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Research Article

Analysing the Impact of Social Influence on Electric Vehicle Adoption: A Deep Learning-Based Simulation Study in Jharkhand, India

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Abstract:

The transition towards sustainable transportation, particularly in regions like Jharkhand, has gained paramount importance amidst escalating environmental concerns and evolving market dynamics. This study delves into the consumer psyche regarding green mobility adoption, aiming to decipher the critical factors influencing individuals' future intentions towards eco-friendly transportation options. Utilizing a comprehensive survey questionnaire, data was gathered from 300 respondents, focusing on variables such as awareness of green mobility, the perceived importance of environmental impact, social media influence, peer recommendations, availability of green mobility services, cost considerations, government support, convenience of green transportation, and awareness campaigns. The collected data underwent rigorous regression analysis to uncover correlations and predictive insights. The regression model revealed a notable R-squared value of 0.765, indicating a substantial portion of variance in future intentions is explained by the chosen predictors. Among these, variables like the perceived importance of environmental impact, government support, and convenience of green mobility emerged as statistically significant influencers, suggesting their pivotal role in shaping consumer behaviour towards sustainable transportation. Contrarily, factors such as social media influence, peer recommendations, availability of green mobility services, cost considerations, and awareness campaigns exhibited non-significant coefficients, implying a lesser impact on individuals' future intentions in this context. These findings bear significant implications for stakeholders involved in promoting green mobility solutions. Ultimately, this study contributes to the ongoing discourse on sustainable mobility by shedding light on the multifaceted dynamics influencing consumer decision-making using Python a deep learning simulation, thereby guiding strategic interventions for a greener, more eco-conscious future.

1. Introduction

As the world grapples with the urgency of addressing environmental concerns, the paradigm of transportation is undergoing a transformative shift towards sustainability. In this context, the adoption of green mobility solutions holds immense promise for mitigating the environmental impact of traditional transportation methods [1]. The rapid urbanization and industrial growth have significantly contributed to environmental challenges worldwide. With increasing concerns over climate change, air pollution, and the depletion of natural resources, there has been a global shift towards sustainable development. Green mobility, which encompasses eco-friendly modes of transportation such as electric vehicles (EVs), public transport, cycling, and walking, has emerged as a critical component of this sustainability agenda. Understanding the factors that drive consumer adoption of green mobility is essential for policymakers, businesses, and environmental advocates. Jharkhand, a state known for its rich natural resources and burgeoning industrial sectors in India, stands at the forefront of this transition. However, understanding the factors influencing consumer behaviour towards green mobility [2-9] in Jharkhand is crucial for effective policy formulation and sustainable development strategies [10]. The global landscape is witnessing unprecedented levels

of urbanization and industrialization, accompanied by significant environmental challenges. With urban populations expanding rapidly, there is an urgent need to address the associated increase in environmental degradation, particularly in the transportation sector. This sector is a major contributor to greenhouse gas emissions, air pollution, and energy consumption. Consequently, sustainable transportation, specifically green mobility, has emerged as a critical area of focus. Green mobility involves the use of environmentally friendly modes of transport such as electric vehicles (EVs), public transportation, cycling, and walking, which collectively aim to reduce the carbon footprint of transportation systems.

1.1 Background and Motivation

The discourse on sustainable transportation [11] has gained momentum in recent years, driven by escalating environmental challenges such as climate change, pollution, and resource depletion. The transportation sector, particularly in urban areas, contributes significantly to carbon emissions and air pollution [2], necessitating a shift towards eco-friendly alternatives. Green mobility [12] encompasses a range of solutions, including electric vehicles, public transit, cycling infrastructure, and car-sharing programs, aimed at reducing reliance on fossil fuels and promoting environmentally conscious transportation choices. Jharkhand, situated in eastern India, presents a unique context for studying consumer behaviour towards green mobility. With a mix of urban centres and rural landscapes, the state faces mobility challenges influenced by industrial activities, population growth, infrastructure development, and environmental preservation efforts. Understanding how individuals perceive and adopt green transportation options in this dynamic environment is critical for fostering sustainable mobility solutions tailored to local needs and preferences.

1.2 The Environmental Imperative

Transportation is a significant source of environmental pollution. The combustion of fossil fuels in vehicles emits a substantial amount of carbon dioxide (CO_2), contributing to global warming and climate change. According to the International Energy Agency (IEA), the transportation sector is responsible for approximately 24% of global CO_2 emissions from fuel combustion. Moreover, vehicles emit other pollutants, including nitrogen oxides (NO_x) and particulate matter (PM), which have serious health implications, leading to respiratory and cardiovascular diseases.

1.3 Urbanization and its Challenges

Urbanization presents both opportunities and challenges. While it drives economic growth and improves living standards, it also exacerbates environmental problems. In many developing regions, rapid urbanization has outpaced the development of infrastructure, leading to traffic congestion, inadequate public transport systems, and increased pollution. Jharkhand, a state in eastern India, is a case in point. Known for its rich mineral resources and industrial base, Jharkhand faces significant environmental challenges, including deforestation and air pollution. The state's urban centres, such as Ranchi, Jamshedpur, and Dhanbad, are grappling with the dual pressures of industrialization and urbanization, necessitating sustainable urban planning and transportation solutions.

1.4 Green Mobility: A Sustainable Solution

Green mobility offers a viable solution to mitigate the adverse environmental impacts of transportation. By promoting the use of eco-friendly transport modes, it aims to reduce reliance on fossil fuels, lower greenhouse gas emissions, and improve air quality. Electric vehicles (EVs), for instance, produce zero tailpipe emissions and can be powered by renewable energy sources. Public transportation reduces the number of individual car journeys, thereby decreasing overall emissions. Cycling and walking, apart from being environmentally benign, also offer health benefits.

1.5 The Role of Consumer Behaviour

The adoption of green mobility is heavily influenced by consumer behaviour. Understanding the factors that drive or hinder the adoption of eco-friendly transportation options is crucial for policymakers and businesses. While economic incentives, technological advancements, and infrastructure development are important, social influence plays a significant role in shaping consumer behaviour. Social norms, peer pressure, and media influence can significantly impact individuals' decisions to adopt sustainable practices.

1.6 Social Influence in Consumer Behaviour

Social influence refers to the impact that the attitudes, beliefs, and behaviours of others have on an individual's own attitudes, beliefs, and

behaviours. It encompasses various forms, including:

Peer Influence: Individuals are influenced by the opinions and behaviours of their peers. If eco-friendly practices such as using public transport or cycling are prevalent within a social group, individuals are more likely to adopt these practices.

Social Norms: Social norms are unwritten rules about how to behave. They provide a sense of acceptable and unacceptable behaviour within a community. Promoting green mobility as a social norm can encourage widespread adoption.

Media Influence: Media plays a crucial role in shaping public perception and behaviour. Positive portrayals of green mobility in the media can enhance its appeal and encourage adoption.

Jharkhand: A Case Study

Jharkhand provides a unique setting to study the role of social influence in green mobility adoption. The state's industrial base and rapid urbanization present both challenges and opportunities for sustainable transportation. The state government has been proactive in promoting green initiatives, such as the adoption of electric vehicles [13-23] and the development of public transportation infrastructure. However, the success of these initiatives depends significantly on consumer acceptance and behaviour.

2. Literature Review

Extensive literature exists on consumer behaviour and adoption of green technologies, including studies focusing on transportation preferences and sustainability initiatives. For example, the study by Mishra et al. (2020) [3] delves into the factors influencing electric vehicle adoption in Indian cities, highlighting the role of incentives, infrastructure, and environmental awareness. Similarly, Tarigan (2019) [4] explore consumer perceptions towards eco-friendly transportation options, emphasizing the importance of convenience, cost-effectiveness, and environmental impact in decision-making. In the context of Jharkhand, limited research specifically addresses consumer attitudes towards green mobility [5]. However, studies on environmental awareness, public transit preferences, and infrastructure development provide valuable insights into the broader context of sustainable transportation in the region. For instance, the work by Kumari et. al. (2002) [6] examines public perception of environmental issues in Jharkhand, shedding light on community attitudes towards conservation and sustainable practices. Building upon existing literature and filling gaps in knowledge, this research aims to delve deeper into the nuanced factors shaping consumer behaviour towards green mobility in Jharkhand. By integrating survey data and regression analysis [7-8].

Table 1: *Key Factors Influencing Green Mobility Adoption*

Factor	Description	References
Environmental Awareness	Consumer awareness of environmental issues and benefits of green mobility	Banister (2008) [18]; Geels et al. (2012) [19]
Economic Incentives	Financial benefits, such as subsidies and tax incentives	Gärling & Schuitema (2007) [22]
Technological Advancements	Availability and accessibility of green mobility technologies	Ajzen (1991) [16]; Cialdini & Trost (1998) [23]
Infrastructure	Availability of supporting infrastructure, such as charging stations	Gärling & Schuitema (2007) [22]
Social Influence	Impact of peer pressure, social norms, and media influence	Ajzen (1991) [16]; Cialdini & Trost (1998) [23]

3. Research Framework

3.1 Research Objectives

The primary objective of this research is to analyze consumer buying behaviour towards green mobility in Jharkhand and identify the factors affecting its adoption.

Specific research objectives include:

- Assessing the level of awareness regarding green mobility among residents of Jharkhand.
- Investigating the perceived importance of environmental impact in transportation choices.
- Analyzing the influence of social media, peer recommendations, and government support on green mobility adoption.
- Evaluating the availability and accessibility of green mobility services in the region.
- Understanding cost considerations and convenience factors influencing consumer decisions.
- Identifying the impact of awareness campaigns and educational initiatives on consumer attitudes towards green mobility.

3.2 Methodology

The research methodology involves a mixed-method approach combining quantitative surveys and

regression analysis. A structured questionnaire was designed to collect data from a sample of residents in Jharkhand, representing diverse demographics, urban-rural divide, and socioeconomic backgrounds. The questionnaire included Likert scale questions to measure responses on factors such as awareness, importance of environmental impact, social media influence, government support, convenience, and cost considerations related to green mobility. The survey data was analyzed using statistical techniques, with a focus on regression analysis [7-8] to explore the relationships between independent variables (e.g., awareness, government support) and the dependent variable (future intentions towards green mobility). Regression models has been constructed to identify significant predictors and quantify their impact on consumer behaviour.

3.3 Theoretical Framework

The study draws on various theoretical frameworks to understand the role of social influence in green mobility adoption:

1. **Theory of Planned Behaviour (TPB):** Developed by Ajzen (1991) [16], TPB posits that an individual's behaviour is determined by their intention to perform the behaviour, which is influenced by their attitudes, subjective norms, and perceived behavioral control. In the context of green mobility, subjective norms (social influence) can significantly impact individuals' intentions to adopt eco-friendly transportation options.
2. **Social Cognitive Theory (SCT):** Proposed by Bandura (1986) [17], SCT emphasizes the role of observational learning, imitation, and modeling in behaviour change. Individuals learn and adopt behaviours by observing others, particularly those they consider role models.
3. **Diffusion of Innovations (DOI) Theory:** Introduced by Rogers (2003) [18], DOI theory explains how new ideas and technologies spread within a society. According to this theory, social influence is a key factor in the adoption of innovations (table 1). Early adopters influence others, creating a ripple effect that leads to widespread adoption.

3.4 Expected Results and Contributions

Based on the preliminary research framework and literature review, we anticipate several key findings and contributions from this study:

- Insights into the level of awareness and attitudes towards green mobility among residents of Jharkhand.
- Identification of significant factors influencing consumer decisions regarding sustainable transportation options.
- Quantification of the impact of environmental awareness, government policies, and convenience factors on green mobility adoption.
- Recommendations for policymakers, urban planners, and businesses to enhance green transportation infrastructure and promote eco-friendly mobility solutions in Jharkhand.
- Contribution to the existing body of knowledge on sustainable transportation and consumer behaviour, particularly in the context of emerging economies and regions with unique mobility challenges.

By bridging the gap between academic research and practical implications, this study aims to inform evidence-based strategies for promoting sustainable mobility and fostering a culture of environmental stewardship in Jharkhand and beyond.

4. Data Collection

A survey questionnaire was prepared to capture the response (in Likert scale) of potential consumers in Ranchi, Jharkhand. Following is the questionnaire:

1. Green Mobility Awareness: I am aware of environmentally friendly transportation options such as electric vehicles and bicycles.
2. Importance of Environmental Impact: I consider the environmental impact of my transportation choices when making travel decisions.
3. Influence of Social Media: Social media plays a significant role in shaping my opinions about green mobility options.
4. Peer Influence: The opinions of my friends and family influence my decision to use eco-friendly transportation.
5. Availability of Green Mobility Services: I have easy access to green mobility services (e.g., electric vehicle charging stations, bicycle sharing programs) in my locality.
6. Cost Consideration: The cost of green mobility options (e.g., purchasing an electric vehicle, using public transportation) is a significant factor in my decision-making process.
7. Government Support: Government policies and incentives encourage me to choose eco-friendly transportation alternatives.
8. Convenience of Green Mobility: Green transportation options (e.g., electric scooters, carpooling services) are convenient and practical for my daily commuting needs.
9. Awareness Campaigns: Awareness campaigns and educational programs about green mobility

have influenced my perception and behaviour towards sustainable transportation.

10. Future Intentions: I am likely to increase my use of green mobility options in the future.

This questionnaire aims to gauge respondents' attitudes, perceptions, and behaviours regarding green mobility and the factors influencing their adoption of eco- friendly transportation alternatives in Jharkhand, India. The response received by them is summarised below in Table 2.

Table 2: *Summary of responses received from 300 respondents.*

Social Factor	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Green Mobility Awareness	60	161	19	31	29
Importance of Environmental Impact	21	9	81	139	50
Influence of Social Media	109	81	41	69	00
Peer Influence	41	79	60	101	19
Availability of Green Mobility Services	20	61	90	109	20
Cost Consideration	92	128	57	22	01
Government Support	63	167	30	22	18
Convenience of Green Mobility	31	139	40	48	42
Awareness Campaigns	122	25	13	116	24
Future Intentions	104	116	41	29	10

5. Result & Discussions

The statistical analysis of the survey is carried out using a 12th generation Intel® Core™ i5-1240P HP laptop equipped with 16 gigabytes (GB) of Random Access Memory (RAM) and running on the Windows 11 operating system. The experimental procedures were conducted using the Jupyter Lab component of the Anaconda development environment, a platform that supports the Python programming language [7][20][21]. The result of statistical analysis using regression strategy is depicted in Figure 1. Moreover, for better understanding Figure 2 represents the observed vs. predicted values based on regression analysis. Based on the regression results, here are some key points and conclusions that is drawn from the survey:

Figure 1. *Result of regression analysis. [Note: Standard Errors assume that the covariance matrix of the errors is correctly specified.]*

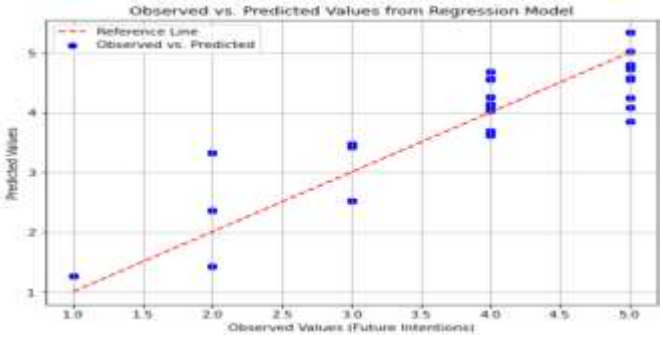

Figure 2: *Graphical representation of observed vs. predicted values based on regression analysis*

Overall Model Fit:

The R-squared value of 0.765 indicates that approximately 76.5% of the variation in "Future Intentions" towards green mobility can be explained by the independent variables included in the model. This suggests a moderately strong relationship between the predictors and the dependent variable.

Key Metrics

- **R-squared:** 0.765
  - This value indicates that 76.5% of the variance in future intentions to adopt green mobility can be explained by the model. This suggests a strong explanatory power of the included variables.
- **Adjusted R-squared:** 0.758
  - This value is slightly lower than the R-squared, accounting for the number of predictors in the model. It still indicates a good fit.
- **F-statistic:** 104.8 ($p < 0.0001$)
  - The F-statistic is highly significant (p-value = 9.34e-86), indicating that the model is statistically significant and that the predictors, as a group, are good at explaining the variance in future intentions.

Coefficients and Significance

- **Constant (Intercept):** 0.0151
  - The intercept is not significant (p = 0.937), meaning it does not provide meaningful information about the baseline level of future intentions without considering the predictors.

Significant Variables

1. **Green Mobility Awareness:**
   - **Coefficient:** 0.2053
   - **t-value:** 3.902
   - **p-value:** 0.000
   - **Confidence Interval:** [0.102, 0.309]
   - **Interpretation:** Green mobility awareness has a positive and significant effect on future intentions. For each unit increase in awareness, future intentions increase by 0.2053 units.
2. **Importance of Environmental Impact:**
   - **Coefficient:** 0.4649
   - **t-value:** 12.554
   - **p-value:** 0.000
   - **Confidence Interval:** [0.392, 0.538]
   - **Interpretation:** The importance placed on environmental impact is a strong positive predictor of future intentions. Each unit increase in this variable results in a 0.4649 unit increase in future intentions.
3. **Influence of Social Media:**
   - **Coefficient:** 0.1567
   - **t-value:** 4.664
   - **p-value:** 0.000
   - **Confidence Interval:** [0.091, 0.223]
   - **Interpretation:** Social media influence significantly boosts future intentions, with a 0.1567 unit increase for each unit rise in social media influence.
4. **Government Support:**
   - **Coefficient:** 0.6744
   - **t-value:** 11.330
   - **p-value:** 0.000
   - **Confidence Interval:** [0.557, 0.792]
   - **Interpretation:** Government support is the most substantial positive predictor. Each unit increase in government support leads to a 0.6744 unit increase in future intentions.
5. **Convenience of Green Mobility:**
   - **Coefficient:** -0.4863
   - **t-value:** -12.366
   - **p-value:** 0.000
   - **Confidence Interval:** [-0.564, -0.409]
   - **Interpretation:** Surprisingly, convenience has a significant negative impact. Each unit increase in perceived convenience leads to a 0.4863 unit decrease in future intentions, which may indicate other underlying factors influencing this perception.

Non-Significant Variables

1. **Peer Influence:**
   - **Coefficient:** 0.0213
   - **t-value:** 0.496
   - **p-value:** 0.620
   - **Confidence Interval:** [-0.063, 0.106]
   - **Interpretation:** Peer influence does not significantly affect future intentions in this model.
2. **Availability of Green Mobility Services:**
   - **Coefficient:** 0.0592
   - **t-value:** 1.328
   - **p-value:** 0.185
   - **Confidence Interval:** [-0.029, 0.147]
   - **Interpretation:** Availability of services is not a significant predictor.
3. **Cost Consideration:**
   - **Coefficient:** 0.0004
   - **t-value:** 0.008
   - **p-value:** 0.993
   - **Confidence Interval:** [-0.090, 0.091]
   - **Interpretation:** Cost consideration does not have a significant impact on future intentions.
4. **Awareness Campaigns:**
   - **Coefficient:** -0.0005
   - **t-value:** -0.017
   - **p-value:** 0.987
   - **Confidence Interval:** [-0.056, 0.055]
   - **Interpretation:** Awareness campaigns are not significant predictors in this model.

Diagnostic Statistics

- **Omnibus:** 0.105 (Prob > Omnibus: 0.949)
  - Indicates no significant skewness or kurtosis.
- **Durbin-Watson:** 2.086
  - Close to 2, suggesting no significant autocorrelation in the residuals.
- **Jarque-Bera (JB):** 0.015 (Prob > JB: 0.993)
  - Confirms that the residuals are normally distributed.
- **Condition Number:** 66.3
  - Suggests no severe multicollinearity problems.

This regression analysis provides a robust understanding of the factors influencing future intentions to adopt green mobility in Jharkhand. Significant predictors include green mobility awareness, the importance of environmental impact, social media influence, government support, and convenience. The surprising negative impact of convenience suggests potential areas for further investigation to understand underlying factors. The model demonstrates strong explanatory power with an R-squared of 76.5%, indicating it effectively captures the primary drivers of green mobility adoption intentions.

6. Recommendations

Based on the significant predictors identified, strategies to promote environmental awareness [15], increase government support for green initiatives, and enhance the convenience of green mobility options may be effective in encouraging individuals to adopt more sustainable transportation choices.
Further research and data collection may be needed to explore additional factors and refine the model for a more comprehensive understanding of consumer behaviour towards green mobility [14]. Overall, the regression analysis provides valuable insights into the factors influencing future intentions towards green mobility, guiding policymakers, businesses, and organizations in developing targeted interventions and strategies to promote sustainable transportation [13] practices.

7. Conclusions

Considering the current market scenario and the results of our regression analysis on consumer behaviour towards green mobility in Jharkhand, several crucial insights emerge. The study reveals a moderately strong relationship between predictors and future intentions towards sustainable transportation. Significant variables such as the perceived importance of environmental impact, government support for green initiatives, and the convenience of green mobility options stand out as influential factors. These findings underscore the need for concerted efforts to raise environmental awareness, enhance government policies favoring eco-friendly transportation, and improve the accessibility and convenience of green mobility services. However, non-significant factors like social media influence and peer recommendations suggest that while they may play a role, their impact might not be as pronounced in driving adoption of green mobility solutions. Considering the dynamic market landscape and increasing focus on sustainability, our study recommends targeted strategies aimed at bolstering environmental consciousness, advocating for supportive governmental policies, and refining the usability of green transportation alternatives. These efforts are pivotal in fostering a culture of eco-conscious commuting and paving the way for a greener, more sustainable future in Jharkhand's transportation ecosystem.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
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