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Original Research Article

Adoption and Perception of CNG Auto Services: An Empirical Study on Economic, Environmental, and Service Dimensions

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Abstract: The growing need for sustainable and cost-effective urban transport has led to increased attention towards alternative fuels such as Compressed Natural Gas (CNG). This paper analyses the adoption and usage behaviour, level of satisfaction and future intentions of the users of CNG auto services in semi-urban setting. Descriptive and analytical research design was used and primary data was obtained via a structured questionnaire that was given to CNG auto users. The analysis on the impact of socio-economic factors, awareness, cost perception, and service quality on the usage behaviour and satisfaction is conducted. The results indicate that the lower and middle-income populations have been the major users of CNG autos, which can be attributed to the fact that it is affordable and is perceived to save money. The statistical analysis shows that the awareness and frequency of usage have a significant association, and the service quality factors, especially comfort and availability, have a significant association with customer satisfaction. Moreover, environmental awareness is determined to have a positive impact on intentions to adopt in the future. The paper concludes that CNG-driven auto services are the potential and sustainable means of transportation, with both economic and environmental benefits. However, challenges related to infrastructure and availability needs to be addressed to enhance adoption. The results can be useful to policymakers and service providers to advance environmentally friendly urban mobility solutions.
Keywords: CNG Auto Services, Sustainable Transport, Consumer Behaviour, Service Quality, Environmental Awareness.

1. INTRODUCTION

The growing global alarm on environmental degradation, escalating fuel prices and the necessity of using sustainable urban transport has resulted in the growing trend towards using alternative fuels like Compressed Natural Gas (CNG). CNG is also well known to be a cleaner and cheaper alternative to the traditional fuels such as petrol and diesel especially in the transport industry of the cities. Auto-rickshaws are a prevalent form of public transport in India, and they are moving towards the use of CNG as a form of transport because of its cost-effectiveness and low emissions (Muhammad *et al.,* 2015). In consumer behaviour, post-purchase satisfaction is a very important concept that is described as the process of assessment of a product or service after consumption. It is crucial in influencing future behavioural results like repeat purchase, brand loyalty and word-of-mouth recommendation. When considering the CNG auto operators, the satisfaction depends on several aspects such as the mileage, fuel efficiency, maintenance cost, quality of service, and vehicle performance (Md Saifullah Khalid, 2024). These operators rely on their vehicles as their means of livelihood and therefore, their post purchase analysis directly affects their economic and workplace choice.

Although the use of CNG vehicles has increased, operators usually experience issues in terms of infrastructure and technical support, as well as in terms of maintenance, which can impact their satisfaction rates and their operational efficiency (Scott Kelley and Kuby, 2017). In addition, the literature on CNG is mostly technical and environmental oriented and little has been done to address user satisfaction and behavioural reactions particularly in rural or semi-urban settings. Thus, this paper will seek to investigate the post purchase satisfaction and behaviour of CNG auto operators in

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Nadapuram Grama Panchayat. Through their analysis of experiences, challenges, and satisfaction levels, the study aims to add to a deeper insight into the real-life effectiveness of CNG implementation in the transport sector.

2. REVIEW OF LITERATURE

The using of Compressed Natural Gas (CNG) as a substitute automotive fuel has attracted extensive research on the various levels, such as environmental effects, engine efficiency, economic viability, and acceptance by the end users. The initial research studies focused more on the macro level upshots of CNG usage. An example is that Liew and Liew (1995) studied the economic and environmental impacts of adopting CNG based on the PHVIO model and discovered that the adoption of CNG over traditional fuel has a positive impact on the industrial production and air pollution. Likewise, Albert *et al*., (1995) emphasised the fact that CNG automobile produces much less non-methane hydrocarbons and toxic substances than gasoline or traditional fuel automobiles, but methane emissions are normally greater. The other studies centred on the technical and performance-related points of CNG engines. Rosli *et al.,* (2002) found out that natural gas has the merits of high octane rating, low maintenance needs and the clean burning. However, the researchers also ascertained some weaknesses like the reduced volumetric efficiency, and the challenges associated with combustion. In tune with this, Aslam *et al*., (2006) have proven that the CNG driven engines are more efficient and have reduced carbon dioxide, carbon monoxide, and hydrocarbon emissions but the nitrogen oxide emissions may be higher in some conditions. The technological developments in CNG systems have also been researched. Virendra *et al*., (2006) talked about using biogas as a source of Bio-CNG, stating that it could be used as a source of sustainable energy and rural job. Seung-Moo *et al*., (2009) and Kim *et al.,* (2009) worked on making storage systems better and the effects of fuel composition on engine functioning, respectively. Such studies show that the advancement of technology is significant in improving the efficiency and safety of CNG vehicles.

On the side of performance comparison, various studies have made a comparison between CNG and conventional fuels. Mohammad *et al*., (2010) discovered that CNG can cut down harmful emissions, but could lead to a slightly reduced engine power. Likewise, Jay *et al*., (2014) also found that CNG vehicles have lower fuel economy and reduced acceleration rates than gasoline vehicles because of lower engine power output. But such disadvantages are usually compensated by cheaper fuel and environmental advantages. Over the past few years, the focus of research has been on the behaviour and adoption patterns of the users. Nongnuch Likitsuwannakool (2008) put the significance of social influence and fuel attributes in consumer adoption of natural gas vehicles. Khalid (2024) also examined the topic of user satisfaction and discovered that the level of operational factors (like working hours) greatly affects the level of satisfaction among CNG auto drivers. These results underscore the significance of socio-economic aspects in influencing user perceptions.

One of the biggest impediments to the adoption of CNG has been found to be infrastructure availability. Kelley and Kuby (2017) discovered that the availability of refuelling stations can greatly influence the user preference and convenience of operation. Similarly, Ubani and Ikpaisong (2018) stressed the need for improved regulatory and infrastructural frameworks to promote CNG usage. Research in third-world countries like Nigeria (Ibeneme & Ighalo, 2020) also shows that infrastructural deficiencies and insufficient policies prevent widespread adoption even when natural gas resources are available. Auto-rickshaws are an important mode of transport in the Indian context and their conversion to CNG has far reaching consequences. Simon *et al*., (2016) emphasized the need to include the views of the auto drivers in the policy decisions, as they are an important stakeholder in the transport system. In addition, research on three-wheelers suggests that other alternative fuels like hydrogen-enriched CNG (HCNG) can additionally enhance performance and decrease emissions (Subramanian, 2011; Lather & Das, 2019). The environmental and economic advantages of CNG are still highlighted in recent studies all over the world. As Thanh *et al*., (2025) and Usiayo *et al.,* (2025) emphasized, CNG is a sustainable solution to energy and environmental issues, but the challenges to its successful implementation include favourable policies, infrastructural development, and awareness.

In spite of the comprehensive research conducted on technical and environmental factors, a gap in the literature on post-purchase satisfaction and behavioural consequences of CNG users, especially in local context, is evident. This is a big gap since user satisfaction will determine long term adoption and sustainability of alternate fuel technologies. The current research is trying to fill this gap by analysing CNG auto operator experiences and behavioural response in a given rural environment.

3. OBJECTIVES AND RESEARCH METHODOLOGY

3.1 Objectives

The increasing use of CNG auto-rickshaws in the transport industry has rendered it significant to comprehend the factors that guide the decision of the operators to purchase and how satisfied they are upon their utilization. Although there are a lot of economic and environmental advantages, operators can encounter a number of operational and infrastructural issues that can influence their general experience. In this regard, the research is aimed at measuring post-purchase satisfaction, the impact this has on the behaviour and subsequent choices of CNG auto operators. To be more

specific, for the present study the following objectives were formulated.

- To investigate the determinants of the purchase decision and post purchase satisfaction of CNG auto operators.
- To determine and evaluate the key issues that CNG auto operators encounter once they buy their vehicles and especially in regards to performance, maintenance, and availability of infrastructure.
- To determine the effects of post-purchase satisfaction on behaviour of CNG auto operators, their usage trends, perceptions of income, and intentions to recommend.

3.2 Methodology

This study adopts the descriptive research design, which is used for examining the post purchase satisfaction and behaviour of CNG auto users or operators. The descriptive research is suitable because it allows systematically learning about user experiences, their satisfaction, and the behavioural patterns related to the same. The research is carried out in Nadapuram Grama Panchayat with the target population being CNG auto operators. The population will include all those working on CNG auto-rickshaw in the study area. Purposive sampling method is adopted, where only relevant respondents with experience in the running of CNG autos are sampled to form a sample of 75 respondents. Both primary and secondary data are used for the study.

The method of gathering primary data is a structured questionnaire, which is aimed at capturing the information on demographic factors, level of satisfaction, operational challenges and behavioural reactions. The books, scholarly articles, and past studies are used to collect secondary data, which supports the study in theoretical and contextual terms (Muhammad *et al.,* 2015; Khalid, 2024).

To analyse data, percentage analysis and ranking methods are used to analyse the responses in an effective way. The tools assist in determining the major trends, satisfaction levels and key issues that the respondents are experiencing. Tables, charts and diagrams are used to present data in order to make it more understandable. There are, however, some limitations of the study such as it being limited to a particular geographical region and the sample size used was relatively small and could not be used to generalize the results. Irrespective of these drawbacks, the research offers some valuable information regarding the post-purchase behaviour and satisfaction of CNG auto operators.

3.1 Conceptual Framework

The conceptual framework (figure 1) reveals the major variables that affect the utilization, satisfaction as well as future adoption of CNG auto services. It is organized in the form of a cause and effect model interconnecting independent, mediating and outcome variables. On the input level, there are four key determinants that have been identified: socio-economic factors, awareness level, the cost perception, and service quality. The affordability and need to use CNG autos is influenced by social-economic factors like income and age. The awareness shows the extent to which people are aware of what CNG is as another form of fuel, which can have a great impact on its acceptance and utilization. Perception of costs especially perceived savings is a very powerful economic driver whereas aspects of service quality such as comfort and availability define user experience. All these factors affect the central construct, CNG auto usage and adoption, that is a mediating variable. When there is increased awareness, affordability and quality of the service, levels of usage are increased. The results of such usage are depicted in the level of satisfaction and intentions in the future. Satisfaction will encompass customer experience and attitudinal towards the environment whereas future intentions will involve the repeat use and probability to adopt. Finally, the whole this framework is backed by the policy and infrastructural support and facilities, which entails that the government efforts and access to CNG facilities is a very facilitating factor in increasing adoption and sustainability.

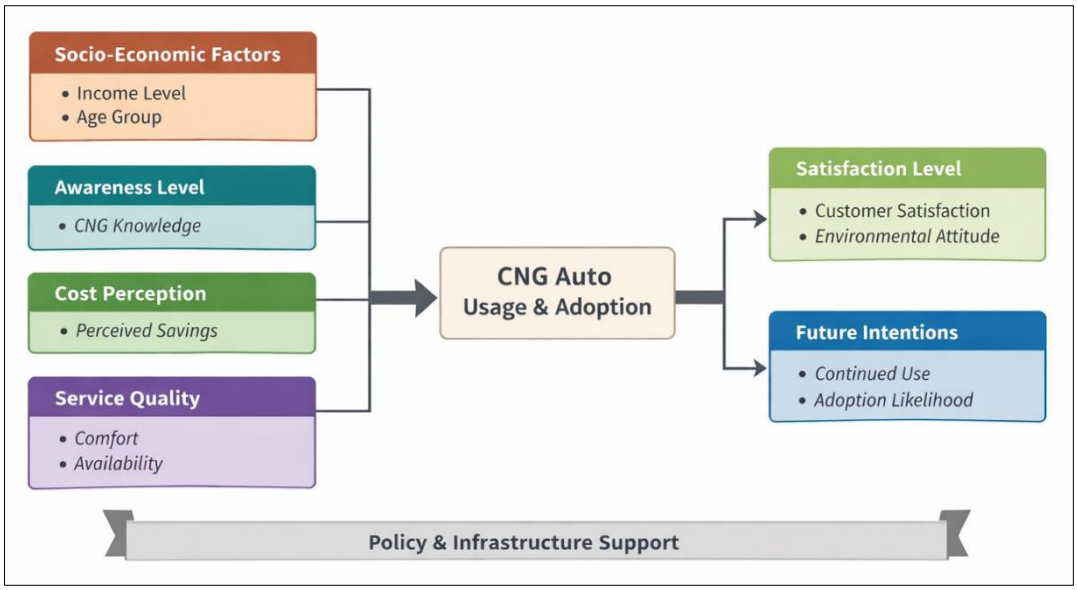

Figure 1: Conceptual Framework of the study

4. FINDINGS AND DISCUSSION

The result and discussion of this paper consists of three sections such as analysis of socio-economic profile of respondents, results of hypotheses testing and the discussion of overall insights generated from this study.

4.1 Analysis of Socio-Economic Profile

In order to ensure clarity and academic objectivity, the socio-economic data analysis has been organised into 5 important thematic tables showing the respondent profile, usage patterns, economic impact, satisfaction, and overall perception of CNG auto services.

Table 1: Socio-Economic Profile of Respondents

Variable	Category	Percentage (%)
Age	Below 30	42
	30–50	38
	Above 50	20
Occupation	Employed	46
	Self-employed	28
	Others	26
Monthly Income	Below ₹20,000	40
	₹20,000–₹40,000	35
	Above ₹40,000	25

Discussion

The samples of the study are biased towards the younger and middle-aged respondents, i.e., the economically active groups are basic users of the CNG auto services. A significant part of them are lower and middle-income category, which implies that affordability is a prime consideration when taking up CNG-based transport. This is consistent with the cost-sensitive transport behaviour prevailing in semi-urban population.

Table 2: Usage Pattern of CNG Auto Services

Variable	Category	Percentage (%)
Frequency of Use	Daily	48
	Weekly	32
	Occasionally	20
Purpose of Travel	Work	45
	Education	30
	Personal	25
Awareness of CNG	High	60
	Moderate	28
	Low	12

Discussion

The results show that around 50 % of the respondents commute on CNG autos on a daily basis. Most of them (45%) use them for work related travel. It is found that the level of awareness on CNG among the respondents is relatively high which reveals that information about CNG as alternative fuel has been spread successfully. This routine usage highlights the CNG autos as part of regular mobility and this underlines their role in the sustainable transport systems.

Table 3: Economic Impact of CNG Autos

Variable	Category	Percentage (%)
Perceived Cost Saving	High	52
	Moderate	34
	Low	14
Fare Affordability	Affordable	58
	Neutral	27
	Expensive	15
Driver Income Stability	Improved	49
	No Change	33
	Declined	18

Discussion

Most of respondents recognise CNG autos as the cost-effective, endorsing their economic benefits over conventional fuel-based autos. The perception of affordability supports the statement that CNG contributes to reduced transportation costs. Moreover, nearly 50% of the respondents believe that drivers' income has improved, signifies the positive economic implications for CNG service providers or operators.

Table 4: Satisfaction Level with CNG Auto Services

Variable	Category	Percentage (%)
Overall Satisfaction	High	46
	Moderate	38
	Low	16
Comfort Level	Good	50
	Average	32
	Poor	18
Availability	Adequate	44
	Moderate	36
	Inadequate	20

Discussion

Commuters satisfaction is largely favourable, with a bulk of them reporting moderate to high satisfaction levels. Comfort levels are perceived positively, even if some respondents indicate concerns regarding availability. This implies that while service quality is fairly acceptable, infrastructural expansion is needed to improve accessibility and meet increasing demand of the commuters.

Table 5: Environmental and Overall Perception of CNG Autos

Variable	Category	Percentage (%)
Environmental Friendliness	High	62
	Moderate	25
	Low	13
Preference over Petrol/Diesel	Yes	55
	No	20
	Indifferent	25
Future Adoption	Likely	58
	Uncertain	27
	Unlikely	15

Discussion

Environmental awareness is remarkably high, with majority of respondents recognising CNG automobiles as an eco-friendly alternative. A majority also prefer CNG autos over conventionally fuelled vehicles, revealing a shift towards sustainable consumption and commutation behaviour. The strong disposition toward future adoption suggests growth potential for CNG-based transport systems, provided infrastructural and policy support is strengthened.

4.2 Hypotheses Testing

This research examines the socio-economic profile, usage behaviour, economic impact, satisfaction level, and perception towards CNG auto services. Both the descriptive and inferential statistical tools were employed to derive meaningful insights. There are five important hypotheses set for this study. They are:

H1: *The income level of people and usage frequency of CNG autos are associated*

H2: *The awareness level on CNG affects CNG auto usage behaviour*

H3: *The cost perception has significant effect on the overall CNG auto usage behaviour*

H4: *The service attributes significantly influence the CNG auto user satisfaction*

H5: *The environmental perception and future adoption intention of CNG autos are associated*

4.2.1. Socio-Economic Characteristics and Usage Behaviour

In order to examine the association between the socio-economic factor (income level) and frequency of CNG auto usage, a Chi-square test was applied in the study.

Table 6: Association between Income Level and Usage Frequency

Income Level	Daily (%)	Weekly (%)	Occasional (%)	Total
Below ₹20,000	55	30	15	100
₹20,000–₹40,000	48	34	18	100
Above ₹40,000	32	40	28	100

Chi-square value (χ^2) = 12.64, $p < 0.05$

Discussion

The Chi-square test result reveals that there is a statistically significant association between income level of respondents and frequency of CNG auto usage. Lower-income population tend to use CNG autos more frequently on a day-to-day basis, reflecting their dependence on affordable and cost effective public transport modes. Higher-income respondents show relatively lower daily usage, possibly due to access to privately owned vehicles. This result highlights the role of CNG autos as an economically inclusive mode of transport.

4.2.2. Awareness and Usage Relationship

For assessing whether awareness level influences usage behaviour, correlation analysis was used.

Table 7: Correlation between Awareness and Frequency of Use

Variables	Correlation Coefficient (r)
Awareness & Frequency of Use	0.62

Significance: $p < 0.01$

Discussion

The positive and statistically significant correlation between the variables ($r = 0.62$) hints that a strong relationship between awareness and usage of CNG auto services. Higher awareness levels are associated with increased frequency of CNG usages. This suggests that the information dissemination and awareness campaigns among the people can play a vital role in promoting CNG adoption among commuters.

4.2.3 Economic Impact Analysis

A regression analysis was carried out to examine the effect of cost perception on overall usage of CNG autos.

Table 8: Regression Results – Impact of Cost Savings on Usage

Variable	Beta Coefficient (β)	t-value	Significance
Perceived Cost Saving	0.58	6.12	$p < 0.01$

$R^2 = 0.34$

Discussion

The regression results reveals that perceived cost savings have a significant positive impact on usage of CNG auto services ($\beta = 0.58$, $p < 0.01$). The model explains that 34% of the variation in the usage behaviour, suggesting that the economic considerations are a major factor. This aligns with earlier descriptive findings where affordability emerged as a important factor influencing CNG adoption.

4.2.4. Satisfaction and Service Quality

For evaluating whether the service attributes affects overall satisfaction, another regression model was carried out.

Table 9: Regression Results – Service Factors and Satisfaction

Variable	Beta (β)	t-value	Significance
Comfort	0.41	4.85	$p < 0.01$
Availability	0.36	4.12	$p < 0.01$

$R^2 = 0.47$

Discussion

Comfort and availability are playing a very important role in customer satisfaction. The influence of comfort factor is a little more significant (β = 0.41) than availability (β = 0.36). The model predicts 47% of the satisfaction variance, which means that improved dimensions of service quality are essential in creating user experience. The overall satisfaction is positive, and the availability should be increased to further improve service effectiveness.

4.2.5 Environmental Awareness and Future Adoption

A Chi-square test was used to test the degree of association between environmental perception and future adoption intention.

Table 10: Environmental Perception and Future Adoption

Environmental Awareness	Likely (%)	Uncertain (%)	Unlikely (%)	Total
High	70	20	10	100
Moderate	52	30	18	100
Low	30	40	30	100

Chi-square value (χ^2) = 15.27, $p < 0.01$

Discussion

The test result reveals that there is a strong correlation between the environmental consciousness and future intentions to purchase and use CNG autos. The respondents who have greater awareness of the environment will more likely adopt CNG based transport in future. This emphasises the significance of sustainability awareness in shaping consumer behaviour and policy efforts that lead to transportation that is environmentally friendly.

Table 11: Hypotheses Test summary

H. No	Description	Results
1	The income level of people and usage frequency of CNG autos are associated	Accepted
2	The awareness level on CNG affects CNG auto usage behaviour	Accepted
3	The cost perception has significant effect on the overall CNG auto usage behaviour	Accepted
4	The service attributes significantly influence the CNG auto user satisfaction	Accepted
5	The environmental perception and future adoption intention of CNG autos are associated	Accepted

4.3 Overall Insights

The findings of this study indicate that CNG auto services are adopted by the virtue that they are affordable, environment-friendly, and have moderate service quality. The result of inferential analysis confirmed that income level, awareness level, cost perception and service quality attributes have significant impacts on usage behaviour and satisfaction. This study shows that:

- Economic factors are the most powerful force of adoption.
- Users 'awareness on CNG enhances usage intensity.
- Service quality impacts level of CNG Users 'satisfaction.
- Environmental consciousness will be a driver to future adoption.

In structural constraints, especially limited availability remains a concern. However, with stronger policy support, improved distribution channels, and better awareness programs, the uptake and adoption of CNG auto services and usages can be significantly improved.

5 CONCLUSION AND IMPLICATIONS

The study concluded that the CNG auto services have become a feasible, cost-effective and an environmentally friendly means of transport especially among the semi-urban commuters. The results reveals that socio-economic dimensions, especially income level, have a profound bearing on the usage frequency with the less affluent groups having to depend more on CNG autos to get to their daily commutation. The perception of cost saving and level of awareness were used as significant factors that influence the CNG auto adoption and service quality dimension like comfort and availability are important factors that influence customer satisfaction. The statistical analysis also supports the findings that the perception of cost savings and awareness has a positive impact on the usage behaviour, and the level of service quality affects the level of satisfaction significantly. Also, environmental awareness was identified to be a significant predictor of intentions to adopt in the future, which suggests that

users have a gradual transition towards sustainable consumption behaviour.

Implication of the Study:

Practically speaking, there are some significant implications of the study. The findings suggest to policy makers the importance of enhancing infrastructure support such as development of CNG refuelling stations and better regulatory frameworks to facilitate increased adoption. In the case of service providers and auto operators, quality service provision and increased availability can serve to increase customer satisfaction and retention. Adoption can also be accelerated through awareness campaigns which focus on both the economic and environmental positive effects. In addition, the paper highlights the need to incorporate sustainability and affordability in the urban transport planning. Encouraging transport systems based on CNGs can help to reduce carbon emissions and make transport accessible to economically diverse populations. All in all, the study offers useful findings to develop effective, environmentally-friendly, and user-friendly transport solutions in semi-urban settings.

Ethical Approval and Consent

Before collecting any data, the institutional ethics committee gave its approval. Participants were told about the reason for the study, its boundaries, and that they could take part willingly. Consent was given by the participants in every case, whether it was written or spoken. Data were protected by anonymity and confidentiality, and they were kept safe in line with the university's data policies.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

Competing Interests: Authors have declared that no competing interests exist.

Authors' Contributions: This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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