method involves systematically reviewing and interpreting existing research papers, government mobility reports, industry analyses, and policy documents related to EV adoption. The study extracts key themes, patterns, and trends from these sources, focusing on urban and rural differences.

To ensure data reliability and validity, the following criteria were used for source selection:

Credibility: Data was sourced from peer-reviewed journals, government agencies, and industry leaders such as the International Energy Agency (IEA) and World Economic Forum.

Relevance: The documents selected focused on EV adoption, infrastructure, government policies, and consumer behaviours.

Recency: Priority was given to studies published within the last 10 years to ensure updated insights.

This approach enables the study to identify gaps, validate findings, and draw meaningful conclusions about EV adoption in different geographic settings.

Purposive Sampling

The study adopts a purposive sampling technique, which involves selecting data sources that are most relevant to the research objectives. This non-probability sampling method ensures that the analysis focuses on high-quality and contextually appropriate studies.

The selection criteria for purposive sampling include:

Geographical Representation: Data is drawn from studies on EV adoption in both urban and rural areas.

Relevance to UTAUT Model: Only studies discussing performance expectancy, effort expectancy, social influence, and facilitating conditions were included.

Policy and Infrastructure Focus: Reports that examine government incentives, charging infrastructure, and technological advancements were prioritized.

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Consumer Behaviours Insights: Studies analysing consumer perceptions, driving habits, and adoption barriers were included.

A **t-test** is a statistical test used to compare the means of two groups to determine whether there is a significant difference between them. It helps to evaluate if the observed differences are due to chance or a real effect.

Types of t-tests:

1. **Independent t-test (Unpaired t-test)** – Compares the means of two independent groups (e.g., test scores of two different classes).
2. **Paired t-test (Dependent t-test)** – Compares the means of the same group at different times (e.g., before and after treatment).
3. **One-sample t-test** – Compares the mean of a single group against a known value (e.g., checking if the average height in a city is different from a national average).

Key Assumptions of a t-test:

- The data is normally distributed.
- The samples are independent (for independent t-tests).
- The variances of the two groups are equal (for standard t-tests).
- **Difference Scores Calculations**
-

Significance Level:

○ .01
◉ .05
○ .10

One-tailed or two-tailed hypothesis?:

◉ One-tailed
○ Two-tailed

Treatment 1

N_1: 50 $df_1 = N - 1 = 50 - 1 = 49$
M_1: 5.94
SS_1: 2.82 $s^2_1 = SS_1/(N - 1) = 2.82/(50-1) = 0.06$
Treatment 2

N_2: 50 $df_2 = N - 1 = 50 - 1 = 49$
M_2: 25.82 SS_2: 13.38 $s^2_2 = SS_2/(N - 1) = 13.38/(50-1) = 0.27$

T-value Calculation

$s^2_p = ((df_1/(df_1 + df_2)) * s^2_1) + ((df_2/(df_2 + df_2)) * s^2_2) = ((49/98) * 0.06) + ((49/98) * 0.27) = 0.17$

$s^2_{M1} = s^2_p/N_1 = 0.17/50 = 0$ $s^2_{M2} = s^2_p/N_2 = 0.17/50 = 0$ $t = (M_1 - M_2)/\sqrt{(s^2_{M1} + s^2_{M2})} = -19.88/\sqrt{0.01} = -244.48$

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IV. FINDINGS AND DISCUSSION

Urban vs. Rural EV Adoption Rates
Findings indicate that EV adoption is significantly higher in urban areas due to:
Greater charging infrastructure availability (Javid & Nejat, 2017).
Higher financial incentives and subsidies (Hardman et al., 2017).
Stronger social influence from peers and media (Börjesson & Mattsson, 2017).
In contrast, rural EV adoption remains low due to:
Limited charging station availability (Sierzchula et al., 2014).
Longer driving distances, leading to range anxiety (Nykvist & Nilsson, 2015).
Lower exposure to EV promotional campaigns (Sovacool et al., 2018).
Policy Recommendations for Bridging the Urban-Rural Gap To promote equitable EV adoption, policymakers should:
Expand charging infrastructure in rural areas through targeted investments.
Introduce rural-specific incentives, such as tax credits and subsidies for home charging units.
Develop robust EV servicing networks to support maintenance in remote regions.
Enhance public awareness campaigns tailored to rural communities.

V. CONCLUSION

The adoption of EVs varies significantly between urban and rural areas, driven by differences in infrastructure, consumer perceptions, and policy support. The UTAUT model provides a valuable framework for understanding these disparities, highlighting the importance of performance expectancy, effort expectancy, social influence, and facilitating conditions in shaping adoption behavior.
While urban areas benefit from stronger infrastructure and policy support, rural areas face significant barriers that require targeted interventions. Policymakers must adopt regionspecific strategies to ensure the equitable distribution of EV benefits, promoting widespread adoption across diverse geographic contexts.

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