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Awareness-Related Perceptions and Adoption of Green Energy Transportation in Tanzania: Implications for Perceived Climate-Change Benefits

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Abstract

This study examines how awareness-related perceptions influence the adoption of green energy transportation in Tanzania and how adoption relates to perceived climate-change benefits. Drawing on the Norm Activation Model, Value–Belief–Norm theory, and the Theory of Planned Behaviour, the study tested seven hypotheses linking perceived ease of access, perceived cost, adoption of green energy transportation, and perceived climate-change benefits. Data were collected through a cross-sectional survey of 200 natural-gas vehicle users at CNG refueling stations in Dar es Salaam. The data were analysed using partial least squares structural equation modelling. The findings show that perceived ease of access significantly enhances adoption of green energy transportation, whereas perceived cost has no significant effect. Adoption significantly improves perceived climate-change benefits. Mediation analysis further reveals that adoption fully mediates the relationship between perceived ease of access and perceived climate-change benefits, while the indirect effect of perceived cost through adoption is insignificant. The study contributes to behavioural and green logistics literature by demonstrating that infrastructure accessibility, rather than cost perception, is a key driver of green transport adoption in an emerging economy context. The findings suggest that policymakers should expand CNG refueling and vehicle conversion infrastructure, strengthen technical service capacity, and design public awareness programmes that link green transport adoption to climate-change mitigation benefits.

Keywords: Ease of access, perceived cost, green energy transportation, climate change benefits

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Introduction

Addressing the environmental impacts of transport and logistics has become a global sustainability concern. The logistics sector plays a crucial role in economic development, yet it is also associated with high energy consumption, resource use, and greenhouse gas emissions, making it a major target of environmental regulation and sustainable development initiatives (Aldakhil et al., 2018; Centobelli et al., 2017, 2020; Ibrahim et al., 2019; Khan, 2019). In Tanzania, the rapid growth of road transport and freight movement has intensified concerns about pollution, fossil-fuel dependence, and the need for environmentally friendly transport alternatives. Although green logistics practices are increasingly promoted at organizational and policy levels (Bratt et al., 2021), their long-term success depends not only on firm-level initiatives but also on public acceptance and adoption of cleaner transport technologies, including natural gas vehicles (NGVs). Using the concepts of sustainability theory and behavioral theory, the present research focuses on investigating the role that the perceived ease of access and cost play on the adoption of green energy transportation

Green logistics requires coordinated action among business organizations, transport users, and public institutions. The practice of green logistics at an organizational level has the potential to decrease the impact of activities on the environment, enhance economic efficiency and help in achieving a circular economy (Aldakhil et al., 2018). Both environmental sustainability and economic sustainability depend on the implementation of green logistics in the logistics process (Yu et al., 2018). Research done by Karaman et al. (2020) and Seroka-Stolka and Ociepa-Kubicka (2019) reveals that green logistics is beneficial for the circular economy goals as well as economic development of countries through green packaging, transport, storage, and processing practices. Logistics sustainability practices in Africa also incorporate port sustainability and digitization efforts associated with Sustainable Development Goals where social and organizational dimensions are not highlighted yet (Almeida & Okon, 2025). Thus, it becomes apparent that green logistics has transformed from a firm-level approach to a system-level approach due to its link with energy consumption and carbon emissions.

Tanzania's transition toward sustainable transport is particularly important because the transport sector is a major consumer of energy and a significant contributor to emissions. As of 2022, the share of energy consumption in the country due to transportation was 12.2%, with 59% of CO_2 emissions being produced because of fuel combustion (NBS, 2024). Currently, natural gas already takes a significant part in generating electricity at the national energy level. There is a consistent pattern showing that greening the logistic processes leads to positive environmental and financial results in all areas including transport, storage, and packaging (Evangelista et al., 2018; Ibrahim et al., 2019; Khan, 2019). However, previous research has mainly centered on manufacturing enterprises while neglecting to consider the adoption of new environmentally-friendly technologies among the general public (Centobelli et al., 2020; El Baz & Laguir, 2017; Pålsson & Kovács, 2014; Richnák & Gubová, 2021; Sureeyatanapas et al., 2018;

Vienažindienė et al., 2021). Thus, ensuring that public opinion matches the strategies of encouraging NGV usage becomes crucial.

While organizations may be able to minimize environmental impacts via green logistics practices, ultimately success will hinge on the implementation of green energy vehicles among end users. Most empirical research concerning NGVs is drawn from advanced countries like China and Europe, where fleet size and the capacity for policy evaluation have facilitated thorough analysis (EPRS, 2021; Pan et al., 2020). Meanwhile, developments in sub-Saharan Africa are hampered by poor infrastructure, lack of finance, and sociocultural constraints (Agyekum et al., 2023). Given these disparities in existing literature, there is a need for further exploration of public awareness components.

There is a need to analyze public knowledge about the concept of green logistics in Tanzania considering the critical importance of Tanzania as a logistics center in Eastern and Central Africa. Tanzania is surrounded by many big lakes and contains two international transport corridors in its territory. It acts as a transport gateway between regions and plays an important role in the trading process that connects east-west and north-south economies. The transport sector accounts for more than 8.1% of GDP in Tanzania; thus, the government continues to invest in the development of infrastructure. However, growth in cargo volume results in higher levels of pollution and waste production.

Globally, the adoption of natural gas vehicles has expanded most rapidly in countries where supportive infrastructure, policy incentives, and market readiness are in place. For example, over the period between 2000 and 2017, China has increased its NGV stock from an estimated 6,000 to more than 6.08 million, which made it possible for scientists to conduct various analyses in this domain (Pan et al., 2020). EU member countries have also regularly monitored alternative fuel infrastructure and NGV diffusion, considering that NGVs constitute an advanced but unevenly distributed technology (EPRS, 2021). At the same time, sub-Saharan African countries still experience challenges in terms of infrastructure, funding, and socio-cultural obstacles (Agyekum et al., 2023). In Tanzania, increasing urbanization and population density led to a higher number of vehicles, resulting in elevated levels of fossil fuel use and greenhouse gases emissions (Urio & Mwakyusa, 2022). Transport sector is responsible for more than one-quarter of global CO_2 emissions, hence, there is a need for more environmentally friendly transport solutions (IEA, 2021). Natural gas constitutes a transitional fuel due to its carbon content and lesser pollution.

The studies done at the municipality level, for instance, in Dar es Salaam, highlight lack of refueling infrastructure, safety issues, and high conversion costs as major barriers to adoption (Mbwette & Tesfaye, 2025). While the perception studies indicate that there is some level of awareness among the affected population, it does not provide information on why people adopt or perceive environmental benefits (Tinali, 2021). With all the natural gas available in Tanzania, favorable policies (URT, 2013), and piloting of NGVs in Dar es Salaam and Mtwara regions, NGVs have been slow to adopt due to several factors.

The gender dimension adds another layer to transport transition challenges, as women's mobility continues to be constrained by available resources and existing societal norms (Mulongo, Porter & Tewodros, 2019/2020). Further, no Tanzanian study has used theory-based structural modeling to analyze the behavior drivers of NGVs' adoption or the possibility that adoption may mediate the link between infrastructure and climate change benefits of adoption (Dimoso, 2025). Most other studies have focused on technical viability, infrastructure challenges, or adoption rates but not behavioral factors leading to adoption (Kinyami, 2024). This study builds on previous research using PLS-SEM and mediation models (Tinali, 2021; Singogo, 2021) and uses the green energy and sustainable transport literature combined with adoption literature to provide insights into clean mobility transitions in Sub-Saharan Africa.

Theoretical Frameworks

The psychological theory that explains green energy transportation acceptance is referred to as Norm Activation Model (NAM). According to Schwartz (1977), NAM is composed of three aspects of the individual which explain his pro-environmental behavior: awareness of consequence (AC), ascription of responsibility (AR), and personal norms (PN). The factors Perceived Ease of Access and Perceived Cost do not fall under the NAM model. Nevertheless, they work as facilitators of behavior. In this study, NGV adoption is viewed as a behavior resulting from activated personal norms and positive perception of environmental impact.

The study is also informed by the Value-Belief-Norm Theory of Environmentalism put forth by Stern et al. (1999). Whereas NAM focuses on moral obligations through consequence recognition and acceptance of responsibility, VBN expands on the theory by including values and environmental beliefs that affect the formulation of norms and actions. In this case, Perceived Ease of Access and Perceived Cost become contextual influences that help realize or hinder the realization of environmental norms, while Perceived Implications on Climate Change Benefits (PICB) can be regarded as environmental beliefs that may support the environmental norms.

Notwithstanding its strong points, NAM and VBN have weaknesses in situations where behavior is largely shaped by perceived feasibility and control. The TPB (Ajzen, 1991), which augments the conceptual framework, clarifies the issue of behavioral intention in terms of attitudes, subjective norms, and perceived behavioral control (PBC), which reflect people's perceptions regarding availability of resources and opportunities. A recent TPB extension employing partial least squares structural equation

modeling (PLS-SEM) shows that both PBC and subjective norms are key elements in adopting low-carbon vehicles, where adoption is constrained by the sensitivity of prices and the enabling environment (Buhmann, Rialp Criado & Rialp Criado, 2024). In SSA, practical considerations have a significant impact on adoption intentions. Hence, facilitating conditions can be viewed as a theoretical manifestation of PBC. Indeed, evidence generated through the adoption intentions study in multiple countries in SSA has shown that facilitating conditions have a more pronounced impact than some other factors considered in the study, indicating that infrastructure and other enabling resources are vital in developing economies (Ajao et al., 2025). Hence, Perceived Ease of Access and Perceived Cost can be defined as awareness-related control beliefs regarding NGV feasibility, whereas NAM and VBN can help explain how adoption affects climate benefits beliefs.

Empirical Literature Review and Hypotheses Development

Ease of Access and Adoption of Green Energy Transportation

Ease of access to alternative fuel infrastructures, e.g., natural gas refueling stations, is deemed one of the most critical factors that affect the adoption of green transport services. Zhang et al. (2014) assert that the lack of infrastructure ranks as one of the major factors that affect the adoption of natural gas-powered vehicles, particularly across developing economies. Presumably, this also influences users' accessibility and the reliability of alternative access travel options. Its importance was noted by Rezvani et al. (2015). Literature suggests that the existing infrastructure of green fuels significantly influences users' adoption decisions (Yeh et al., 2017). Likewise, due to the lack of infrastructure for compressed natural gas stations across developing economies such as Tanzania and the fact that existing ones are mainly located in key urban areas like Dar es Salaam, this hampers the high adoption of green transport services (Gerutu et al., 2023). Thus, given that adoption of green energy transportation can be backed up with the theory of planned behaviour and ease of access with the norm activation model and value-belief, it is hypothesized that:

Hypothesis one (H1): Ease of access to green energy infrastructures enhances the adoption of green energy transportation.

Perceived Cost and Adoption of Green Energy Transportation

The cost difference between different types of fuels plays an important role in shaping the behavioral intentions of consumers who switch from traditional gasoline-based fuels to greener alternatives such as CNG, LPG, and solar power, among others. Moreover, different studies have explained that cost-saving potential has remained the strongest behavioral driver, especially in low- and middle-income countries, as noted by Breetz et al. (2018). However, it has been noted that users may not be motivated as they will have to pay an additional amount for vehicle conversion and will not receive any subsidies from the government, as noted by Yeh et al. (2017). Moreover, users of CNG in Tanzania are not motivated due to the cost of vehicle conversion and lack of facilities for maintenance, as noted by Mbwambo et al. (2020). Hence, given that adoption of green energy transportation can be backed up with the theory of planned behaviour and perceived cost with norm activation model and value belief, it can be stated that cost has both economic and psychological implications on behavioral intentions, and therefore it can be safely stated that:

Hypothesis two (H2): The perceived cost of green energy infrastructures lessens adoption of green energy transportation.

Adoption of Green Energy Transportation and Perceived Implications on Climate Change Benefits

Transport sustainability in Tanzania can be observed with reference to urban systems and infrastructural interventions. For instance, an empirical analysis of the Dar-es-Salaam BRT system has revealed its climate change mitigation potential with regard to lower fuel use compared to other modes and thereby confirms the overall policy logic that transport interventions can contribute to climate change benefits in fast-growing cities in developing countries (Helberth & Kimambo, 2021). Other research on transport sustainability in Tanzania has focused on the required integrative aspect so that optimal economic benefits can be secured for the country (Mchome & Nzoya, 2023). Awareness, referring to climate change-related concerns such as rising temperatures, irregular rainfall, and pollution in Tanzania, represents the dependent variable in the model proposed. Climate-related awareness refers to individuals' perception of the relationship between personal transport-related actions and environmental degradation in the local area (Nordlund & Garvill, 2003). This awareness is perhaps most necessary in the sub-Saharan region of Africa, where climate change impacts seem to be manifesting themselves, but awareness of them is still disjointed (Mogaka et al., 2006). Research suggests that actual experiences with climate change enhance pro-environmental attitudes and inspire behavioral change when combined with access and affordability (Clayton et al., 2015). The Theory of Planned Behaviour asserts that a certain behaviour tends to predict outcomes, thus hypothesis three (H3) is proposed as follows.

Hypothesis three (H3): Adoption of green energy transportation enhances perceived implications on climate change benefits.

Ease of Access, Cost Perception, Adoption of Green Energy Transportation, and Perceived Implications on Climate Change Benefits

Human nature: This bridges between infrastructure/economic issues and more general concerns about environmental issues. Where green transportation adoption is concerned in particular, it has become a key way in which people develop a greater awareness and sensitivity to the environmental implications of their actions (Fujii & Gärling, 2003). In this case, visibility and modeling effects also feature (Abouelela et al., 2021). Various models have attempted to address the concept of mediating effects of behavioral adoption, especially regarding sustainable behaviors. A key case has been models such as the Technology Acceptance Model (TAM) and its variants, which often consider behavioral components as a mediating element between perceptions and outcomes (Davis, 1989; Venkatesh et al., 2003). It is wealth enough to check what happens when the norm activation model and value belief norm theory are integrated with the theory of planned behaviour. Thus, it is hypothesized that:

Hypothesis four (H4): Adoption of green energy transportation mediates the association between ease of access to green energy infrastructures and perceived implications on climate change benefits.

Hypothesis five (H5): Adoption of green energy transportation mediates the association between perceived cost of green energy infrastructures and perceived implications on climate change benefits.

Hypothesis six (H6): Ease of access to green energy infrastructures enhances perceived implications on climate change benefits.

Hypothesis seven (H7): The perceived cost of green energy infrastructures lessens perceived implications on climate change benefits.

Based on the theoretical arguments and hypotheses developed above, Figure 1 presents the conceptual model linking ease of access and perceived cost to adoption of green energy transportation and perceived climate-change benefits.

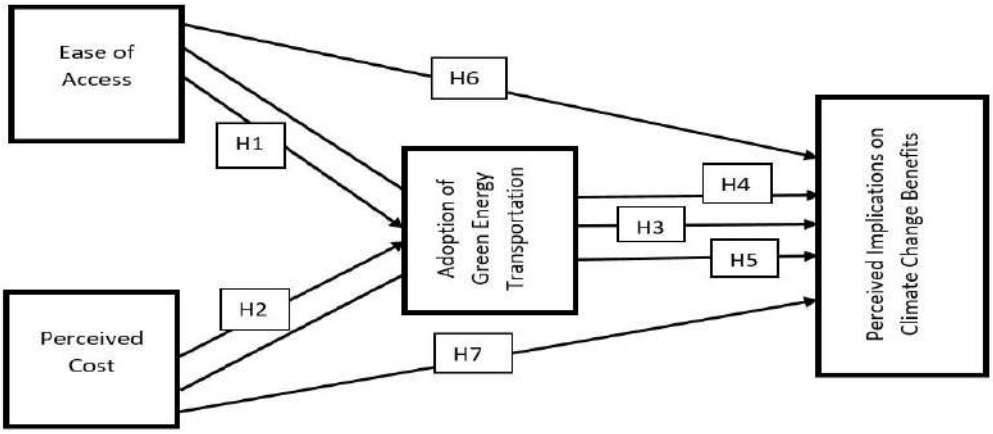


Figure 1: *Conceptual model of the study*
Source: Synthesized from literature

Methodology

The current study utilized a quantitative approach for a cross-sectional survey design to establish the link that exists between ease of access, cost perception, adoption of green transport, and the implications for benefits of climate change and natural gas vehicle usage in Tanzania. A hypothesis-driven approach guided by a conceptual framework was adopted, and the data were analyzed using Partial Least Square Structural Equation Modeling (PLS-SEM). The target respondents were drivers of natural-gas-powered vehicles who visited CNG refueling stations in Dar es Salaam during May 2025. Because a comprehensive sampling frame of NGV users was not available, the study used a station-based intercept approach. A total of 240 drivers were approached, and 200 completed questionnaires were returned, representing a response rate of 83.3%. The respondents included both public transport and private vehicle drivers. The study used a structured questionnaire consisting of validated items adapted from prior green adoption research (e.g., (Ajzen, 1991; Davis, 1989; Venkatesh et al., 2003). All constructs were measured using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire was translated also in the local language (Kiswahili) for easy understanding of the tool to some respondents who are less conversant with English. Descriptive statistics were analyzed using SPSS, while hypothesis testing and model evaluation were performed using SmartPLS. The reliability and validity of the constructs were assessed using Composite Reliability (CR), and Average Variance Extracted (AVE). Discriminant validity was verified through the Heterotrait–Monotrait Ratio (HTMT). Structural model analysis included the examination of path coefficients, R^2 values, effect sizes (f^2), and mediation effects.

Model fit was evaluated using established PLS fit indices.

Respondents' characteristics

The research used a sample of 200 people, and from Table 1, it is noted that most were males (53%) followed by females (47%), and their age range fell between 25-34 years (60.0%), followed by those between 35-44 years (25.0%). In terms of level of education, most survey participants were noted to have undertaken secondary education (59.0%), followed by primary education (31.5%). The research participants showed increased levels of exposure to vehicles using gasoline (65.5%), as well as those using alternative fuel (50.0%). Moreover, when asked what their main reasons for using non-gasoline means of transportation were, the majority cited the ease of access of refiling stations (30.0%) as their main driving concern followed by environmental concerns (22.5%) and then by peer/community influence and better vehicle performance (16.5%). However, lowest cost (7.5%), company/employer requirements (2.0%) and government policy incentives (1.5%) were only a small fraction of the population. These findings by the different demographics of the population underscore the fact that economic benefits play a large part in the driving forces behind the adoption of green transport in Tanzania.

Table 1: Respondents' profiles (n=200)

Demographic Characteristics	Category	Count	Percent
Gasoline-powered driving experience	No experience	32	16.0
	Some experience	6	3.0
	Moderate experience	31	15.5
	Extensive experience	131	65.5
Non-gasoline powered driving experience	No experience	1	0.5
	Some experience	17	8.5
	Moderate experience	82	41.0
	Extensive experience	100	50.0
Gender	Male	106	53
	Female	94	47
Age	<25	19	9.5
	25-34	120	60.0
	35-44	50	25.0
	45-54	9	4.5
	>54	2	1.0
Education level	No formal education	3	1.5
	Primary education	63	31.5
	Secondary education	118	59.0
	Diploma/certificate	9	4.5
	Bachelor's degree	3	1.5
	Master's degree	4	2.0
Reasons for opting non-gasoline transportation	Ease of access to refilling	60	30.0
	Environmental concerns	45	22.5
	Lowest cost	15	7.5
	Better vehicle performance	33	16.5
	Peer/community influence	40	20.0
	Government incentives/policy	3	1.5
	Company/employer requirements	4	2.0

Source: Field data (2025)

Assessment of the measurement model

The measurement model, as depicted in Figure 2, was assessed to establish the reliability and validity of the latent constructs: Ease of Access (EoA), Perceived Cost (PC), Adoption of Green Energy Transportation (AGET), and Perceived Implications on Climate Change Benefits (PICB). Indicator loadings, path coefficients, and explained variance (R^2) were analyzed to ensure the constructs met acceptable measurement standards within a Partial Least Squares Structural Equation Modeling (PLS-SEM) framework (Hair et al., 2019). According to Hair et al. (2019), indicators with loadings below 0.70 may be candidates for removal, particularly when overall construct reliability is compromised, hence

some of the indicators were removed. Within the perceived cost and ease of access constructs, one indicator in each i.e., PC4 (0.687) and EoA5 (0.668), fell below the recommended threshold.

However, the loadings for PC4 and EoA5 are marginally acceptable in exploratory research as they tend to exceed the recommended threshold of 0.60 for exploratory research, and they indicate acceptable convergent validity (Hair et al., 2019). Thus, all retained indicators for each construct had satisfactory loadings as per Hair et al. (2019). Existing variation suggests no potential issues with internal consistency and indicates that there is no need for further refinement or re-specification of the measurement items (Sarstedt et al., 2022). AGET showed robust item loadings ranging from 0.722 to 0.883, and PICB indicators loaded between 0.735 and 0.745, both reflecting strong construct reliability and representation. The measurement model exhibited satisfactory psychometric properties. All constructs showed strong internal consistency and convergent validity. These results reinforce the theoretical proposition that perceived accessibility and behavioral engagement are critical antecedents to sustainable transport behavior in emerging contexts like Tanzania.

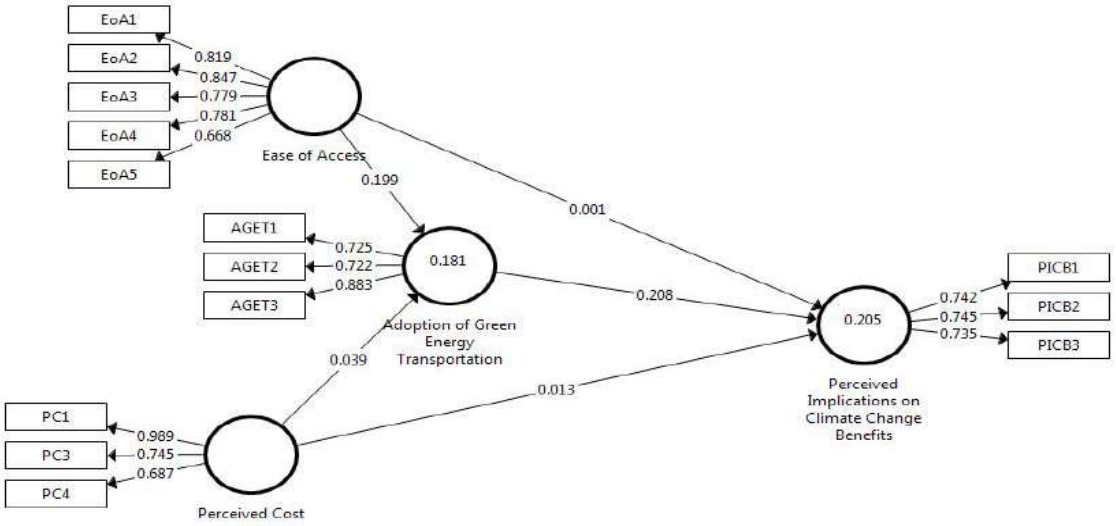


Figure 2: *Algorithm results of the study for assessing measures of constructs*
Source: Field data (2025)

Reliability, Validity, and Common Method Bias Assessment

The study performed a series of analyses to test for the reliability and validity of the construct. The study tested the reliability and validity of the construct following Sarstedt et al. (2022). This study used composite reliability to check for internal consistency, as it is the most preferred under PLS-SEM. Generally, when assessing reliability, a value greater or equal to 0.7 indicates the existence of internal consistency, with composite reliability, a value which is more than 0.95 is not desired (Hair, Hollingsworth, Randolph, & Chong, 2017). For this study, as shown in Table 2, all values for the composite reliability were more significant than 0.7, thus indicating internal consistency in the underlying constructs. Also, convergent validity was examined by observing the resulting value of the average variance extracted (AVE). The average variance extracted has been defined as the average value of the squared loadings of the indicators associated with the construct (Hair et al., 2017). In the study, all values of AVE were above the threshold of 0.5.

Table 2: Reliability test (n=200)

Construct	Item	Loading[a]	CR[b]	AVE[c]
Ease of Access	EoA1	.819	.886	.610
	EoA2	.847		
	EoA3	.779		
	EoA4	.781		
	EoA5	.668		
Perceived Cost	PC1	.989	.855	.668
	PC3	.745		
	PC4	.687		
Adoption of Green Energy Transportation	AGET1	.725	.822	.609
	AGET2	.722		
	AGET3	.883		

Perceived Implications on Climate Change Benefits	PICB1	.742	.785	.548
	PICB2	.745		
	PICB3	.735		

Source: Field data (2025)

Again, the discriminant validity as the differentiating indicator of the model constructs was assessed. According to Sarstedt et al. (2022), discriminant validity is present where the value of its cross-loading in the latent variable is higher than in any other construct. Because of its most likelihood of detecting discriminant validity, the Heterotrait-Monotrait ratio (HTMT) of correlations (Sarstedt et al., 2022). was used in this study. Findings revealed discriminant validity since all indicators had HTMT values below 0.85, as evidenced in Table 3.

Table 3: Discriminant validity with HTMT ratios (n=200)

1	Adoption of Green Energy Transportation	1	2	3	4
2	Ease of Access	.514			
3	Perceived Cost	.129	.119		
4	Perceived Implications of Climate Change Benefits	.666	.355	.176	

Source: Field data (2025)

The study assessed the presence of common method bias based on Harman's single-factor test through principal component analysis under the condition of an unrotated single construct. The results indicated that the largest factor explained 27.52% of total variance, which is below the 50% threshold and suggests limited common method bias

Structural Model Analysis

The structural model was evaluated using the coefficient of determination (R^2), adjusted R^2, and Stone-Geisser's Q^2 values to assess its explanatory and predictive power (see Table 4). The results indicate that the model explains 18.9% ($R^2 = 0.189$) of the variance in the adoption of green energy transportation, and 21.7% ($R^2 = 0.217$) in the perceived implications on climate change benefits. The adjusted R^2 values of 0.181 and 0.205, respectively, confirm the robustness of the model after accounting for the number of predictors. Although these values reflect a moderate level of predictive power, they are considered acceptable in the context of behavioral and environmental studies, particularly in emerging markets like Tanzania, where green transportation is still in early stages (Hair et al., 2019). Furthermore, the Q^2 values for both constructs—0.076 for adoption and 0.093 for perceived climate benefits—are above zero, indicating that the model has predictive relevance (Hair et al., 2019). Despite the relatively modest values, these findings suggest that the model has practical utility in understanding green energy transportation adoption behavior and its perceived environmental implications. This is consistent with previous studies in similar developing contexts, where adoption decisions are shaped by infrastructural, informational, and attitudinal barriers (Ajzen, 1991; Davis, 1989; Venkatesh et al., 2003).

Table 4: Model prediction (n=200)

Endogenous Latent Variable	R^2 Value	R^2 Adjusted	Q^2 Value
Adoption of Green Energy Transportation	.189	.181	.076
Perceived Implications on Climate Change Benefits	.217	.205	.093

Source: Field data (2025)

The hypothesis testing results in Table 5 reflect the conceptual framework informed by the NAM, the VBN theory, and TPB. Hypothesis 1 was supported with a positive effect of EoA on AGET being significant ($\beta = 0.402$, $t = 3.471$, $p < 0.01$). This implies that improving infrastructural-logistical access to the options of green transportation activates the individual's commitment to behavior in concurrence with the awareness of the consequences and the perceived ability to act as central constructs in NAM (Schwartz, 1977). In support, physical accessibility is of practical importance, as reflected by its moderate effect size ($f^2 = 0.199$), in supporting pro-environmental actions. Hypothesis 2 proposed a negative relationship between PC and AGET, which was unsupported with $\beta = –0.178$, $t = 0.628$, and $p > 0.10$. This suggests that, if anything, economic considerations are not as strong a driver of behavioral intentions as might have been assumed. Based on the VBN framework, one explanation could be that cost becomes relatively less important when values are highly important. Alternatively, perceived cost may exert a nonlinear influence or an indirect one, moderated by environmental values or by levels of awareness.

More importantly, Hypothesis 3 was supported: AGET and the Perceived Implications for Climate Change Benefits (PICB) proved to be positively related, at $\beta = 0.448$, $t = 3.624$, $p < 0.01$, implying that green transportation is reinforcing users' perception of the climate change-related benefits derived from

such transportation. While the effect size for H3 was moderate (f^2 = 0.208), the significance and confidence interval [0.223, 0.604] indicate a robust relationship. These findings align with the logic of behavioral spillover effects, as identified in the Norm Activation Model (Schwartz, 1977) and Value-Belief-Norm theory (Clayton et al., 2015), where engaging in pro-environmental behavior can activate stronger environmental concern and perceived responsibility. Notably, Hypothesis 6, which proposed a positive relationship between Ease of Access (EoA) and PICB, was not supported (β = –0.030, t = 0.162, p > 0.10). In the same vein, Hypothesis 7, which proposed a negative relationship between Perceived Cost (PC) and PICB, was not supported (β = –0.101, t = 0.978, p > 0.10).

To a great extent the findings align with reasons for opting non-gasoline energy as one of the demographic characteristics presented in Table 1. From Table 1, it can be noticed that reasons for opting non gasoline energy can be ranked in ascending order as follows: Ease of access to refilling (30%), environmental concerns (22.5%), peer/community influence (20%), better vehicle performance (16.5%), lowest cost (7.5%), company/employer requirements (2%) and government incentives/policy (1.5%). Ease of access, as demonstrated in the structural equation modeling, is significantly associated with the adoption of green energy transportation, aligning well with demographic features presented in Table 1. In the same vein, concern for the environment sounds like perceived implications on climate change benefits. Perceived cost, as reflected in the equation modelling, to have insignificant association with the adoption of green energy transportation, aligning well with demographic features by scoring 7.5%. Figure 3 visually summarizes the bootstrapping results, showing the significant and non-significant structural paths among the study constructs.

Table 5: Direct relationship for hypothesis testing (n=200)

Hypothesis	Relationship	β	Standard Error	t Value	f^2	95% Confidence Interval
H1	EoA->AGET	.402	.116	3.471***	.199	[.245;.621]
H2	PC->AGET	-.178	.283	.628	.039	[-.418;.510]
H3	AGET->PICB	.448	.124	3.624***	.208	[.223;.604]
H6	EoA->PICB	-.030	.182	.162	.001	[-.394;.219]
H7	PC->PICB	-.101	.104	.978	.013	[-.212;.127]

Notes: ***p < 0.01, two-tailed, # based on 5000 bootstrapping samples, effective size (f^2) measures the effect of the specific predictor on an endogenous construct (0.02 small, 0.15 medium, 0.35 large).
Source: Field data (2025

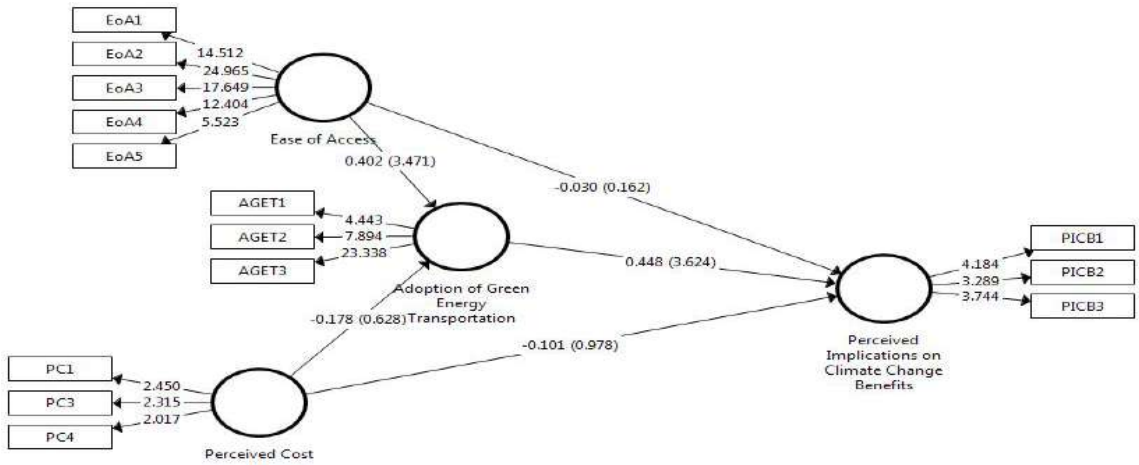


Figure 3: *Bootstrapping results (path coefficients with associated t-values in brackets) of the study*
Source: Field data (2025)

Mediation Analysis

The results in Table 6 reveal two key indirect relationships through the mediating variable, Adoption of Green Energy Transportation (AGET). Hypothesis H4, which states that EoA indirectly affects PICB through AGET, is significant with β = 0.180, t = 2.816, p < 0.01. Also, the 95% confidence interval [0.086, 0.284] does not contain zero, which further clears up that this mediation is meaningful. This indicates that ease of access plays a vital role in making adoption behavior easier for the respondents, which in turn enhances an individual's ability to get aware or recognize the environmental, green transport benefits. In other words, when more and more ease of access to green transportation is available to the people, they tend to adopt that, and then due to that practice or experience, they develop a better perception about its climate-related implications. On the other hand, Hypothesis H5, describing the conditional indirect effect of PC on PICB via AGET, proves to be insignificant with β = –0.080, t = 0.546, p>0.10. Furthermore, the confidence interval is [–0.208, 0.284], containing zero. This suggests that, in

turn, cost perception does not have a significant effect on climate benefit awareness by way of adoption. While it might conceivably be assumed that cost might factor into adoption decisions, it appears not to have a subsequent effect over broader-ranging environmental awareness and/or concerns—potentially by being a utilitarian motivation unrelated to environmental attitudes. These results correspond to the broader category of implications based on theoretical models that suggest that actual behavioral engagement with green transport, that is adoption acts as a cognitive bridge between environment-level enablers like access infrastructure and outcomes such as environmental perception. However, purely economic considerations such as cost do not appear to stimulate this broader reflection.

Table 6: Indirect relationships for hypothesis testing (n=200)

Hypothesis	Relationship	β	Standard Error	t-Value	95% Confidence Interval
H4	EoA>AGET->PICB	.180	.064	2.816***	[.086;.284]
H5	PC->AGET->PICB	-.080	.146	0.546	[-.208;.284]

***p < 0.01

Source: Field data (2025)

Discussions and Implications

The study examined the importance of dimensions of public awareness on the adoption of green energy transportation in Tanzania and the perceived implications for the benefits from climate change. The results indicate that perceived cost had no impact on the adoption of green energy practices in contrast to previous research that considers cost as a critical issue in sustainable technology adoption in underdeveloped countries (Khan, 2019). This could be explained by the fact that cost could be overshadowed by other dimensions such as convenience and accessibility. Increasing awareness of the impact of climate change could have made people more environmentally conscious and thus focus more on the benefits of using green technology rather than costs associated with it. The use of natural gas vehicles (NGVs) could have been more common and thus people would have considered efficiency and low-emissions as well as lower costs for maintenance more important than higher costs compared to gasoline. Finally, people may not have enough information about costs associated with NGVs and financial benefits of their adoption.

The data from the demographics support the fact that ease of access is critical in promoting green transportation. About 30% of the participants noted that they opted for green transport mainly because it was easy to access, which shows that building refueling stations and facilities can enhance the adoption of NGVs. Other determinants include environmental considerations (22.5%), peer/community influence (20.0%), and better vehicle performance (16.5%). On the other hand, low costs (7.5%), employer demands (2.0%), and incentives by the government/policies (1.5%) were cited much less, implying that the general public may not be aware of financial and environmental benefits of green transport. This means that education programs targeted at transport consumers who are educated at the most basic level should be prioritized so as to promote the benefits of sustainable transportation amidst climate change. From the demographics, it is also clear that men constitute the highest proportion of transport users since 53% of the respondents were males.

The results confirm the presence of a high degree of practical familiarity with green modes of transportation since 91% of respondents claimed to have previously used cars that did not run on gasoline. Consequently, lack of knowledge does not seem to be the main obstacle in adopting such technology, while availability of relevant infrastructure and environmental consciousness become the more significant determinants of adoption. As for the age structure of respondents, the majority of the participants were identified as belonging to the 25-44 age bracket, which represents an economically active part of society that benefits from adopting new forms of transport technology due to enhanced environmental conditions.

The considerable impact of perceived ease of accessibility validates the importance of infrastructural availability in fostering environmental transportation changes. In Tanzania, where there are very few compressed natural gas filling stations and conversions centers, it seems like the decision to embrace this environmentally friendly mode of transport hinges on whether it is feasible. Indeed, the outcome is in agreement with the Theory of Planned Behavior in the sense that perceived behavioral control plays a major role in technology adoption. Specifically, people are motivated to adopt environmentally friendly modes of transport if the necessary conditions for doing so are present.

Conversely, the lack of relationship between cost perception and adoption contradicts traditional expectations concerning economic constraints on the adoption of environmentally friendly technologies. First of all, since the survey was carried out among current owners of NGVs, it can be argued that these people have already covered costs associated with the first purchase of an environmentally friendly car, therefore, it is no longer a decisive factor for them. Second, previous operating experience with the use of this new technology could make people less sensitive to the costs associated with its adoption and more concerned about serviceability and accessibility. However, this result should be treated carefully since the survey was performed among current users of NGVs and does not reflect the situation with non-adopters of environmentally friendly vehicles.

Conclusion

The present study investigates the factors that influence the adoption of green transportation, in particular natural gas-powered vehicles, in the Tanzanian context. Based on conceptual underpinnings derived from the NAM, VBN Theory, and TPB, the research showed that ease of access to CNG infrastructure and services significantly influences both the adoption of green transportation and perceived implications on climate change benefits. However, cost perception, as indicated by most of the literature, was found not to be a significant predictor in this context. Surprisingly, it thus appears that accessibility may outweigh cost as a factor affecting decisions that pertain to sustainable transport. The mediating role of green transportation adoption was statistically significant, which points to the facilitation and promotion of actual behavioral adoption as being a crucial link between enabling factors, such as accessibility, and heightened environmental awareness or concern. These findings reinforce the importance of investing not only in infrastructure but also in behavioral change strategies that support long-term sustainability goals. The results also provide evidence that, although economic motivations, such as fuel savings, are presently the dominant drivers of non-gasoline transport uptake, environmental motivations and policy incentives remain underutilized. This suggests a pressing need for comprehensive public awareness campaigns and stronger institutional support to elevate environmental responsibility alongside economic considerations.

Limitations and Future Research

This study has some limitations. First, the data were collected from CNG refueling stations in Dar es Salaam, which may limit generalisation to other regions of Tanzania where CNG infrastructure is less developed. Second, the study focused mainly on existing users of natural-gas-powered vehicles; therefore, the findings may not fully capture the perceptions of non-users or potential adopters. Third, the cross-sectional design limits causal interpretation. Future studies could use longitudinal designs, include both users and non-users, and compare different cities or transport corridors. Further research may also examine moderating variables such as income, vehicle type, environmental values, gender, and policy awareness.

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